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Levingston

TECHNOLOGY TRANSFER PROGRAM (TTP)

FINAL REPORT

PLANNING & PRODUCTION CONTROL

PLANNING & PRODUCTION CONTROL
VOLUME 2 APPENDICES

Prepared by:

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in conjunction with:
IHI Marine Technology, Inc.

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FOREWORD

This document is Volume II of a two volume report on Planning & Production Control resulting from the Shipbuilding Technology Transfer Program performed by Livingston Shipbuilding Company under a cost-sharing contract with the U.S. Maritime Administration.

This volume contains Appendices comprising data provided to Livingston by Ishikawajima-Harima Heavy Industries (IHI of Japan) as source material for the studies performed on the Planning and Production Control functions in use in the IHI shipyards.

For information concerning the Technology Transfer Program and the findings and conclusions on the IHI Planning and Production Control system as developed by Livingston, refer to Volume I of this report.

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APPENDIX A

GLOSSARY OF TERMS

GLOSSARY OF TERMS

ACCURACY CONTROL - The IHI concept of maintaining the correctness of material at each step in the production process.

ADDED MATERIAL PLAN - A plan for leaving extra material on the sides of fabricated components, sub-assemblies or unit assemblies so that the fitting of these units can be precisely accomplished at the subsequent production stage.

ALLOCATION CONTROL - The department within the Hull Construction Workshop responsible for the planning, scheduling and operation of all cranes, transporters, and scaffolding.

ASSEMBLY JIG PLAN - A plan showing the requirements for construction of a jig for a curved unit panel.

ASSEMBLY JIG SETTING LIST - A computer-generated list for setting the height of the pins on a pin jig to accept a curved unit panel.

ASSEMBLY SPECIFICATION PLAN - A detailed diagram and instructions for the build-up of an individual unit assembly showing the methods to be used, the critical dimensions, and any special considerations in processing.

BASIC DESIGN - The preliminary ship design created by the IHI Head Office (Tokyo) for use in the sale of the ship and in fixing the general arrangements and the technical and performance specifications. The Basic Design consists generally of: unfaired ships lines, midship section, construction profile, general arrangement and machinery arrangement drawings.

BASIC PRODUCTION FLOW LIST - The basic plan of how to use the available facilities for the production of a given product.

BENDING PLAN - A plan showing the requirements for the bending of curved plates (i.e. both mechanical and flame bending).

BLOCK ARRANGEMENTS PLAN - A plan showing the arrangement of finished assembly units or blocks in the building basin prior to joining. This plan may also show the arrangement of finished blocks on the platen prior to their being landed in the basin.

BLOCK ASSEMBLY PLAN - The breakdown of each block or major assembly unit into its sub-assemblies and detail parts.

CUTTING PLAN - A plan showing the requirements for cutting of flat plates or panels and used by Mold Loft personnel for creation of N/C tapes for N/C burning machines.

DETAILED DESIGN - Working drawings are developed during this design stage. All hull structural detail information, block (or unit) arrangement, unit weights, weld lengths, center of gravity of units, piece lists and auxiliary foundation drawings are developed at this time. Other working level drawings include outfitting piece drawings, detail fabrication drawings, sub-assembly drawings, assembly drawings, Assembly Specification Plans and Detail Working Instructions Plans.

E.P.M. - Electro Photo Marking. A method of projecting a l/10th scale drawing onto the painted surface of a steel plate sufficient to enlarge the drawing full scale on the plate's surface. Marking is accomplished as the projected image exposes a photo sensitive powder on the plate causing the powder to adhere to the plate.

FABRICATION LANE PLAN - A plan showing the process lanes for the different types of sub-assemblies for flat panel or curved unit assemblies.

FIELD PLANS - A series of plans specifing work requirements during the erection stage (e.g. temporary holes in the hull for access to interior holds, ventilation requirements, etc.).

FUNCTIONAL DESIGN - The preliminary design of the ship systems performed by the shipyard design department. This design yields system diagrammatics, calculations of weights and strengths, rudder design, stern frame design, and outfitting key plans. Hull block planning is accomplished during this design stage.

GATE SYSTEM - An adaptation of the Process Lanes system where the term "Gate" is used to specify a particular sub-stage within a production stage.

HULL BLOCK - One or more Unit Assemblies comprising the hull component that will eventually be erected in the building basin.

HULL BLOCKING PLAN - The breakdown of the ship into its major assembly units.

INTERIM PRODUCT - A term applied to the finished unit assemblies prior to their incorporation into the ships hull.

LIFTING INSTRUCTIONS PLAN - A plan showing the placement of lifting pad eyes on a particular assembly unit together with instructions for making the lift.

MAJOR SHIP ZONES - The overall ship is usually divided into four Major Zones which are used for the categorization of the work according to the part of the ship being worked. The major zones are: the house, mid-ship (or hold), the stern and the bow.

MARKING PLAN - A plan showing the requirements for the marking of flat or curved plates. Used by Mold Loft personnel for the preparation of N/C tapes for the EPM machine or for marking tapes for checking base-lines and center lines of curved plates.

MASTER KEY EVENT SCHEDULE - A schedule showing only the start of fabrication, keel laying, launch and delivery of each ship in production in a given yard.

MATERIAL INFORMATION LIST - A listing of the component parts required to build-up a specific assembly unit.

MATERIAL REQUISITION SCHEDULE - A schedule showing the sequence of the ordering,of material.

MATERIAL ORDERING ZONE - A totally different organization of material than that reflected by the Major Ship Zones or Outfitting Zones. This organization is for the convenience of ordering outfitting material and usually comprises from four to seven zones depending on ship type. Generally, the Material Ordering Zones are: House, Main Deck, Holds and Engine Room.

MLC - Material List Components. A listing of outfitting components to be fabricated for a given ship.

MLF - Material List Fitting. A listing of the material required for the outfitting to be accomplished in a particular outfitting work zone.

MLP - Material List Pipe. A listing of the pipe required to be fabricated for a given ship.

MLS - Material List System. A listing of the component parts of a functional ship system taken from system diagrams and used for procurement of outfitting components.

OUTFITTING ZONE - A geographical area of the ship designated as an area suitable for composite outfitting. Outfitting zones may be portions of a deck or several decks, one or more compartments, portions of the engine room, etc., without regard to the functional systems combined in that area.

PALLET - A collection of material, information, and manpower required to perform a specific job (usually an outfitting job) within a particular work zone. Physical "pallets" (i.e. platforms) are used to accumulate the material needed for the job. Both design and production information supplement this material to form the IHI "pallet".

PROCESS LANES - The routes-established for the processing of the different types of unit assemblies (i.e. flat panel assembly or curved unit assembly). These' routes comprise the fabrication of individual steel components, the sub-assembly of the components and the assembly of other components and the sub-assemblies to form unit assemblies.

SCAFFOLDING ARRANGEMENTS PLAN - A plan showing the scaffolding requirements during the build-up of the ship in the building basin.

SHIPWRIGHT DIMENSIONS PLAN - A plan showing the methods of landing and securing the upright units (bulkhead or hold section side units) when landed in the building basin.

STAGE (PRODUCTION) - One of the several major construction steps in the production process. The production stages are: Mold Loft; Fabrication (which includes sub-assembly); Assembly; and Erection.

SUB-STAGE (PRODUCTION) - Individual steps in the processing of steel in each stage of production, such as: marking, cutting and bending in the fabrication stage.

SUPPORT BLOCK ARRANGEMENTS PLAN - A plan showing the dispersion of support blocks in the building basin prior to the landing of the unit assemblies.

UNIT ASSEMBLY - A steel component of the ship such as a side double bottom unit, which is a part of one ship section. Unit assemblies are the individual building blocks (or interim products) built-up through the welding of flat or curved panels to structural internal members. Determination of units is based on size, weight, area required for assembly and storage, and outfitting requirements.

UNIT INFORMATION LIST - A listing of the component parts required to build-up a specific assembly unit.

WELDING INSTRUCTIONS PLAN - A plan detailing the procedures for joining the various assembly units at erection.

WORK INSTRUCTION DESIGN - Drawings which detail the outfitting work to be accomplished within a specific outfitting work zone.

WORK INSTRUCTION PLANS - Detail plans for fabrication, assembly and erection of parts, pieces, sub-assemblies and assembly units. These plans also cover aspects of construction such as unit lifting and scaffolding arrangement, not covered by working drawings.

WORK ZONE - A term used to identify a particular area and package of work within an Outfitting Zone. Work zones are determined based on the extent of the work required and the time requirements.

APPENDIX B

EXAMPLE

PRODUCT-ORIENTED WORK BREAKDOWN STRUCTURE

FOR

HULL PRODUCTION IN IHI

IHI MARINE TECHNOLOGY, INC.

REFERENCE :

PRODUCT-ORIENTED WORK BREAKDOWN STRUCTURE FOR HULL PRODUCTION IN IHI:

1. Logic and Principle of Product-Oriented Work Breakdown Structure.

2. Work Package: Product Aspects

3. Product Resources

   1) Material

   2) Manpower

   3) Facilities and Expences

4. Accounting and Estimating Method of Production in Product-Oriented Work Breakdown Structure.

   1) Follow-Up of Process in Production.

   2) Evaluation of Efficiency in Production.

   3) Formulation of Transposition from Zone-Oriented Data to SYSTEM-Oriented Data.

IHI MARINE TECHNOLOGY, INC.

1. Logic and Principles of Production-Oriented Work Breakdown Structure for Shipbuding in IHI:

In Japan, during the last 30 years, the Shipbuilding process has been developed to higher and higher productivity in a production-oriented manner) being by the introduction of the advanced process:

Hull Block Construction and Zone Pre-Outfitting.

These advanced processes facilitate to progress rationalization and mechanization of the process in order to obtain higher efficiency, short production period, simultaneous activity running, and safety working conditions.

The significant differences between the conventional (System-by-System) and advanced (Zone-by-Zone) processes are shown in Figure 1 and 2.

Furthermore, an applicable concept of the product-oriented work breakdown structure about the IHI's logic and principles will be present.

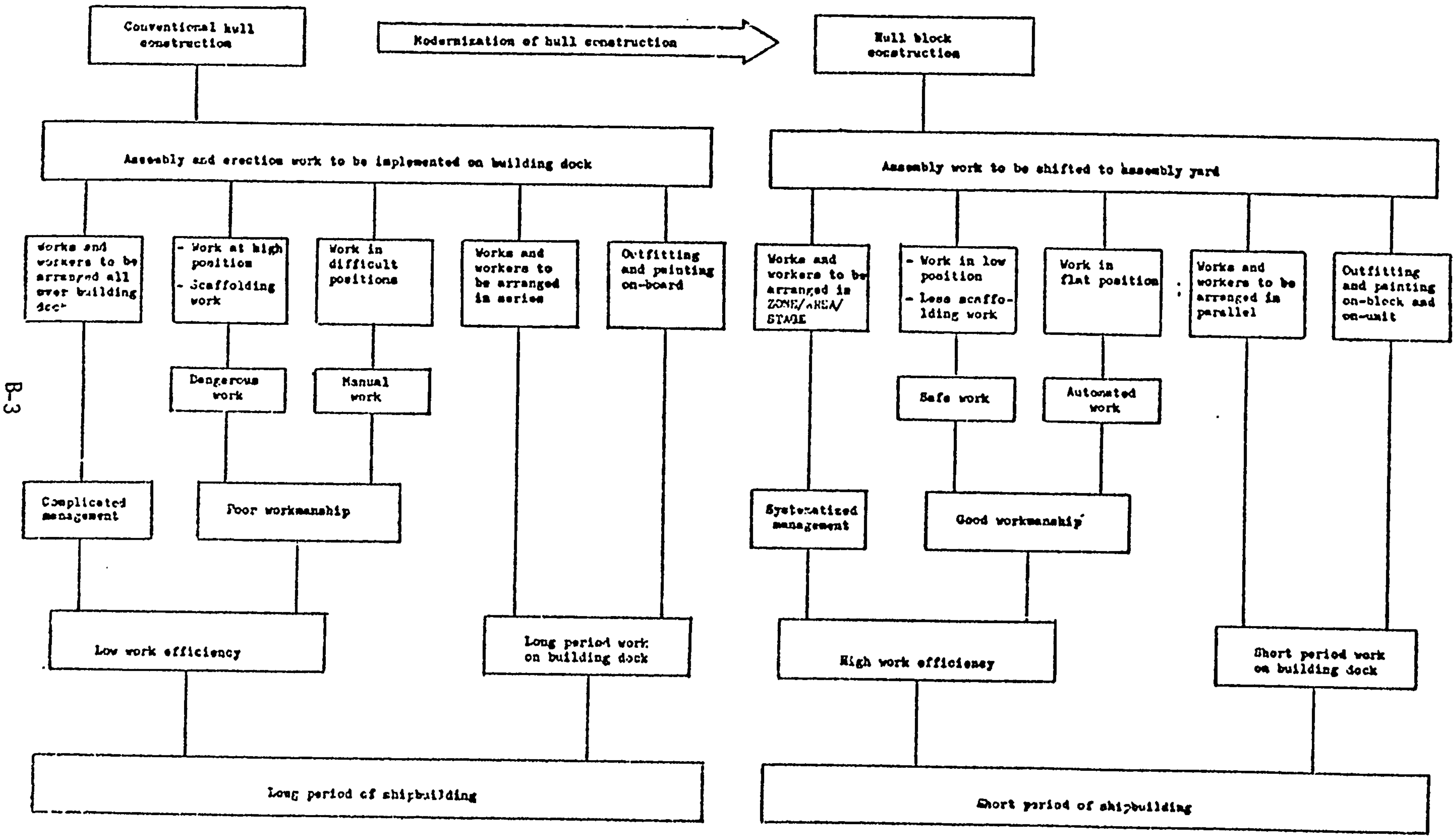


Fig. 1 Hull Construction - Advantages by Modernization from Conventional Hull Construction to Hull Block Construction

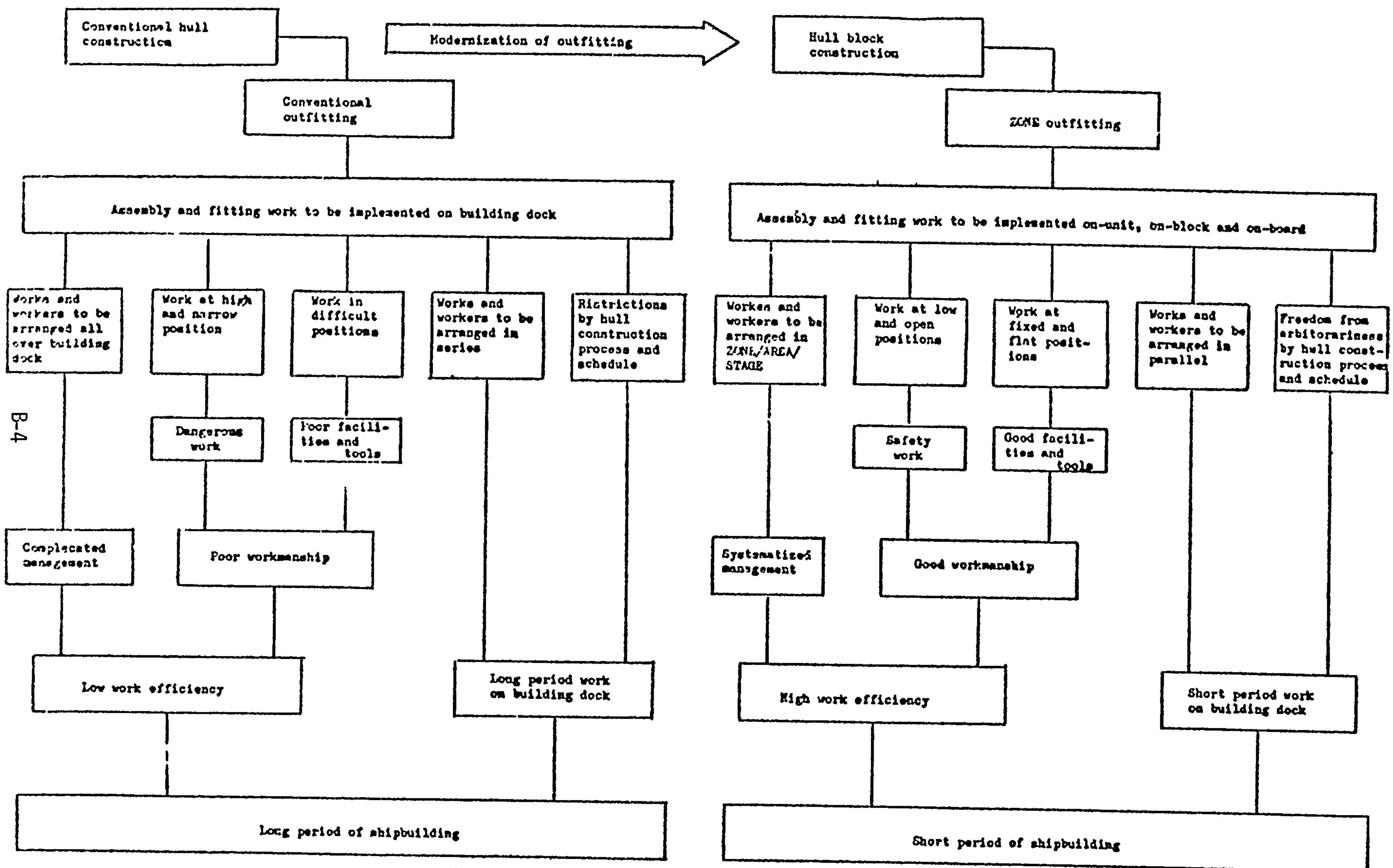


Figure 2 Outfitting - Advantages by Modernization from Conventional Outfitting to ZONE Outfitting

The large size and huge number of products, such as a ship, must be constructed in accordance with a plan which envisions fabricated and purchased parts, such assembly, blocks/units and other services necessary for completing a ship. Each of these entities is termed as interim product. That each is *a* discrete element identified as an objective in a work package. The first consideration is a hierarchical breakdown of the envisioned ship into interim products which would permit systematic fabrication and assembly, taking into account certain Product Aspects:

- SYSTEM - a structual function or an operational function of a product, i.e., longitudinal bulkhead, transverse bulkhead, mooring system, fuel oil service system, lighting system, etc.

- ZONE - a geographically divided part of a product, i.e., cargo hold, superstructure, engine room, etc. and their sub-divisions as an objective of producing, as work group in this shipyard.

- STAGE - a step of the production process grouped by production sequence of work, i.e., fabrication, sub-assembly, assembly, erection, outfitting on-module, outfitting on-block, outfitting on-board, and their sub-steps.

- AREA - a division of production process into similar types of work (either movable or fixed) depending on facilities i.e., feature, quantity, quantity or work process of a interim product.

- SYSTEM AND ZONE - are considerations for the break-down of an envisioned product into interim products.

- STAGE AND AREA - address the process for fabrication and assembly of interim products.

The advanced process with confluence and diversion of uniformed production flow brings the optimum productivity owing to the input variety of Product Resources:

- Material to be used for production, which is either direct or indirect: steel plate, machinery, cable, oil, etc.

- Manpower to be charged for production, direct or indirect: welder, gas cutter, filter, finisher, rigger, material arranger transporter, etc.

- Facilities to be served for production, direct or indirect: building, dock, machinery, equipment, tool, etc.

- Expenses to be charged for production, direct or indirect: designing, transportation, sea trial, ceremony, etc.

Making of a work package, that is, grouping or dividing of the product into the interim products in various types and numerous quantity by using the Product Aspects, must be performed in accordance with evaluation for them to be most optimum. The measuring unit for the evaluation is integration of the Productivity Values:

- Time to be a duration allocated to a work package divided by the Product Aspects.

- Quantity to be quantity of input of the Product Resources to the work package for producing an interim product.

- **Quality to be quality** of the work package to be created by the Product Aspects and the Product Resources.

Each of interim products shall be produced by the unique input of each of the Product Resources. Furthermore, in order to make understanding for the Production-oriented Work Breakdown Structure, the relationship of the three dimensional nature is illustrated in Fig. 3 and 4.

The first of the dimensions, the Type of Work, is related to the other two dimensions as tabulated in Figure 4. The second dimension addresses Product Resources Axis and the third Product Aspects his which are the remaining necessary conditions for product-oriented considerations. Each element of Figure 3 represents the relationship for work breakdown among the dimensions. For example, the darkened element, a top and front corner of the cube, represents painting work during assembly)Pa) relative to material (X_1) dimensions and the elements by their combinations. The darkened first and fourth levels (Hf and Fa) in Figure 3 are tabulated in Figure 4 as examples.

In the product-oriented consideration, the work package can theorically be made by the four aspects listed. Each of the resources shall be grouped into the respective work package, but considering the optimum balance, such as to symplify a cost calculation or scheduling system, some of the aspects may be eliminated from grouping aspects and changed about its concept.

The Productivity Values, illustrated *as* a triangle in Fig. 4, show that each of them must balance in each eleme

Each element is qualitatively formulated as a function of the Productivity Value:

$$E = f(v)$$

E...............element

v...............Productivity Values

Figure 5 represents the evaluation flow of work-packaging and theoretical combination by the Product Aspects, Evaluation of merit and demerit, rectangular boxes, is performed by the above formula.

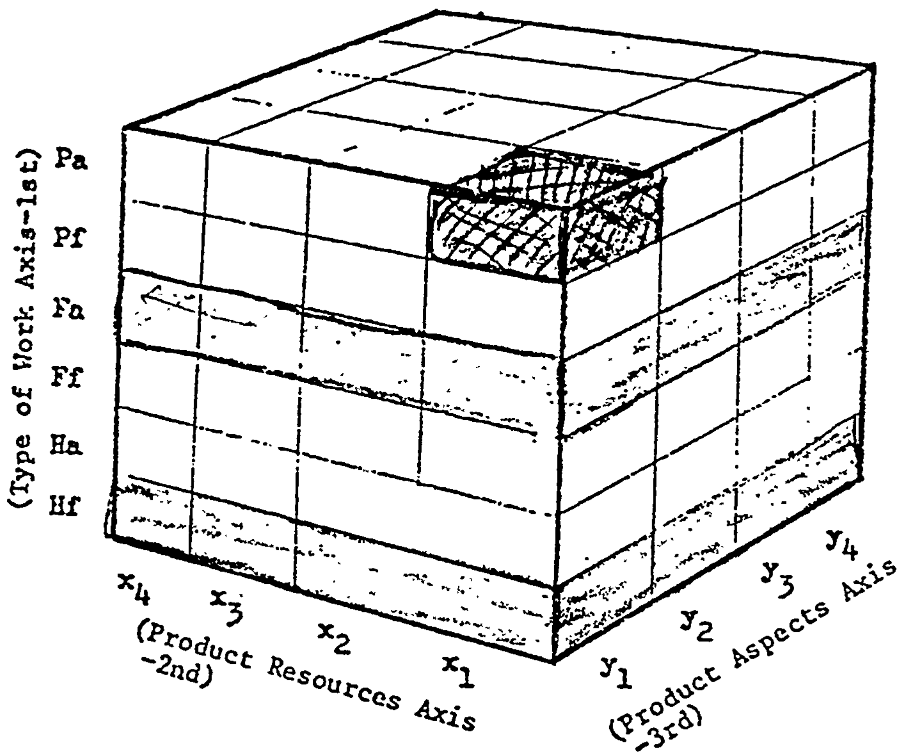


Figure 3 Three-dimensional nature of Product-oriented Work Breakdown Structure.

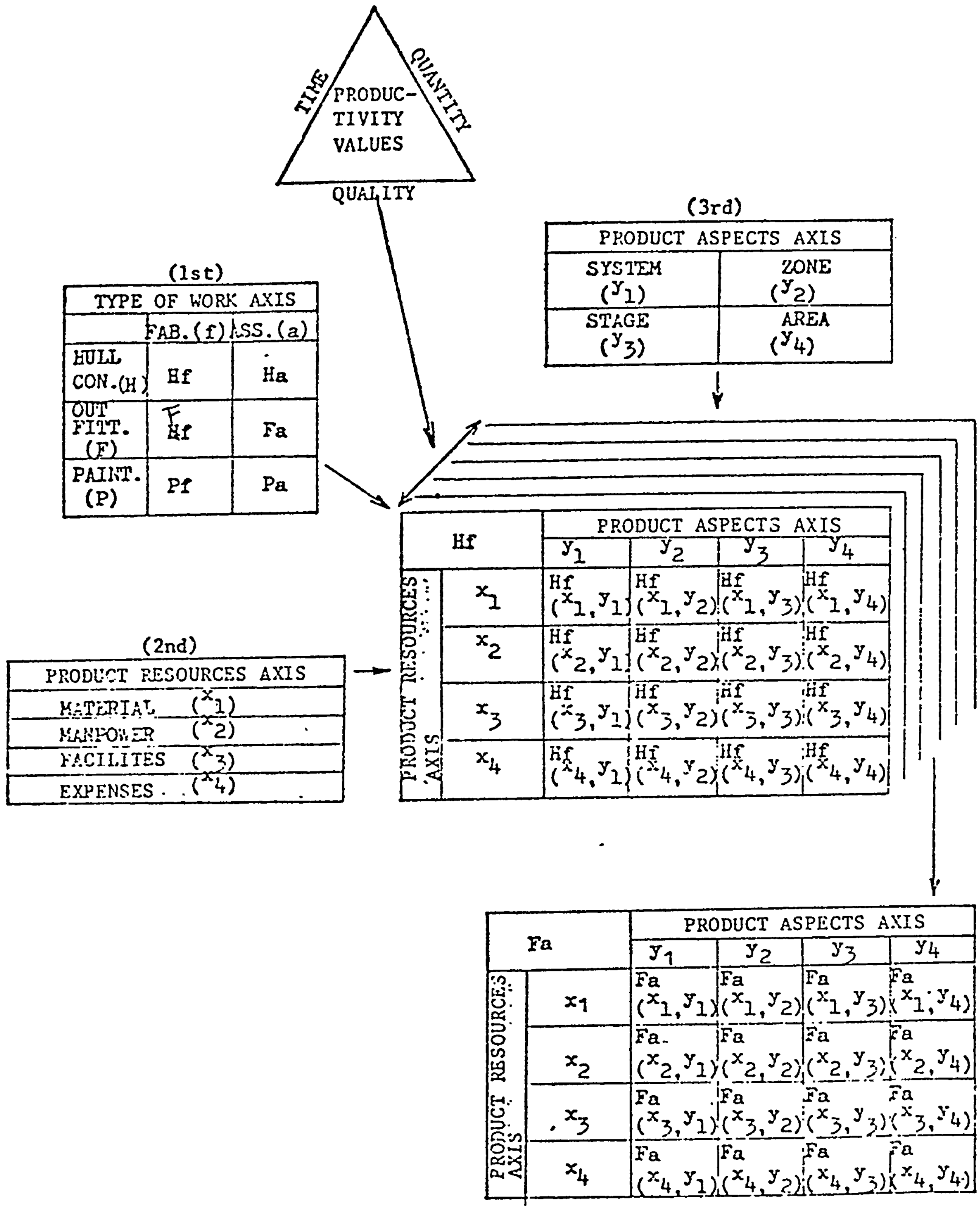


Figure 4 Elements of Product-oriented Work Breakdown by combination of the three dimensions.

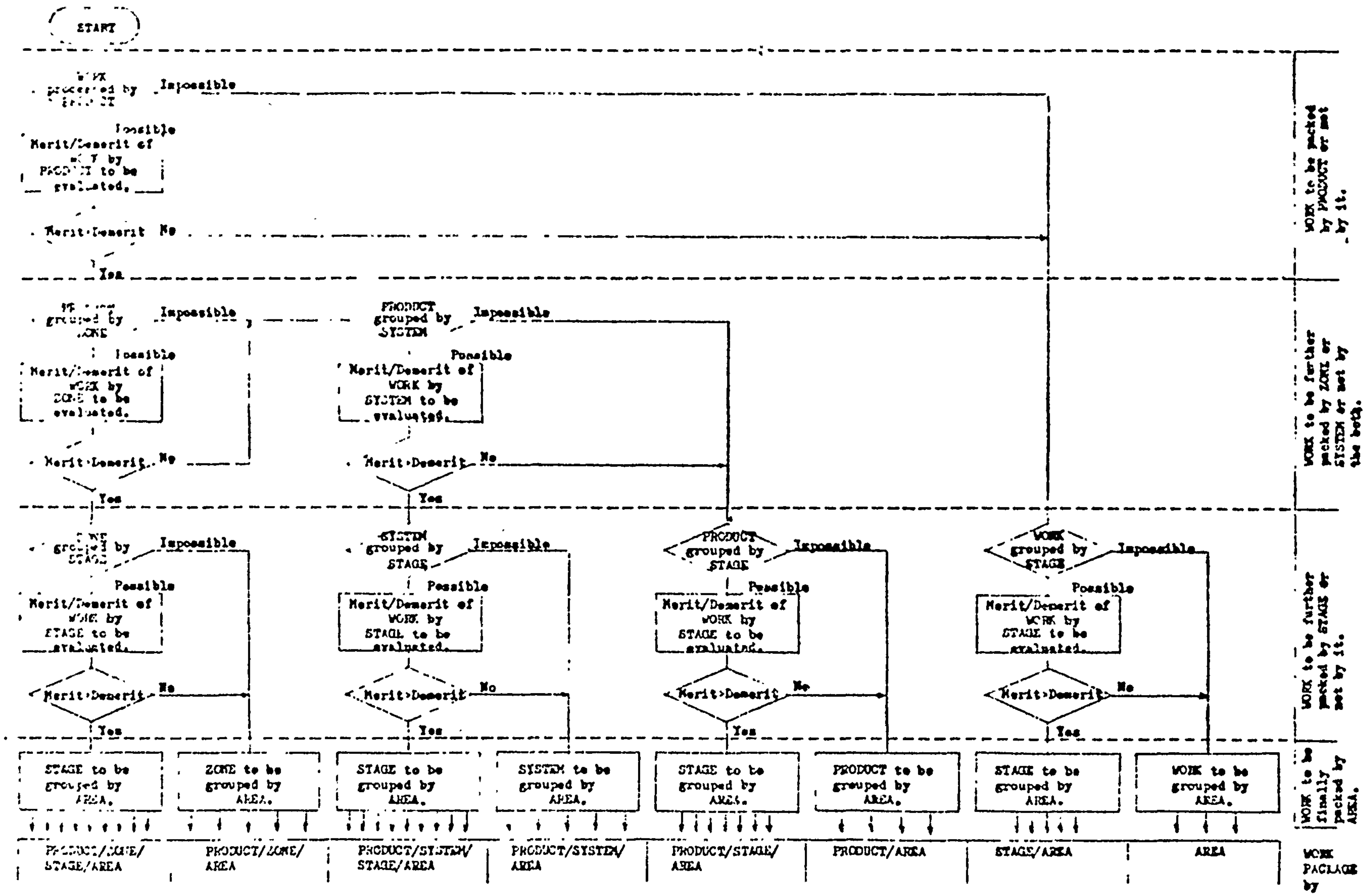
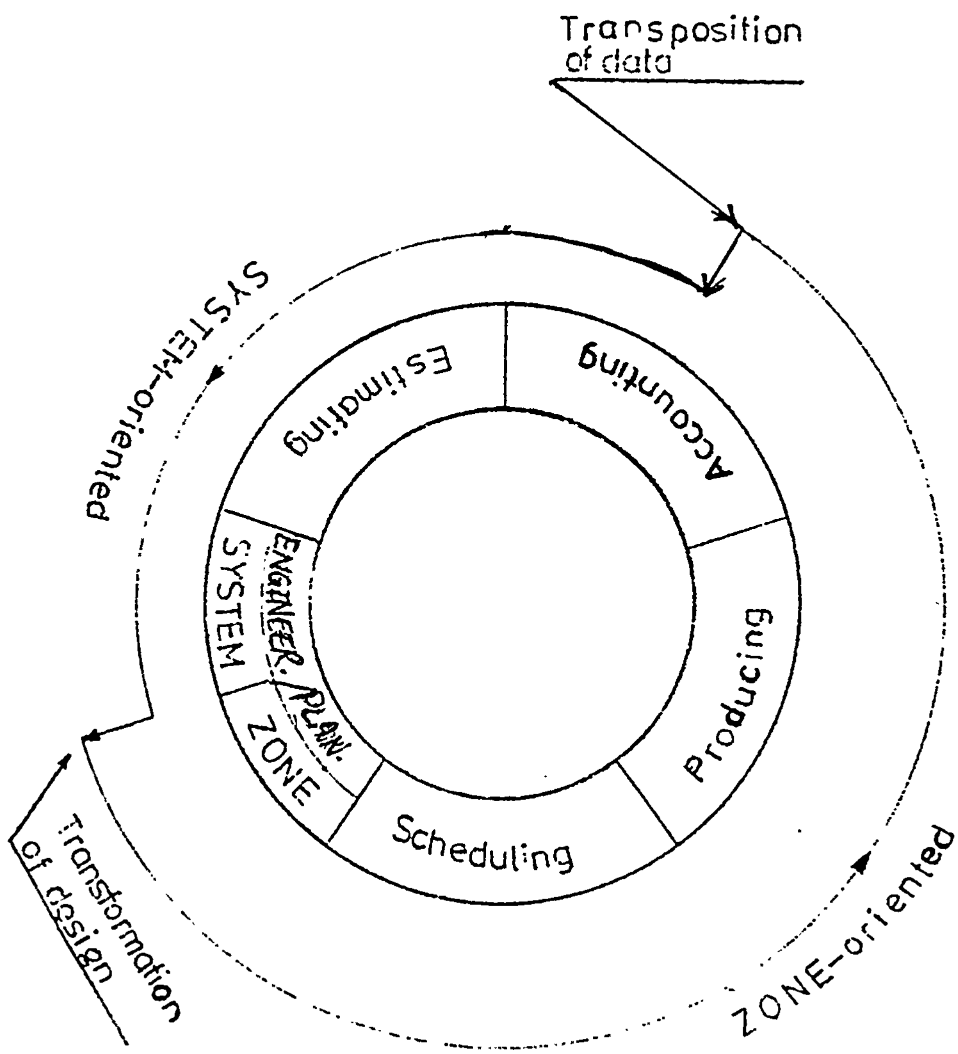


Figure 5 Logic of Decision Making of Work Packages by Product-Aspects

These aspects and resources are usually in contradiction to one another, for example as between estimating and producing. The product-oriented work breakdown structure is a conventional system-oriented one for estimating and *a* revolutional zone-orieneed one for producing in the advanced shipbuilding process. The linkage of its functions; Estimating, Engineering and Planning, Scheduling, Producing and Accounting, *as* shown in Figure 6 must be made to be able to transpose to one another. Therefore, transformation of th work breakdown structure is implemented from the SYSTEM-oriented design to the ZONE-oriented design during the functi of Enginering and Planning, and transposition of the ZONE-oriented data for Accounting is made to the SYSTEM-oriented data for Estimating.

The transformation flow on the design from the SYSTEM-oriented to the ZONE-oriented is shown in Figure 7. The total SYSTEM design of a ship is broken down to hundred numbers of the SYSTEM which are planned on the SYSTEM plans and MLS (Material List for System). They are transform to the ZONE arrangements on which all of SYSTEM are arranged for each of the divisions of the ZONE. Further, the fitting drawings are developed together with MLF (Material List for Outfitting) on the basis of the arrangement, and MLP (Material List for Pipe Piece Manufacturing) and MLC (Materialist for Outfitting Component Manufacturing) are produced with those manufacturing drawings. The fitting drawings and afterward are prepared in consideration with ZONE/AREA/STAGE. Thus, on the engineering and the planning the ZONE are broken down to the minimum level, a part for hull construction and a component for outfitting.

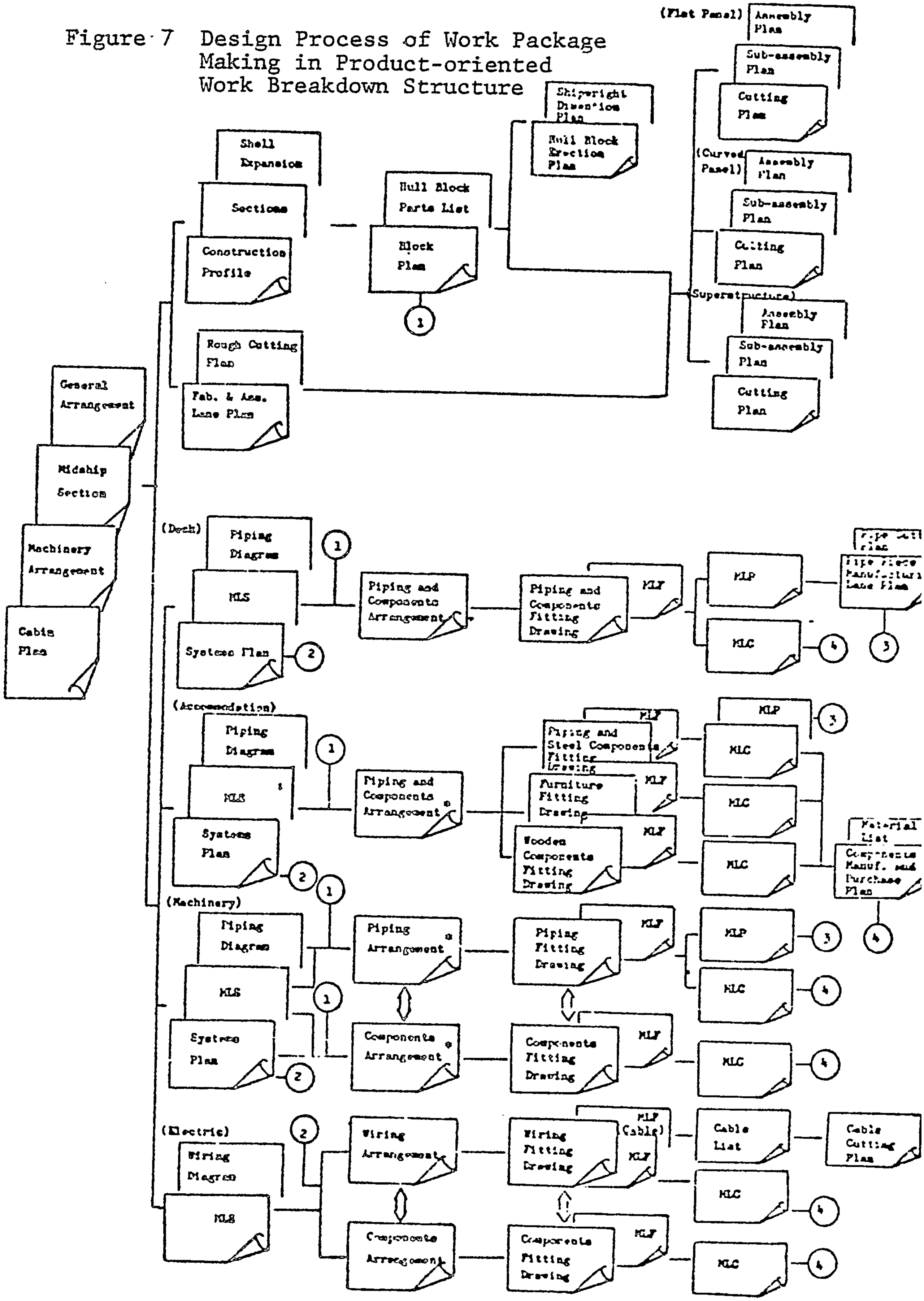
Following to the engineering and the planning, the parts and the components, which are fabricated, manufacture, and purchased, are step by step assembled, fitted and erected be a totalized ZONE product of ship. Figure 8 outlines this production process flow as well as its work packages of shipbuilding grouped by ZONE/AREA/STAGE.



Transposition of data
SYSTEM-oriented
Estimating
Accounting
Producing
Scheduling
ZONE
ENGINEER./PLAN.
SYSTEM
ZONE-oriented
Transformation of design

Total System	System	Zone	Zone/Area/Stage

Figure 7 Design Process of Work Package Making in Product-oriented Work Breakdown Structure



Note: marked arrangements are comprehensively planned without actually producing them, and concretely merged into the subsequent fitting drawings.

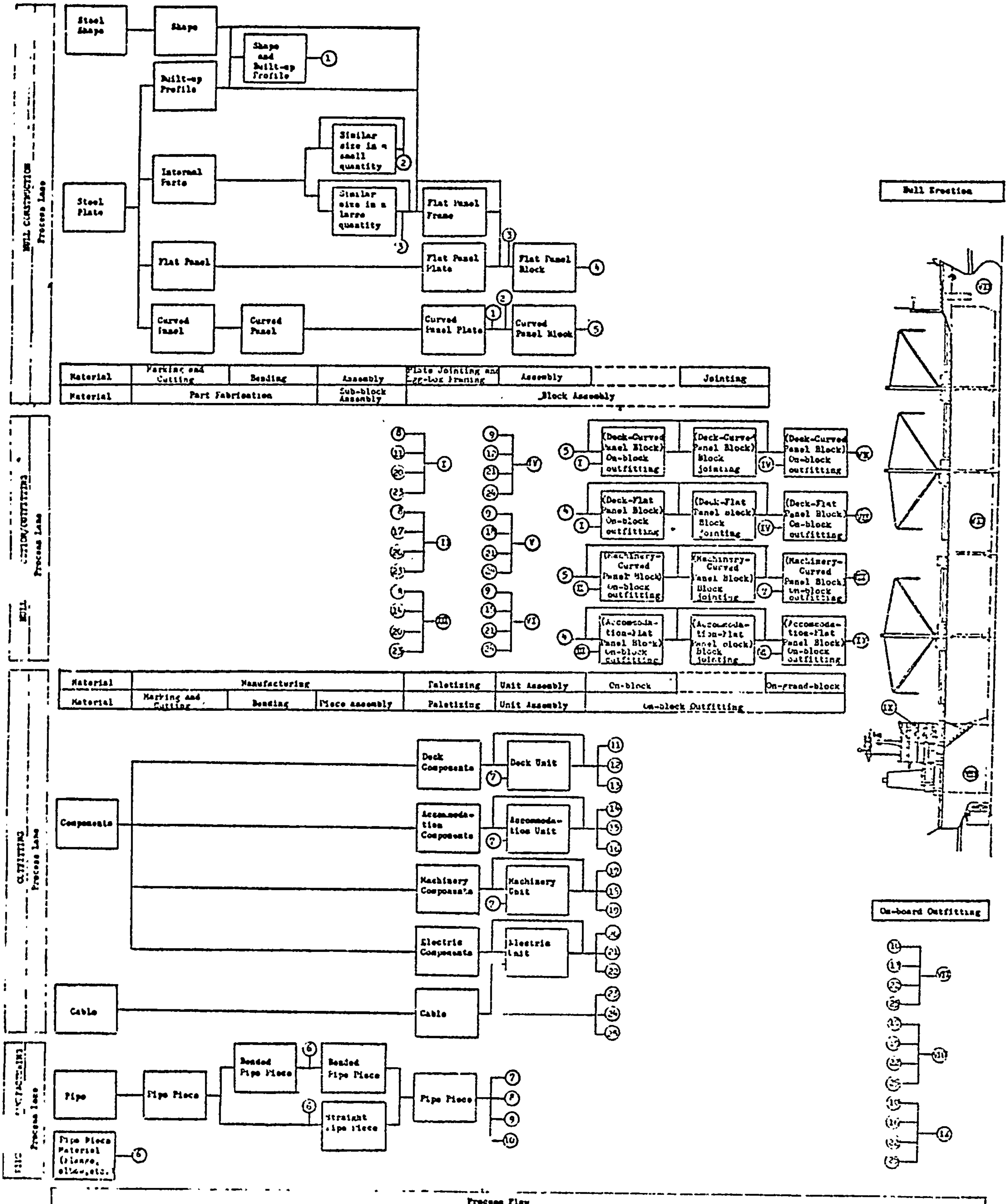


Fig . 8 Integrated Work Processes of Hull Construction and Outfitting have Work Package in Product-oriented Work Breakdown Structure.

2. Work Package for Hull Construction:

The logic and principles for making a work package on the shipbuilding process employed in IHI are confidently proposable and applicable to this shipyard.

As shown in Figure 1, a hull block is a key of ZONE for securing the merits from the Hull Block Construction Method. The key is not only for structuring of Product-oriented Work Breakdown for the hull construction hierarchically displayed in Figure 9, but *also* for facilitating of the ZONE Pre-Outfitting Method.

The hull block is a key objective of the Product-oriented Work Breakdown Structure for the shipbuilding.

Hull Block is a ZONE, an optimum sized division of the hull which is a rigid assembly composed of a panel, and longitudinal and internal structures.

The division is conditioned as follows:

- It is, for block assembly purposes, divided into minimum groups about the similarity of the AREA and the minimum variety of the working time.

  It is, for block erection purposes, shaped in a minimum working time and a stable condition without support and reinforcement.

- It is, for on-block ’outfitting purposes, sized in a maximum space.

The first consideration is "How to divide a hull into the hull blocks" in volume, weight, shape, etc. The similarity in these features must be also a sole fundamental factor for categorization of the hull blocks to be processed through every level from part fabrication to block erection.

The logic and principles of the work breakdown of the levels below the block assembly are to gain the advantages by:

veering of welding objection from the difficult positions; overhead and vertical to a flat position to reduce *a* total working time of all the levels.

transferring of a work from the block assembly level to the lower levels to balance the respective working time of every level.

Since the logic and principles of the work breakdown of a hull to the hull block is to reduce the working time of hull construction on a building dock, the intermediate level between the block assembly and the hull construction is inserted in the case that *a* grand-block is more satisfactory for the hull block defension than *a* hull block is.

Thus, the Product-Oriented Work Breakdown Structure is to be found as displayed in Figure 9

There are seven levels of:

- Part Fabrication
- Part Sub-Assembly
- Sub-Assembly
- Component Assembly
- Block Assembly
- Grand-Block Joining
- Hull Construction (Erection)

The unique similarity to make work packages in each level is seeked through the Product Aspects.
The simplified and grouped work package enables:

- Production Process of Interim Product to be Modulated
- Highly Effective Facility to be Invested
- Manpower to be Saved and Balanced

Horizontal combinations of respective concepts tabulated in "Product Aspects in Detail" in Figure 9 make various types of work package necessary and sufficient to the process of each level. Vertical combinations of the work packages structure on each process lane of hull construction process flow is shown in Figure 8. The work packages shares respectively each input item of the Product Resources.

A size of the work packages is, therefore, determined on the optimum point of the Productivity Value in considera-tion of the resources. More or less groups of AREA depends on the optimum points of the values for each level.

The high productivity is obtainable from a well-balanced planning and scheduling on the basis of the work package grouped by the Product Aspects.

The approach to grouping the work package by the Product Aspects for each level is discussed hereinafter, referring to Figure 9.

1) PARTS FABRICATION (MATERIAL PREPARATION) :

Parts Fabrication is a primary level of hull construction for fabrication a block part, that is a ZONE to be no more broken down.

The AREA of this level is grouped into:

Plate Parts of Skin Panel

Plate Parts of Internal Structure

Angle Parts of Internal Structure

- Other Parts, e.g., Pipe, Flat Bar, etc.

The grouping principle of this AREA is combinations of raw material and finished shape owing to grouping of fabrication process and facility.

Further grouping of Parts Fabrication of parts similarly typed and sized by ZONE and AREA is made by STAGE, namely:

Plate Joining or Nil

Marking and Cutting

Bending or Nil

In other words, each group of parts by ZONE and AREA is fabricated through these stages.

For example, supposing a face plate, an internal structure of plate is marked on and cut from a piece of plate nested together with a same grouped parts by one pass of a multi-flame planer. It is together bent by a bender, if required so, with reducing of rearrangement of press jigs. Those face plates, either bent or not, are grouped into each Work Packages of the following level by each block and fed to the next process.

2) Part Subassembly (Pre-Subassembly)

Part subassembly is a secondary level of hull construction for assembling built-up parts for a longitudinal and a stiffener or assembled parts for a stiffener or a bracket. The ZONE of this level is considered as a part rather than a sub-assembly. Therefore, the mixture of the above two cases with the subassembly is not preferable for leveling of work package of the subassembly.

The AREA of this level is grouped into:

- Built-Up Part: Assembled T-Type or L-Type Bar such as Longitudinals and Stiffeners to be fitted on a subassembly or direct on a block.
- Pre-subassembly: Various types of assembled parts for subassembly, such as brackets fitted with a face plate or a flat bar.

The grouping by the STAGE is as follows:

- Plate Joining or Nil
- Assembly
- Bending or Nil

3) Subassembly:

Subassembly is the third level of hull construction for assembly of internal structure component, that is a ZONE to be generally an assembly of a main part of internal structure with plural-numbered parts or assembled-parts for producing internal structures to be fitted on a panel of hull block.

The AREA of this level is grouped into flat two demențional shapes within:

similar size in a large quantity such as big-sized transverse frame, girder, floor, etc.

- similar size in a small quantity

The first grouped subassembly can be mass-produced by size through each lane of suitable facilities, for example; conveyor lane. The second grouped subassembly cannot be done so because of so many variety of its sizes as to be assembled one by one. The working time per one piece of subassembly is not to be leveled.

The grouping by the STAGE is made as follows:

- Assembly
- Turnover or Nil

4) Component and Block Assembly, and Grand Block Joining:

Assembly of a block, a key ZONE of hull construction, is divided into three levels of:

- Component Assembly
- Block Assembly
- Grand Block Joining

The divisions are made in conceptual grouping of work packages by the AREA and the STAGE.

Component assembly is to be assembled in a partial ZONE of the block separated from its main ZONE of the panel plate to reducing difficulties on the block assembly in one. The component is assembled with its mother block before the block is to be erected.

Grand Block joining is to join a few hull blocks to each other before the block erection in order to:

to reduce a working time of its erection on a building dock.

to be a stabler shape for its erection

to be a more spacious size for on-block outfitting and painting

The first case is ranged in the block erection but on the assembly yard, namely pre-erection, while the second and third cases is rather in the block assembly.

The ZONE of this level is, therefore, ranged to Block and Ship as shown in Figure 9.

The AREA of the component assembly level is grouped into the same concepts of category as for the sub-assembly. Most of the components are rather small from block and two-dimensional so as to be assembled together through the subassembly yard. This is a point of separation of the component assembly from the block assembly.

The STAGE grouping is, therefore, similar to that of the subassembly. In case of a small size ship, this level is grouped into the subassembly and/or semi-flat panel assembly.

The AREA of the block assembly level is grouped into:

- Flat Panel
- Semi-Flat Panel
- Curved Panel
- Special Curved Panel
- Superstructure

This grouping is based on the shape of block panel which is utilized as a basement of the block assembly.

It varies on arrangement of its assembly slab.
The blocks of flat and semi-flat panel and super-structure can be assembled on each process flow line, but the blocks of curved and special curved panel may not be done so because of their assembly slab. In case of small quantity of block production, the above five groups may be reduced.

The block assembly grouping by STAGE is as follows:

- Plate Joining or Nil
- Egg-Box Framing or Nil
- Assembly

  Turnover or Nil

The assembly of STAGE of this level performs to assemble a panel with its internal structures from the lower levels and its component. The assembly process of a panel and its internal structures are grouped in each type of framing process on panel with:

Egg-Boxed Internal Structure

- Parallel-Arranged Longitudinals by a Line Welder Machine

Simultaneously arranged Longitudinals and Sub-assemblies

- Others

The AREA of grand-block assembly level is grouped into:

- Flat Panel
- Curved Panel
- Superstructure

This grouping is made in three types only because its small quantity and huge size.

The STAGE of this level is as follows:

- Joining and Nil

- Pre-Erection and Nil

5) Block Erection

Block erection is a final level of hull construction for shipbuilding that is a totalized ZONE.

The AREA of this level is separated into:

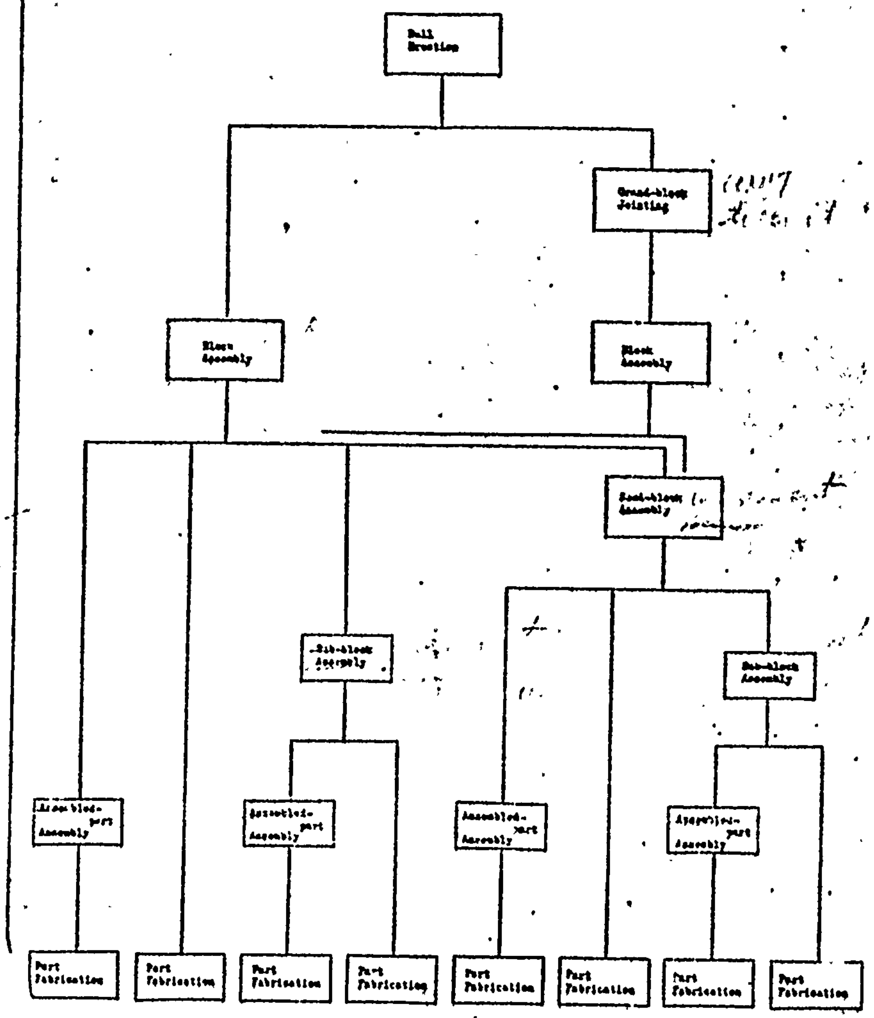
- Fore Hull
  Cargo Hold
- Engine Room
  Aft Hull
- Superstructure

The STAGE of this level is simply divided into:

- Erection
- Test

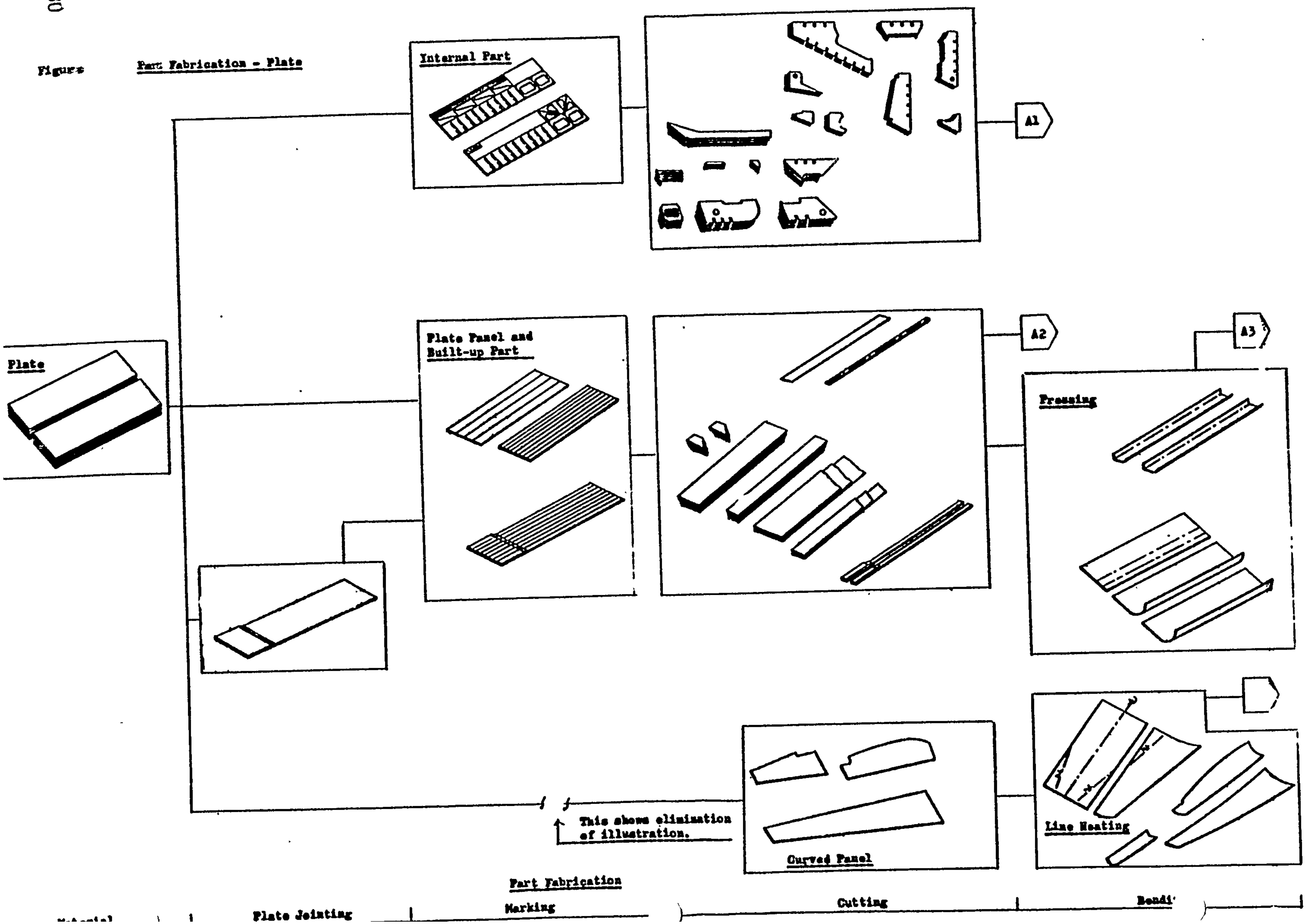
The test of this level such as the tank test is independent from the erection of STAGE about the ZONE, and distinguished about a size of work package in comparison with inspections and tests of the other levels. These are individually involved in the finalized work package of each level to implement on every finish time of interim products.

Figure 9 Hull Construction - Product-oriented Work Breakdown Structure

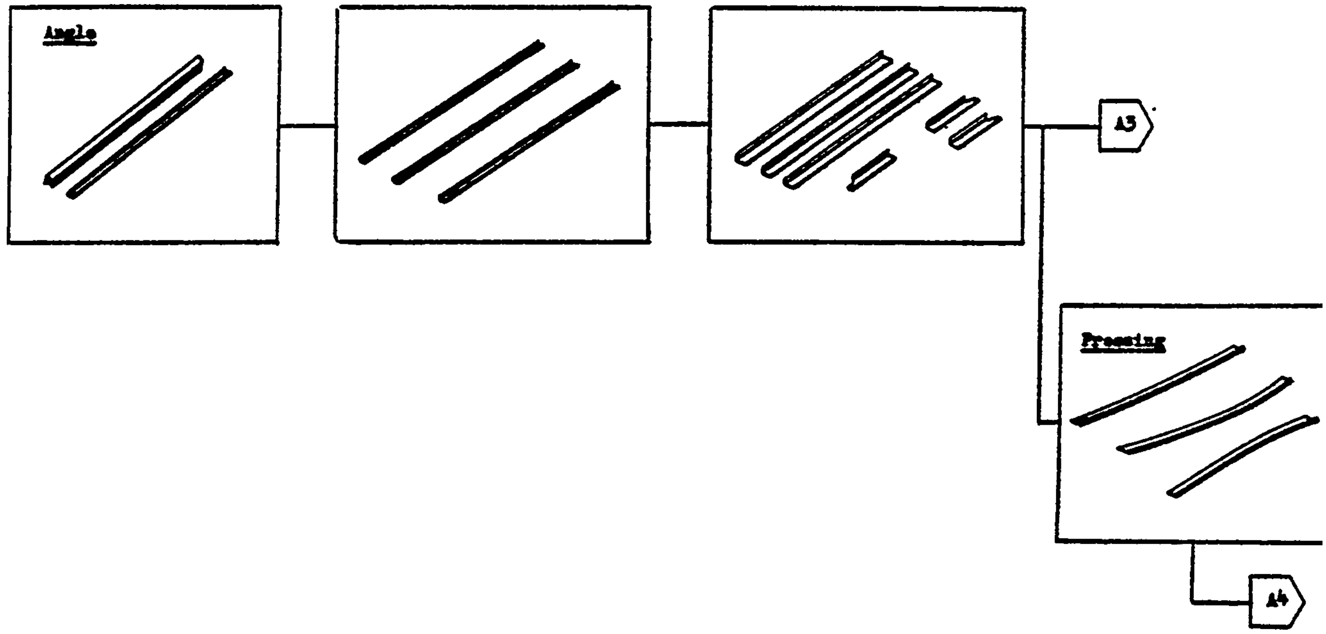


Product Aspects for Grouping	Zone	Area	Stage		Code in ZAS: Zone	Area	Stage
ZONE / AREA / STAGE	Ship	Fore Hull / Cargo Hold / Engine Room / Aft Hull	Test		Ship No.	Block Code	Stage Code
			Erection				
	Grand-block	A Flat Panel / Curved Panel / Super Structure	Pre-erection	Nil	Grand-block Code	Grand-block Code	Stage Code
			Jointing	Nil			
	Block	A Flat Panel / B Semi-flat Panel / C Curved Panel / Special Curved Panel / Super Structure	Back-assembly	Nil	Block Code	Block Code	Stage Code
			Assembly				
			Egg-box Framing	Nil			
			Plate Jointing	Nil			
	Nil	A / B	Back-assembly	Nil	Semi-block Code	Semi-block Code	Stage Code
			Assembly				
			Plate Jointing	Nil			
	Sub-block / Nil	Similar Size in a large quantity / Similar Size in a small quantity	Back-assembly	Nil	Sub-block Code	Sub-block Code	Stage Code
			Assembly				
		Partial Sub-block / Built-up part	Bending	Nil	Assembled-part Code	Assembled-part Code	
			Assembly	Nil			
			Plate Jointing	Nil			
	Part	Plate (Panel) / Plate (Internal Structure) / Angle / Other	Bending	Nil	Part Code	Part Code	Stage Code
			Marking and Cutting				
			Plate Jointing	Nil			

Figure   Part Fabrication - Plate



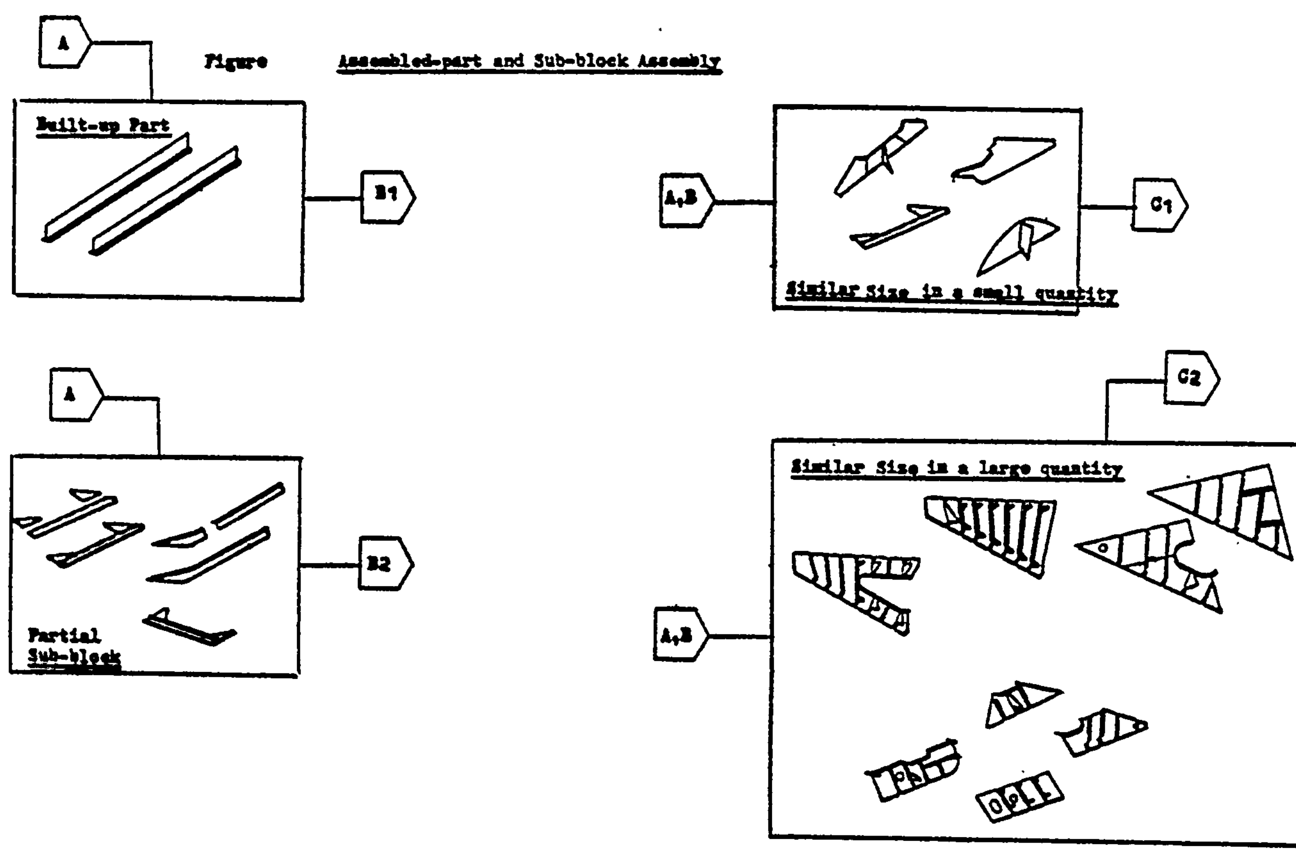
Part Fabrication - Angle



Part Fabrication

Material	Marking	Cutting	Bending

Figure **Assembled-part and Sub-block Assembly**



Assembled-part Assembly		**Sub-block Assembly**	
Assembly	Bending	Assembly	Block-assembly

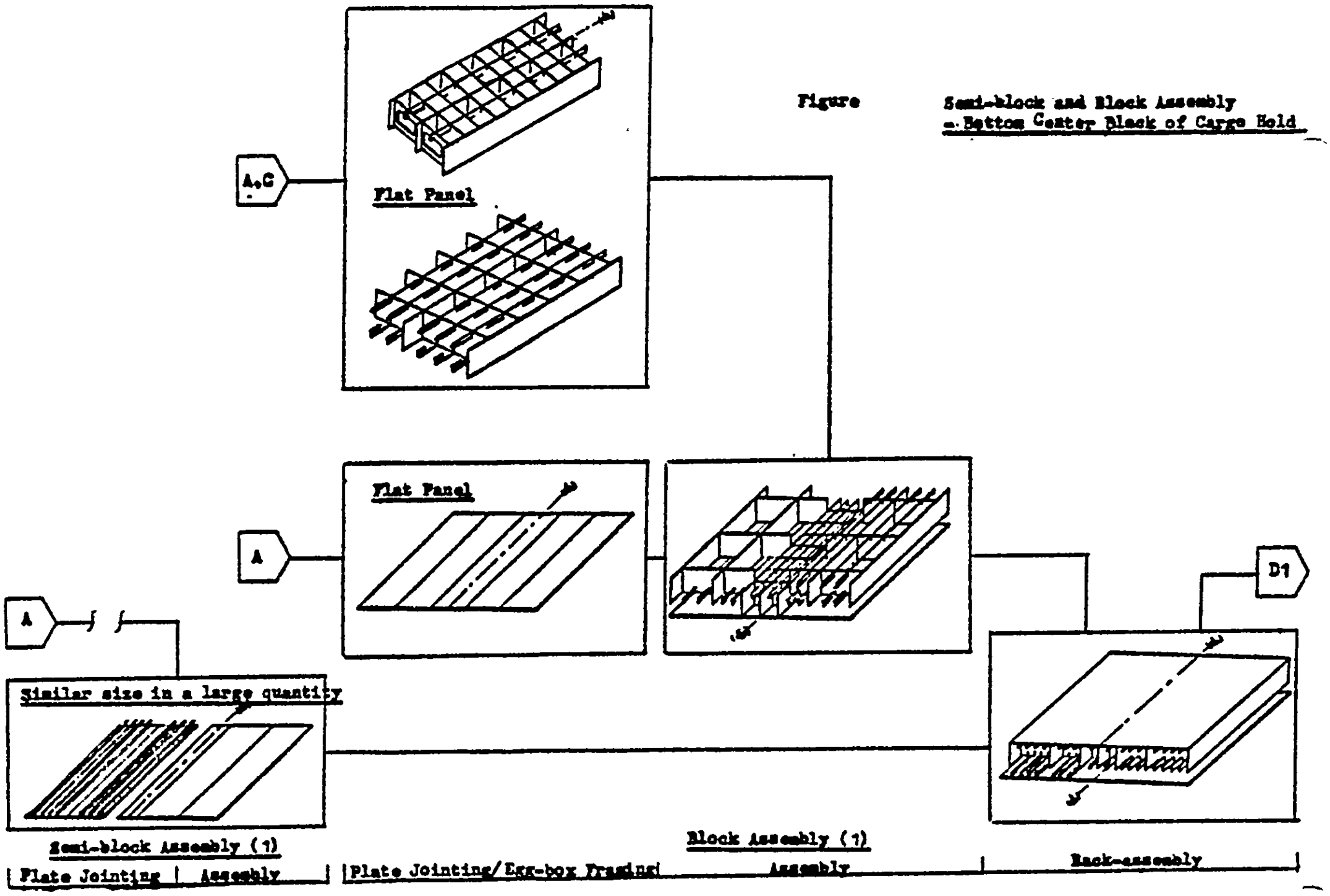


Figure Semi-block and Block Assembly - Bottom Center Block of Cargo Hold

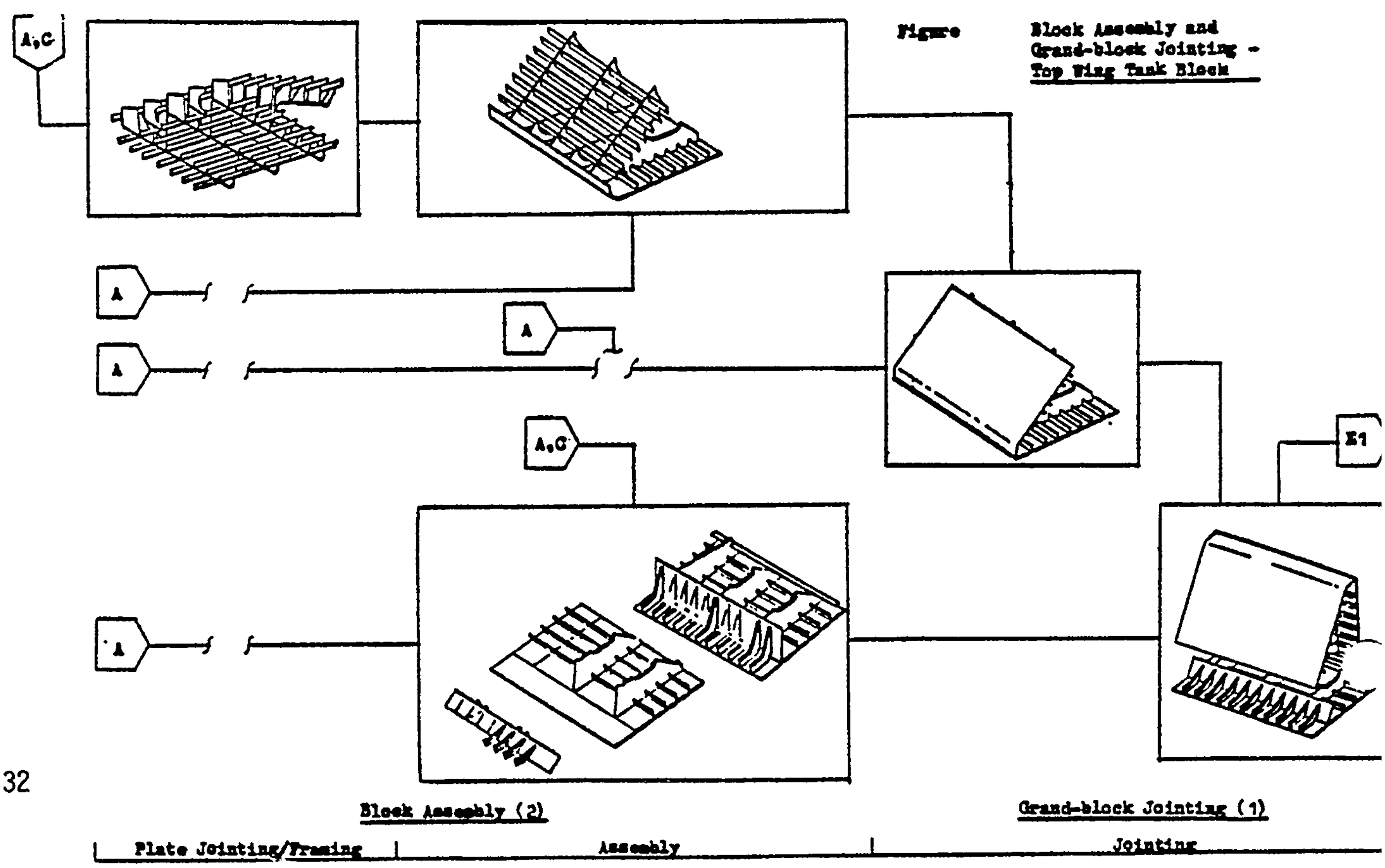


Figure Block Assembly and Grand-block Jointing - Top Wing Tank Block

Figur Block Assembly and Grand-block Jointing – Cent Block

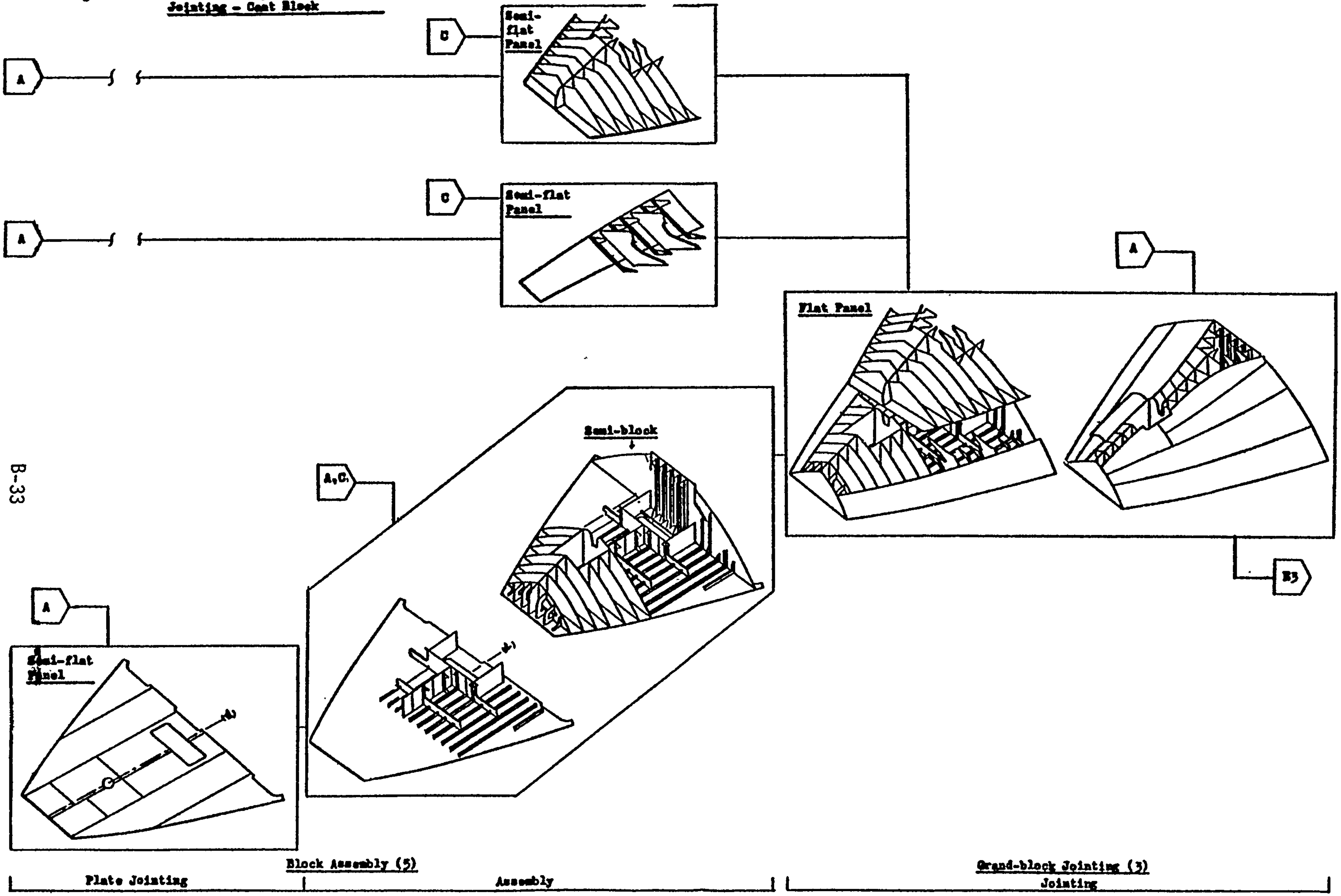


Figure Semi-block and Block Assembly - Blocks of Bottom Wing, Side Shell with Hopper and Transverse Hopper of Cargo Hold

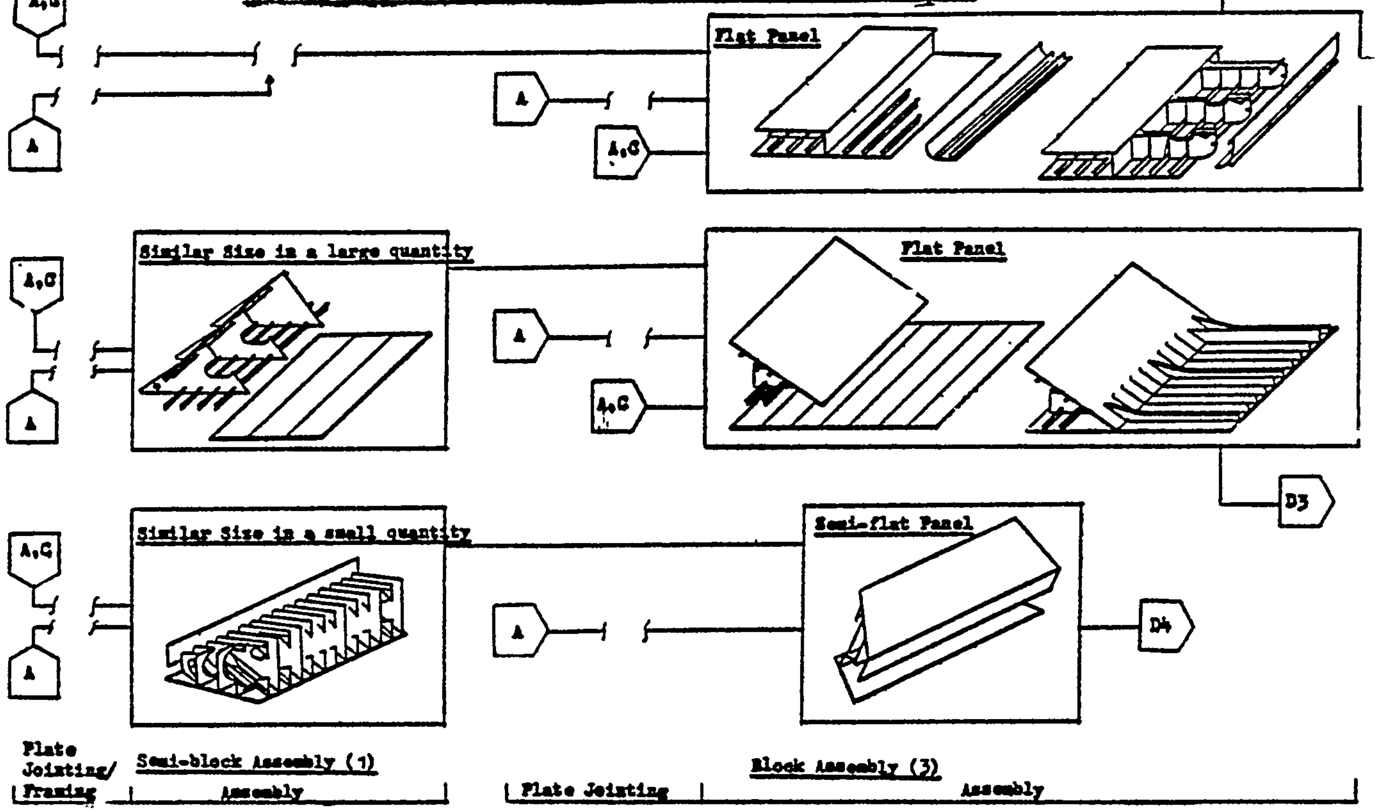


Figure Block Assembly - Blocks of Corrugated Transverse Bulkhead and Deck Center of Cargo Hold

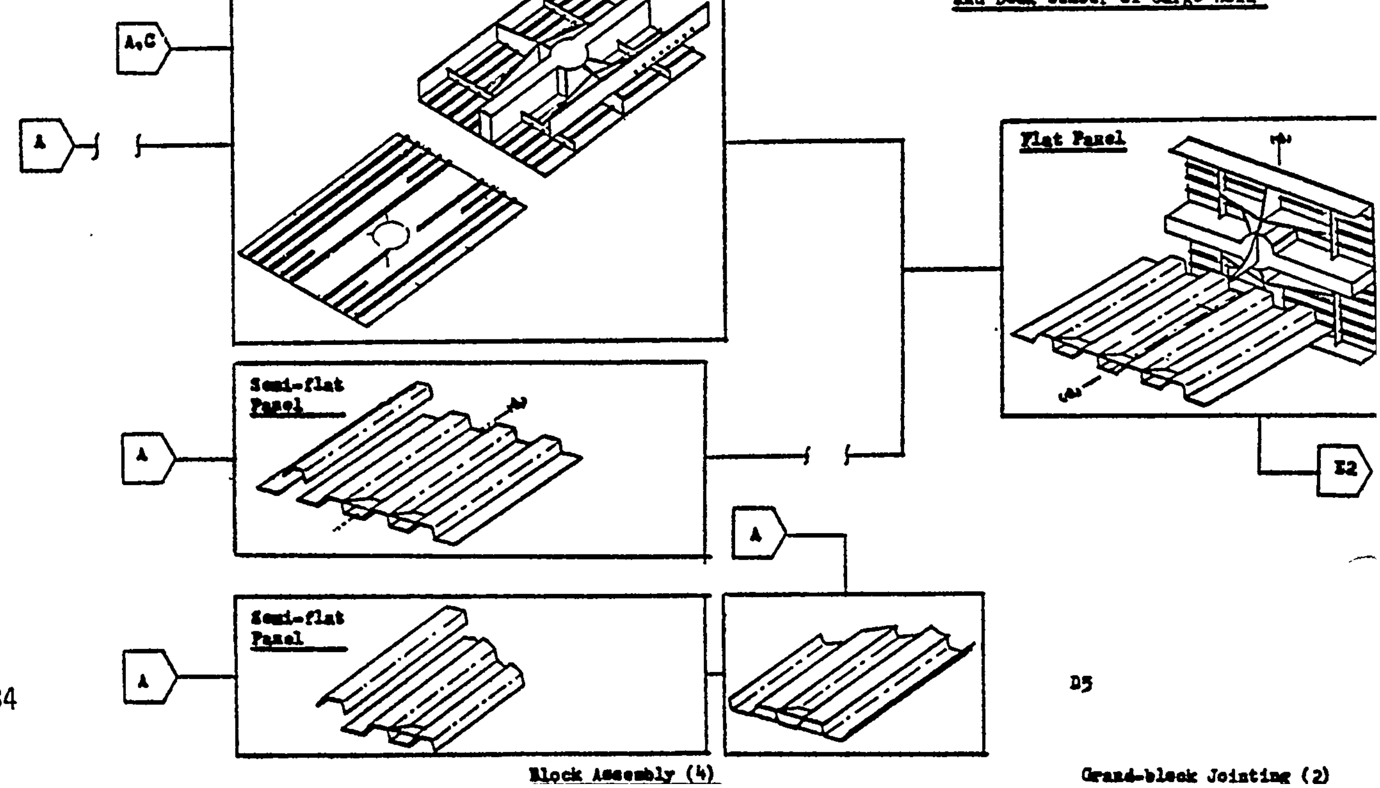


Figure Block Assembly - Upper Deck and Flat Blocks of Engine Room

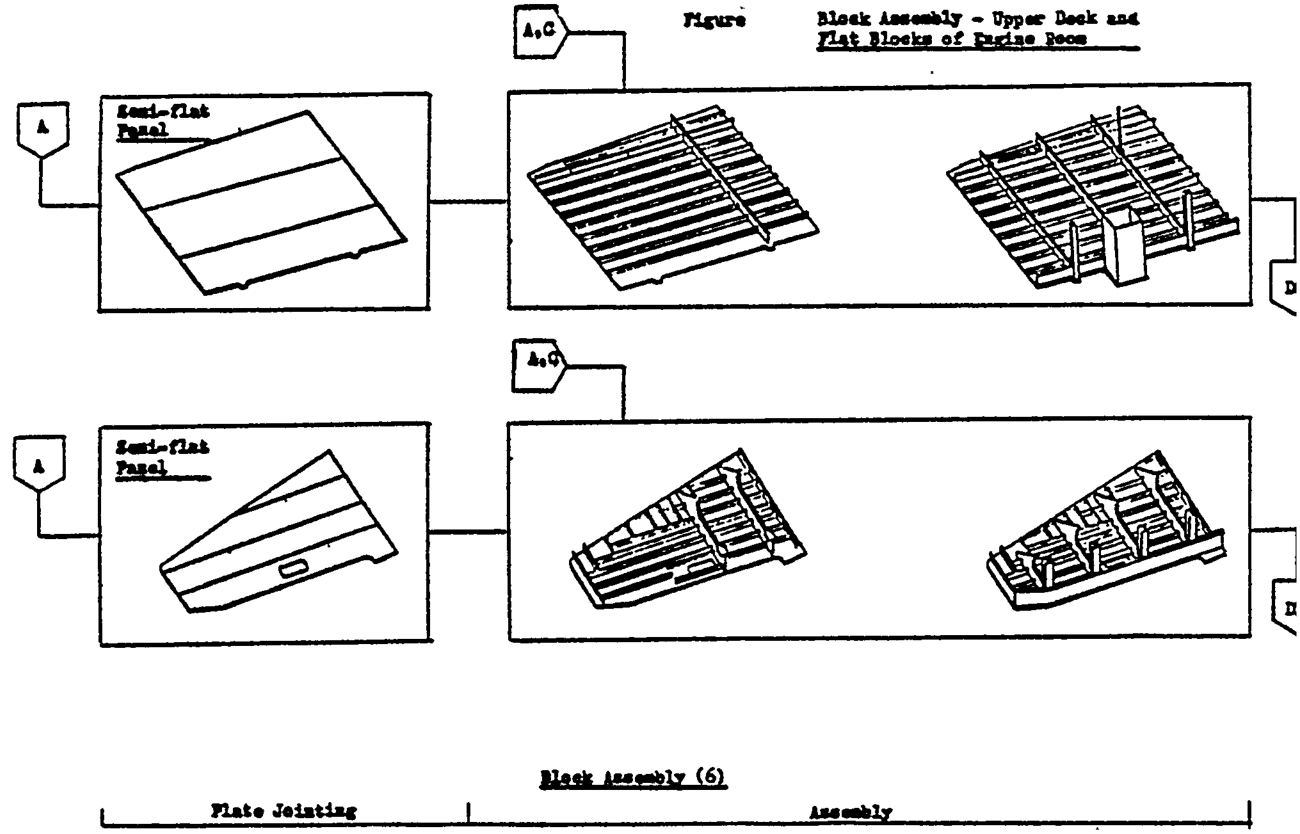


Figure Semi-block and Block Assembly - Bulbous Bow Block

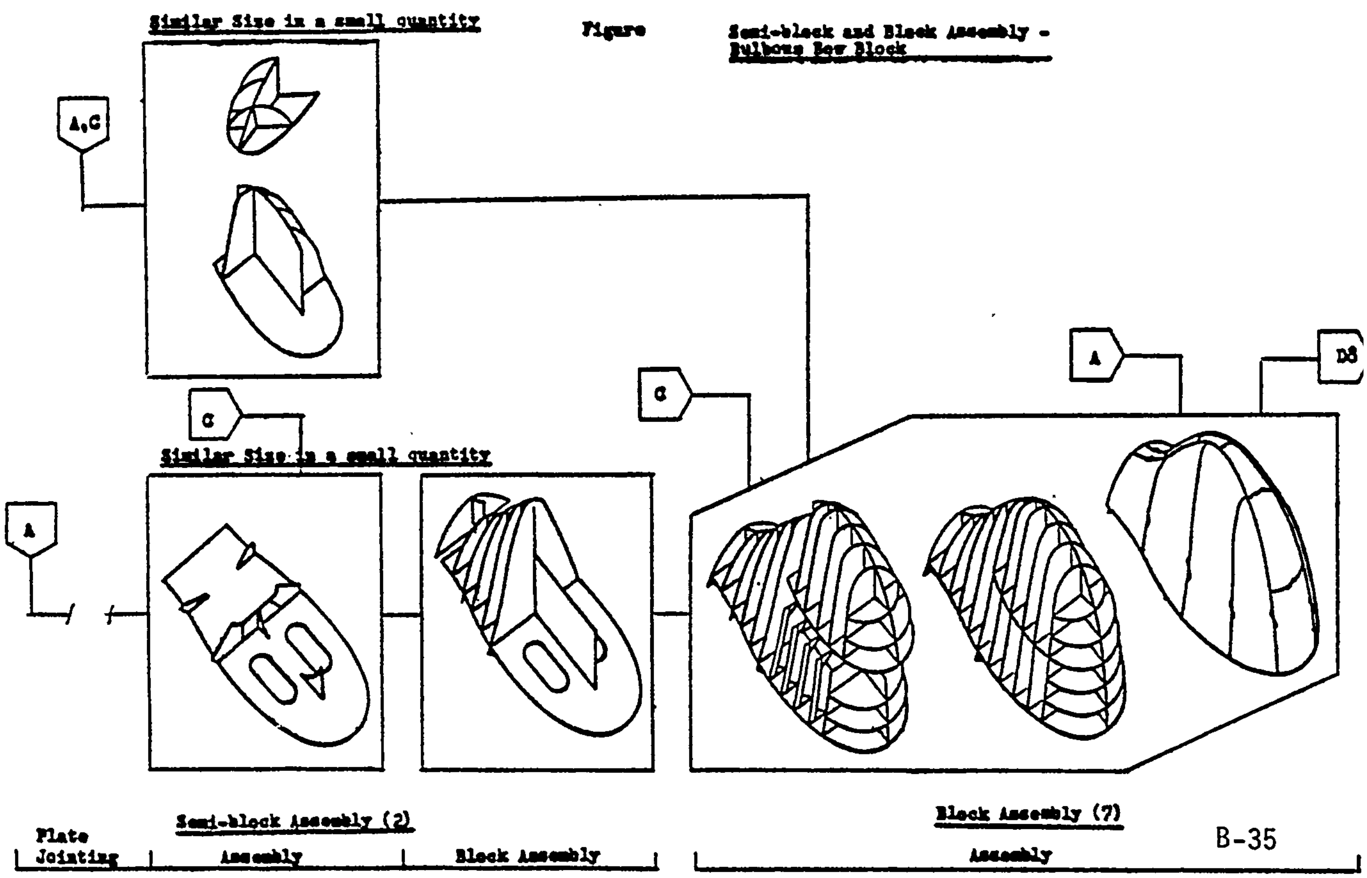


Figure Semi-block and Block Assembly – Blocks of Fo'c'sle and Upper Deck of Fore Body

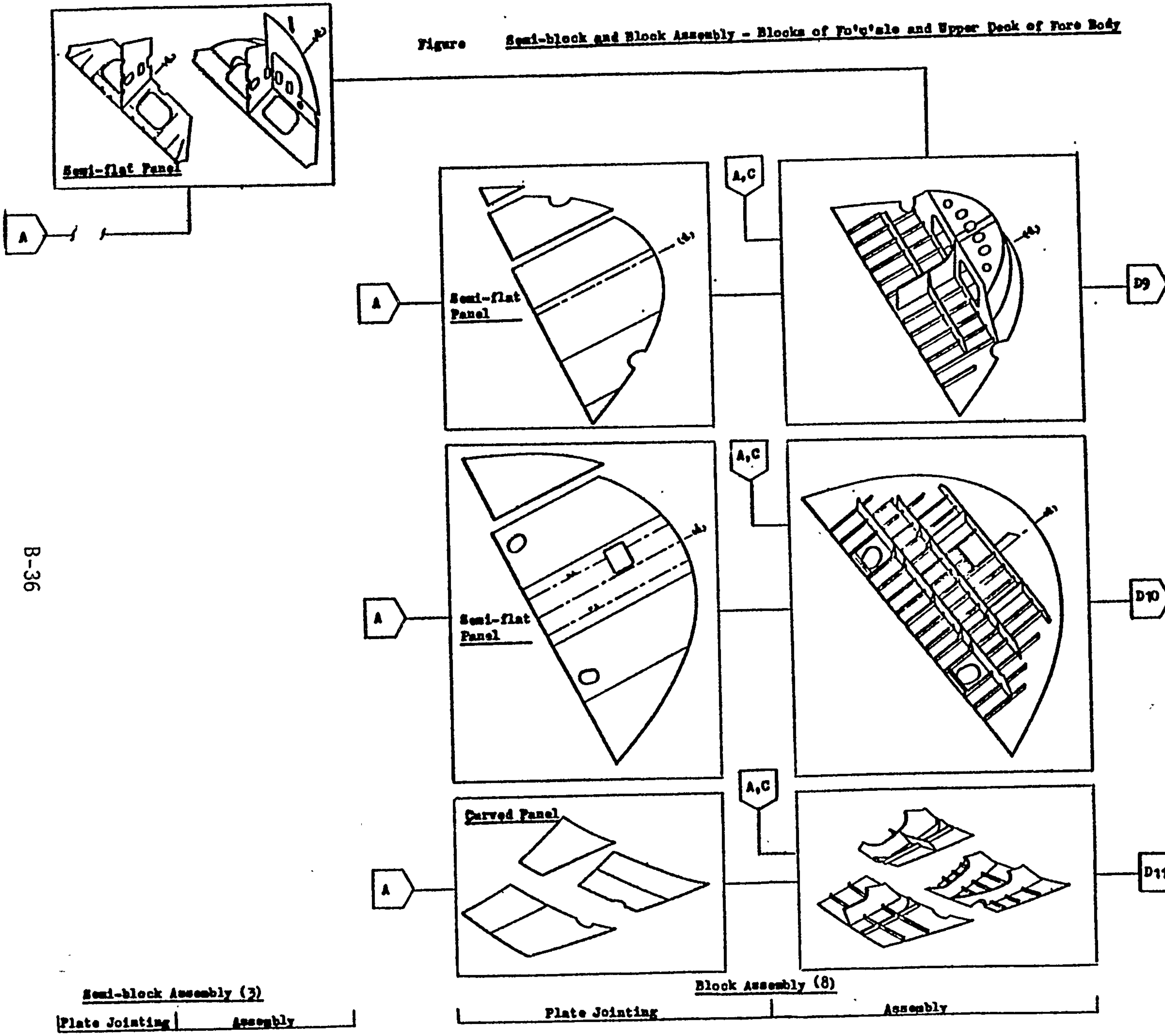
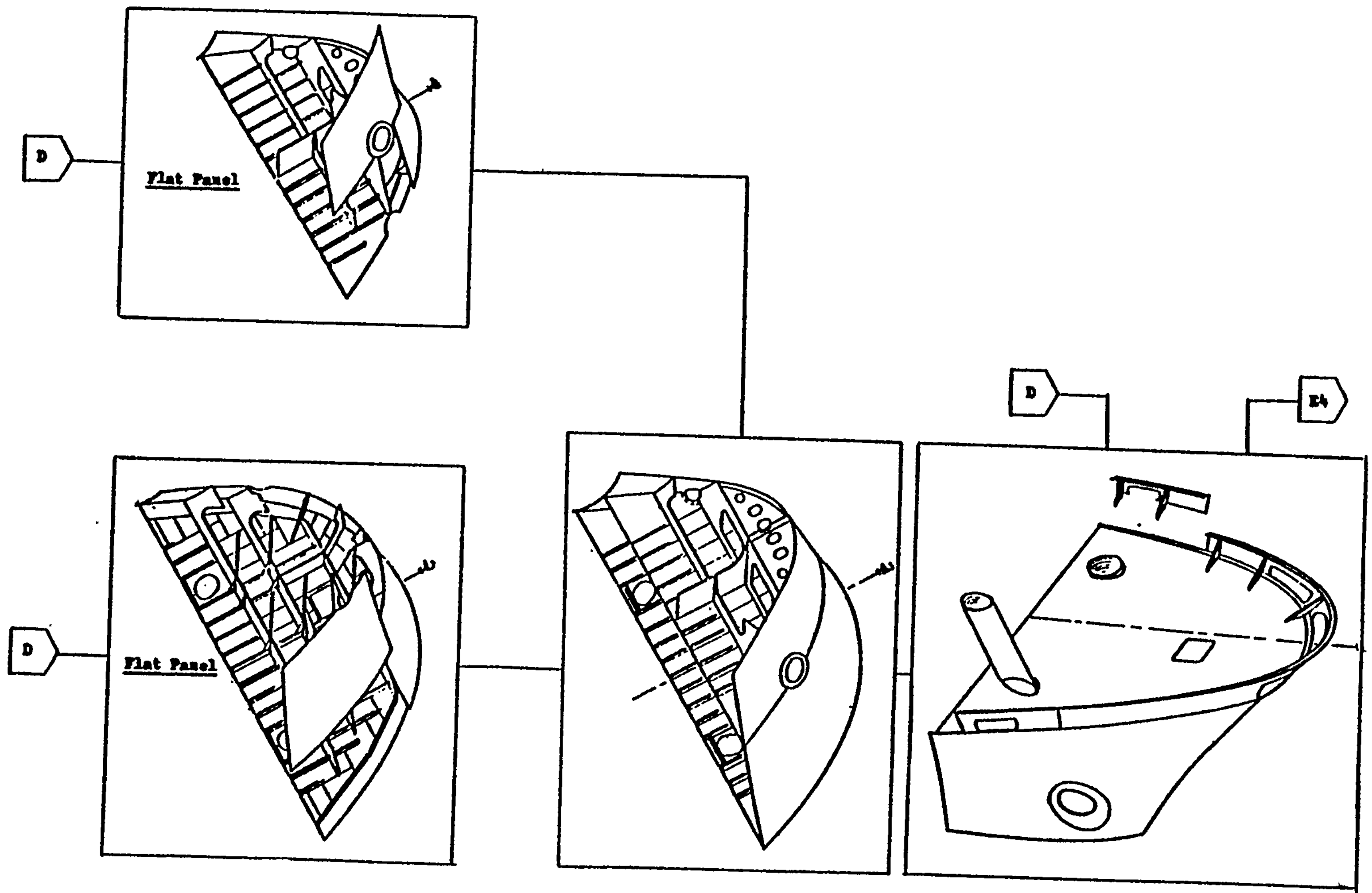


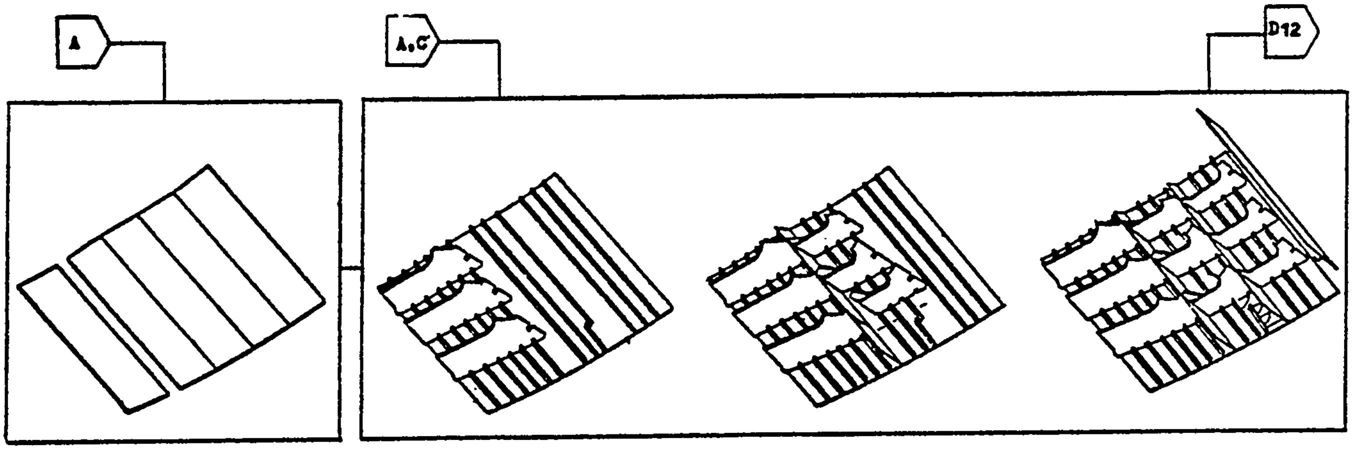
Figure Grand-block Jointing - Grand-block of Fo'c'sle and Upper Deck of Fore Body



Grand-block Jointing (4)

Jointing | Pre-erection | Back-pre-erection

Figure Block Assembly - Side Shell Block of Engine Room



Block Assembly (9)

Plate Jointing | Assembly

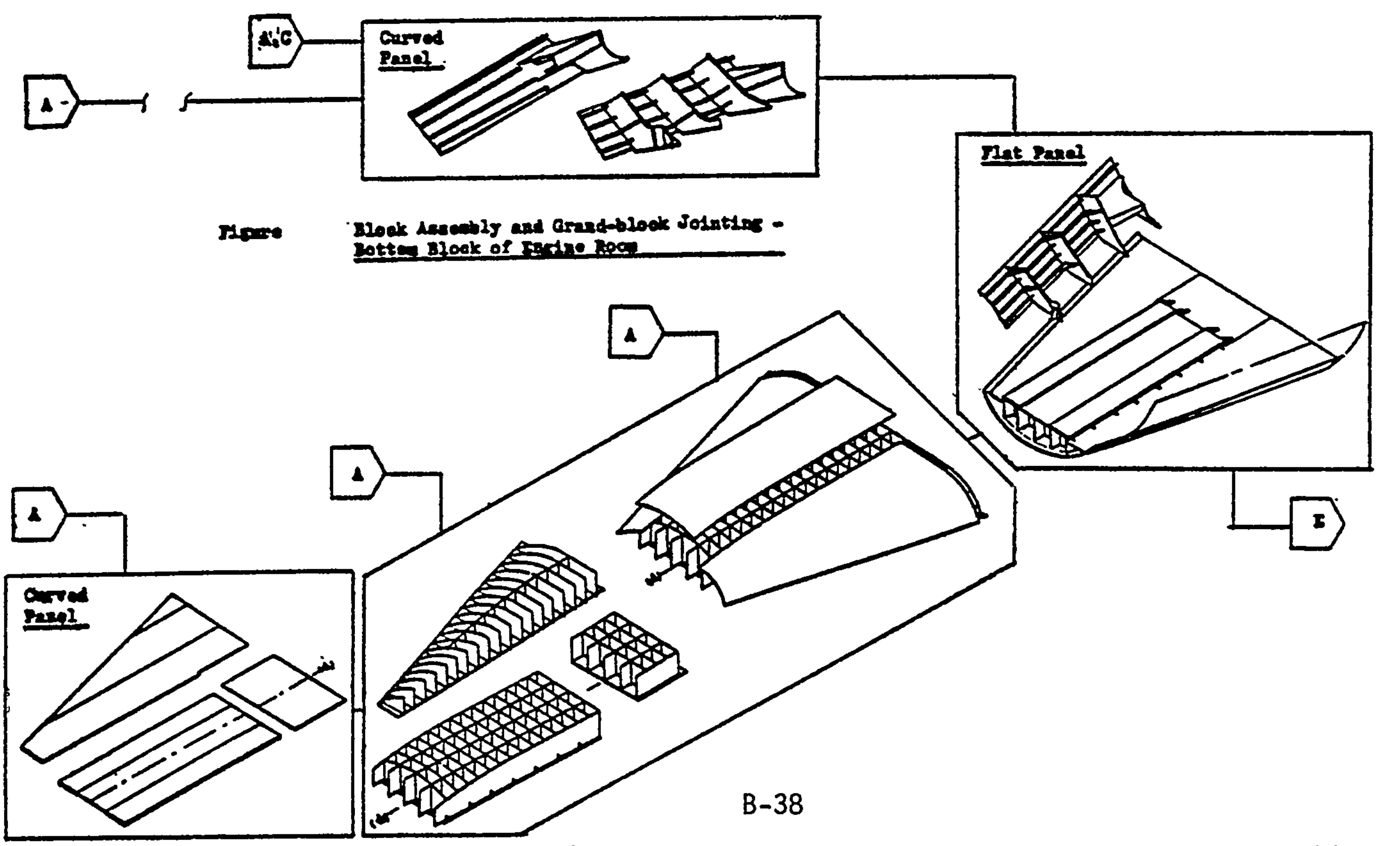


Figure Block Assembly and Grand-block Jointing - Bottom Block of Engine Room

Plate Jointing | Block Assembly (10) Assembly | Grand-block Jointing (5) Jointing

3. Product Resources

The Product Resources in the manner of PWBS (Product-Oriented Work Breakdown Structure) are defined as input items to be allocated to some of the Work Packages by each ZONE for the purpose of assembling all sets of SYSTEM for ship's operation. All of the Product Resources shall be, therefore, requested to identify in the dimericity: their belonging ZONE and SYSTEM.

The dimeric identification is easily satisfied to the material but the manpower, facilities and expenses. The approach to the solution of the difficulties for the manpower will be also discussed in this section.

3-1 Material

The materials including interim products are one of the Product Resources, which are directly allocated into their specified Work Package transformed to a interim product, and finally assembled as part in one of the SYSTEMS operating a ship.

Identification of all the materials is configured for the aforementioned purposes, by:

Material Code identifies what the material is about, its detail descriptions of kind, type, size, grade, etc.

Piece No. identifies serially by each SYSTEM what part of the SYSTEMS the material is assembled in.

- Work Package No. (W/P No.) identifies at which level of the PWBS, on which ZONE, by what AREA, and at which STAGE materials are assembled per ship. These identifications are made by the W/P No. which is integrated by the Level No., ZONE No., AREA No., and STAGE No.

- Material Cost Classification No. (MCL No.) classifies which SYSTEM materials belong to per ships.

1) Material Identification

Figure 18 tabulates the material identification which is made on each of raw materials of HBCM (Hull Block Construction Method), and raw materials and components of ZOFM (Zone Outfitting Method) for their individual allocation to their Work Package. Material identification codes "what the material is" by the Material Code, and "what the material is used piece by piece for each of SYSTEMS" by the Piece No.

The definition extent of the material code is different among its hierarchical groups by:

- Work Shop: Hull Construction, and Outfitting and Painting
- Commonness: Steel material of shipbuilding grade, Common Material commonly used for all the shops such as pipes, pipe fittings, access ladders miscellaneous raw materials, etc. , and Non-common Material.

- Requisition Classification:

  Allocated Material (A-material) to be requisitioned by quantity specified per ship at the time of design.

  Allocated Stock Material (AS-material) to be requisitioned by quantity specified per ship at the time of design plus some surplus reserved for unforseen incidents.

  Stock Material (S-material) to be requisitioned by the most economical quantity estimated by using past statistical data and forecasts of the shipyard entire work load.

- Standardization:

  For Steel material of shipbuilding grade, sketch-sized material individually varied in size (Sketch Size), standard-sized material commonly used for a certain ship (Standard within a ship), and standard-sized material commonly used for any type of ships (Standard)

  Ž For fitting, individually standardized material defined in detail one-by-one (Individual), and non-standard material defined family by family (Family).

The steel materials of shipbuilding grade for Hull Construction can be defined by material/grade/size for any materials of plate, angle, etc. for material procurement. While, the raw materials and components for the Outfitting are defined about the Individual in full description for their one-by-one identification, but about the Family in family description. These two types of descriptions are very serviceable for material procurement. The Individual can be defined by the Material Code one-by-one, but the Family shall be by it family-by-family and detailed one-by-one by the Piece No. specified in their purchase order specification from time to time. Otherwise, its quantity goes up to tremendous numbers.

"System" in this code for the Non-Common Material is very convenient as a part of the material codes which are usable for industry of shipbuilding division.

> "System" is slightly different from the SYSTEM of the Product Aspects shown in Figure 19. The machineries, equipment, etc. are separate from components of pipe lines in the "System" for the convenience of cost estimation, but not in the SYSTEM for designing and producing.

"Blank: in the code for Common Material shall be filled by the "System", when its "System" is specified for its material to be assembled in. This "System" is commonly usable as a tool of standardization to define not only for the material identification but also for the Material Cost Classification and any others as applicable.

While, Piece No. defines its belonging SYSTEM and positi each piece (Part for HBCM and Component for ZOFM) corresponding to Ship No. /SYSTEM in its SYSTEM plan or piping diagram and in its piping and component fitting drawing as shown in Figure 7.

Piece No. for the Part is hierarchically configured as Ship No./Grand-block Code/Block Code/Semi-block Code/Sub-block Code/Part Code as shown in Figure 9. Some of those codes may be blanked as unnecessary. It is more preferable that the serially numbered Part Code defines the type of raw material used, and the SYSTEM and shape of part, and that the Block Code defines the position of a hull body.

Piece No. for the components is configured as Ship No. / SYSTEM Code/Serial No./Component Code.

Component Code signifies a material family which sufficiently indicates a type of components respective to their SYSTEM: namely, in a pipe line, pipe piece, valve, ejector, tank, pump, etc.

The Material Code is mainly utilized for specification Material in the material procurement and the Piece No. is utilized for piece identification in the designing and producing of work-in-process.

2) Material Grouping to Control Groups

Each of the materials belongs to both SYSTEM-oriented and/or ZONE-oriented control groups during its processing through all the functions as shown in Figure 6.

The W/P No. identifies a material, its ZONE-oriented control group for the ZONE-planning, Scheduling, Producing and Accounting, and the MCC No. identifies the same material its SYSTEM oriented control group for the SYSTEM-planning, Accounting and Estimating. The data for all the materials can be transformed from the SYSTEM-oriented to the ZONE-oriented and transposed from the ZONE-oriented to the SYSTEM-oriented as shown in Figure 2, using identification of both the Material Code and the Piece No.

Figure 9, 12, 15 and 17 shows the concepts of compositions of W/P No. in each PWBS, and Figure 18 shows, as a sample, the code system of MCC No. which is employed in IHI.

3-2 Manpower

The manpower are also one of the Product Resources, directly allocated into the respective Work Packages by ZONE, and charged to assemble an interim product of every level which will be finally a part in one of the SYSTEM operating a ship.

Identification of all the manpower is configured for the above purposes by:

Organization Unit Code identifies which shop a worker to be grouped into by shipyard, work shop, shop and trade.

<u>Personal No</u>. identifies each worker.
<u>Work Package No</u>. identifies the allocation of the manpower by Level No. , ZONE No. , AREA No., and STAGE No. This is the same one as for the material.
Cost Center Code (<u>Manpower Cost Classification</u>) classifies the manpower charged on each Work Package into the control group summarized by the similarity in the index of Accounting.

1) Personal Identification

Personal Identification is made on each worker of every trade per shop for his allocation to his Work Package as tabulated in Figure 21. The personal identification codes "which unit the worker belongs to" by the Organization Unit Code, and "who is he" by the Personal No.

This No. is applicable for all employees other than the direct workers.

The Organization Unit Code is hierarchically structured by five levels of Shipyard/Type of Work/Fabrication or Assembly/Shop/Trade. The Personal No. is assigned to every worker in series per shipyard. The Organization Unit Code is utilized for the Manpower Cost Classification as a partial composition of the Cost

Center. The Personnel No. is not so but for worker's payroll only.

2) Manpower Grouping to Cost Center

Different from the materials, the manpower has difficulties to identify itself in the aspect of SYSTEM, because it is charged on the Work Package as PWBS regardless of the SYSTEM aspect. SYSTEM-by-SYSTEM identification of manpower results in considerably inaccurate data only, even if being tried hard for its sorting so. It is a short cut, therefore, to find out a alternative approach. Cost Center is one of the alternatives of the grouping approach to the SYSTEM-by-SYSTEM identification of manpower.

Each of Cost Center includes manpower charged to the Work Packages which are grouped within each of the Organization Unit (Shipyard/Type of Work/Fabrication or Assembly/Shop) by the following statistical conditions:

its index for the purpose of the Accounting to be presentable by the same dimensional unit as shown in the Production Progress and Manpower of Figure 20.

its value of productive efficiency for transposing the manpower data from

ZONE-BY-ZONE to SYSTEM-BY-SYSTEM to be constant under the same dimensional unit as shown in the Efficiency of Productivity of Figure 20.

The Cost Center grouped-the Work Packages under those conditions ensure constancy in systemization of Accounting by ZONE on the basis of PWBS. Simultaneously, its data can be transposed to meet themselves the purpose of the Estimating by SYSTEM. For this grouping, Level and AREA are usable, but ZONE and STAGE are eliminatable with some exceptional cases.

Figure 21 shows all elements usable for the Manpower Classification. The hierarchical combinations of some of those elements enable to severally make the said Organization Unit Code. Personnel No. and Cost Center Code as shown Figure 21.

The method of transposition of manpower data from by ZONE to by SYSTEM will be discussed in 3.2

4. Accounting and Estimating Method of Production in PWBS

As shown in Figure 6, the SYSTEM-oriented Estimating is developed to the SYSTEM-oriented design and transformed to ZONE-oriented design for progressing the Scheduling and Producing.

This process is illustrated in Figure 7.

With the ZONE-oriented Producing in progress, the Accounting must correct, sort, and analize the Producing data in the same manner which enables the management to evaluate the shipbuilding process per ship in production progress and cost. Those data sufficiently satisfy the management but must be transposed to the SYSTEM-oriented statistical data for estimating a ship or its SYSTEM of a future contract.

In this section addressed are how to process the follow-up, the evaluation and the transposing of those data to serve the functions of Accounting and Estimating:

- for each control group of the similar nature of Work Packages.
  on the basis of the manhours and the production progress indexes particularized for each control group, and
- by the efficiency of productivity for each control group.

4-1 Follow-up of Progress in Production

Follow-up of progress in production can be implemented with using some representative indexes proportionally indicating the progress status and their corresponding manhour indicating the manpower consumption.

The progressive data of Producing are summed and reported on the Progress Curve of Production, The reported data are to be compared with their budget for evaluation of production on its half way and at its completion.

The practically applicable indexes are taburated in Figure 20.

The manpower index is employed manhour in all cases. The production progress indexes are weight, length, piece, parametric component weight, DM and BNL.

Parametric component weight includes only component weight correlative between the manhour of manpower consumption and the component assembled at the levels of unit, on-block and on-board.

DM is abbreviation of Deposit Metal of welding, namely welding colume;

Sectional area of welding deposit x welding length

BNL is parametric welding length, which is weighed by difficulty of welding positions such as flat, vertical, over-headed, etc., only used for the level of erection.

Inherency of Type of Work/Shop chooses some of those indexes for each prescribed purpose.

The follow-up of progress in production is implemented to present the data of the production progress and the manpower consumption by those indexes in table and graph per ship.

Figure 4.1 to 4.5 exemplifies those graphs. The curve each, which is made by the summation of the data in every Work Package, signals a sign of the manpower consumption on, over or below its budgetal manhour and of the real production progress on, early or data schedule.

By these data, the leveling, expediting, converting, etc. of work load are flexibly made. Also the follow-up and control by the comparison between the manhour of budget and consumption is performed by each organizatio unit management through the corresponding Cost Center.

4-2 Evaluation of Efficiency in Production

Evaluation of efficiency in production is performed with substituting the data of production progress and manpower used for the follow-up of progress in production.

Figure 20 shows various dimensions which are used for the evaluation of efficiency in production for each control group. Figure 4.6 to 4.11 exemplifies those groups.

The elements of division of Cost Center, tabulated in Figure 21, may be eliminated for making the Control Group of Efficiency in Production for the Evaluation.

(CGEPE) . The constraints on this elimination are:

the Cost Center to be under the same hierarchical tree structure.

the' dimension of efficiency of the Cost Center to be same, and

the equal value of the parameter to be applicable.

For instance, as shown in Figure 4.9, the Machinery Shop eliminates the trades, ZONE, AREA and STAGE from its Cost Center for making its control group. Because all values of the efficiency of Work Packages which belong to one of the Level distribute within allowable range from a mean efficiency. Then it is practically used *as* a common parameter for all the Work packages of the same CGEPE.

4-3 Formulation for Manpower Estimating of SYSTEM-by-SYSTEM Data by ZONE-by-ZONE Data

The procedure of the evaluation of efficiency in production secondarily provides parameters which are employed for manpower estimation. These parameters transpose the ZONE-by-ZONE data of Accounting to the SYSTEM-by-SYSTEM data of Estimating for each CGEPE.

Figure 20 shows those parameters per Type of Work/ Shop. They should be further divided by Trade, Level, ZONE, SYSTEM, and STAGE - elements of the Cost Center - subject to the distribution curve of efficiency value of each Work Package.

However, there are the other assembling parts and components impossible to estimate manpower consumption by this formula, because of no correlativity between the manpower consumption and the production progress index, such as main engine, boiler, the other auxiliary machine, equipments hatch covers, etc. In this *case,* the estimation is compelled to be severally made on the basis of the data inherent to those components. Those data by the past experience must be, therefore, preserved for the future estimation of similar items.

Thus, the manpower consumption estimation are simply formulated as follows:

Hp = ejvj

Hc - hj

Where:

j . . . A number for each CGEPE

Hp ..... Total sum of manhour calculated by parametric estimation of manpower to be spent for *a* SYSTEM

e ..... A efficiency parameter for each CGEPE

v ..... A valuable of Production Progress Index, input to each CGEPE; Total of "v" will be total sum of *all* the input to a whole SYSTEM.

j ..... A number of each component

Hc . . . . . Total sum of manhour by several manpower estimation to be spent for a SYSTEM

h ..... Manhour of several manpower estimation to be spent for each component

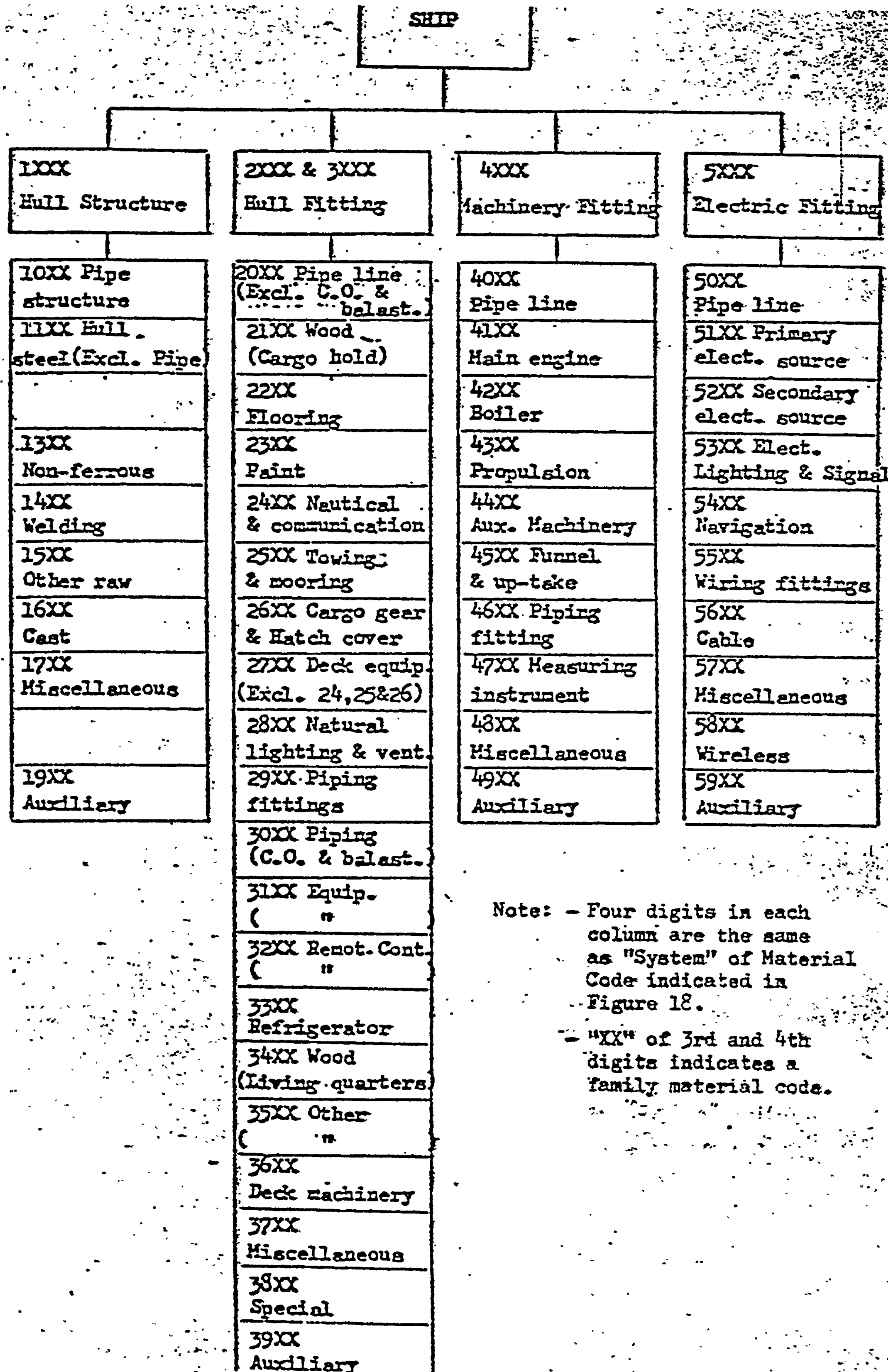
Finally, Total of manpower estimation for whole a SYSTEM is formulated as follows:

$$Ht = Hp + Hc$$

		Material Identification				Identification on Ship
	W/S	Commonness	Requisition Classification	Standardization	Material Code	Piece No.
Material	Hull Construction	Steel material of shipbuilding grade	AS	Sketch size	Material/grade/size	Ship/Block/Semi-block/Sub-block/Piece No.
				Standard within a ship		
				Standard		
		Other material	Same as Fitting			
	Outfitting and Painting	Common	AS & S	Individual	Blank/Full description	Ship/System/Serial No./Component Code.
				Family	Nil	
			A	Individual	Blank/Full description	
				Family	Blank/Family description	
		Non-common	AS & S	Individual	System/Full description	
				Family	Nil	
			A	Individual	System/Full description	
				Family	System/Family description	

Figure 18 Identification Codes for Material

A ...... Allocated Material
AS ...... Allocated Stock Material
S ...... Stock Material



Note: – Four digits in each column are the same as "System" of Material Code indicated in Figure 18.

– "XX" of 3rd and 4th digits indicates a family material code.

Figure 19 Structure of Material Cost Classification

Type of Work/Shop				Production Progress Index	Manpower	Efficiency of Productivity
Hull Construction	Fab.			- Fabricated WT/ship	- Spent manhour/ship	- Spent manhour/Fabricated WT/ship
	Assembly	Sub-ass.		- Sub-ass. WT/ship - Sub-ass. DM*/ship	- Spent manhour/ship	- Spent manhour/Sub-ass. WT/ship - Sub-ass. DM/Spent manhour/ship
		Assembly		- Ass. WT/ship - Ass. DM*/ship	- Spent manhour/ship	- Spent manhour/Ass. WT/ship - Ass. DM/Spent manhour/ship
		Erection		- Erection WT/ship - Erection βNℓ*/ship	- Spent manhour/ship	- Spent manhour/Erection WT/ship - Erection βNℓ/Spent manhour/ship
Fitting	Fab.	Pipe		- Manufactured WT/PPML** - Manufactured pieces/PPML	- Spent manhour/PPFML	- Spent manhour/M. WT/PPML - Spent manhour/M. pc./PPML
	Assembly	Deck		- Parametric component WT***/ship	- Spent manhour/ship	- Spent manhour/Parametric component WT/Ship
		Int.		"	"	"
		Mach.		"	"	"
		Electric		- Laid cable length/ship - Connected cable pieces/ship - Parametric component WT/ship	- Spent manhour/Index of material/ship	- Spent manhour/Laid cable length/Ship - Spent manhour/Connected cable pieces/ship - Spent manhour/Fitted pieces WT/ship
Paint.	Assem.			- Coated square moter/ship	- Spent manhour/ship	- Spent manhour/coated M^2/ship

Figure 20 Parameters employed for Progress Reporting

**.... Pipe Piece Family Manufacturing lane

***.... WT of only components correlative [illegible]

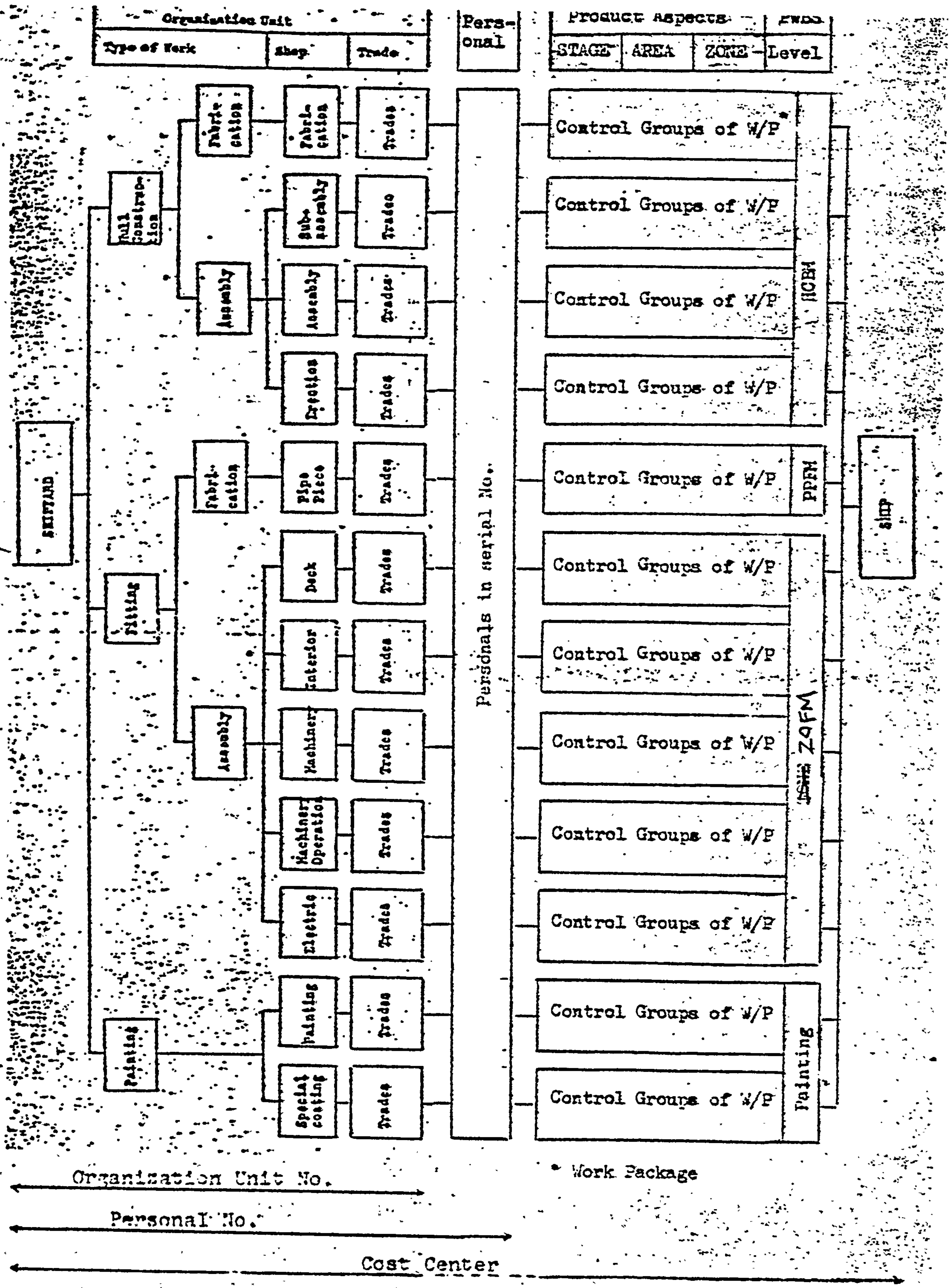


Figure 21 Structure of Manpower Classification

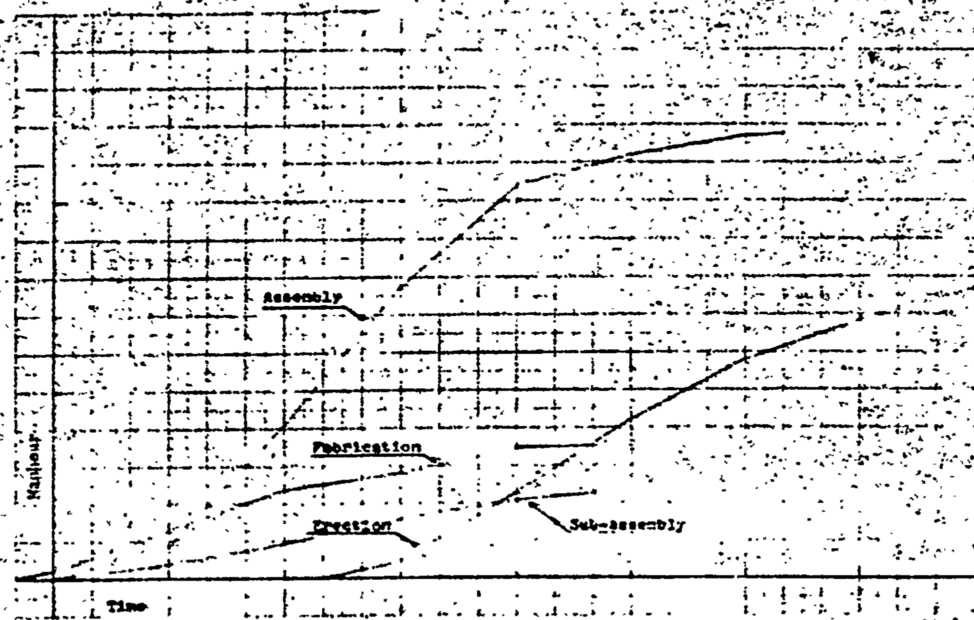


Figure 4.1 Production Progress in Manhour - Hull Construction

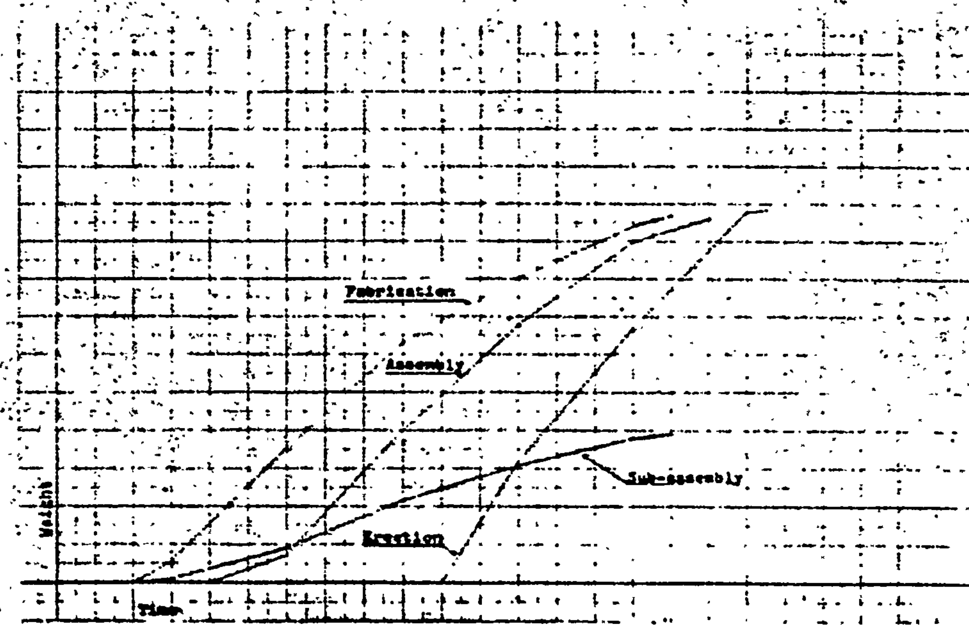


Figure 4.2 Production Progress in Weight - Hull Construction

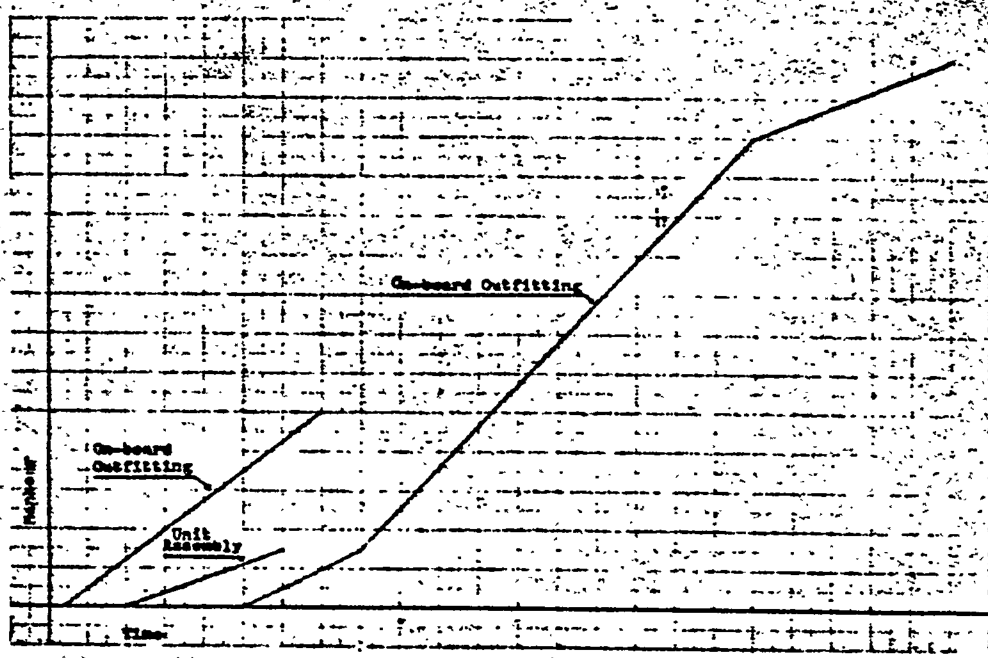


Figure 4.3 Production Progress in Manhour - Outfitting of Machinery Shop

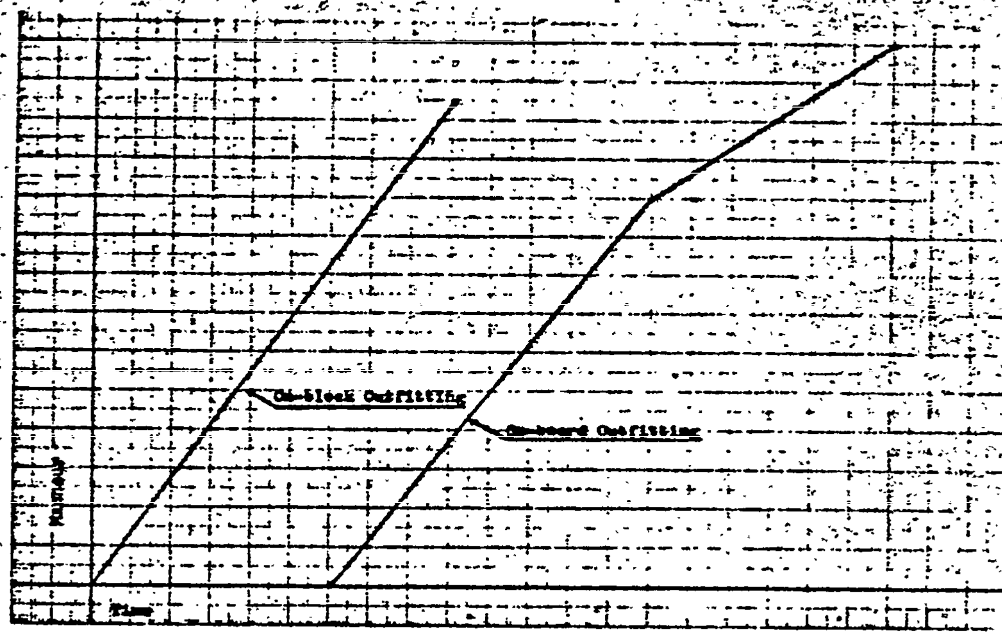


Figure 4.4 Production Progress in Manhour - Outfitting of Electric Shop for All Components Exept Cables

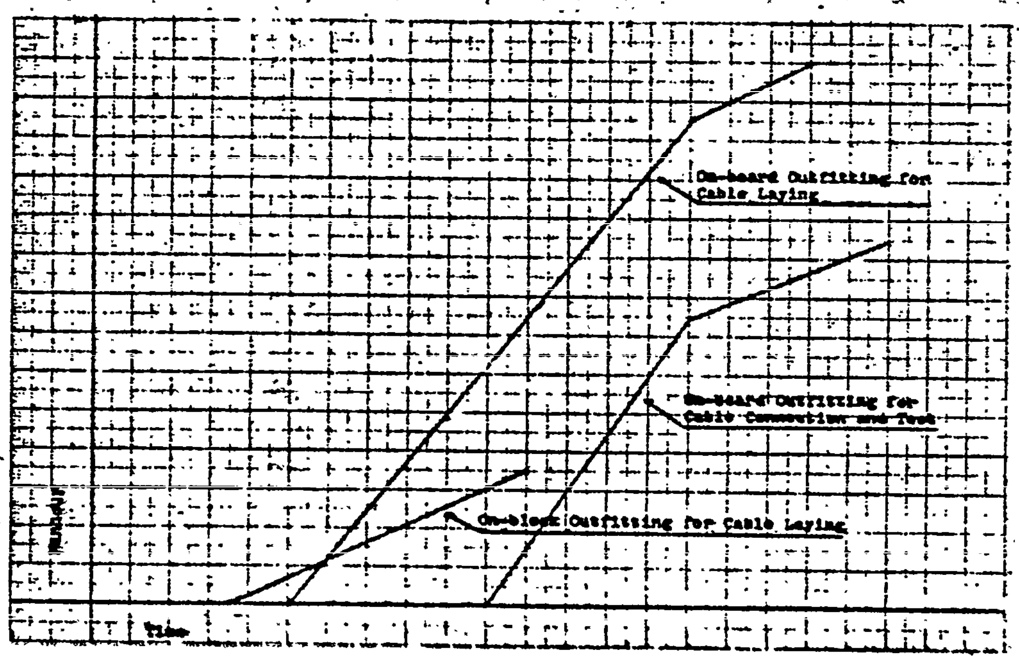


Figure 4.5 Production Progress in Manhour - Outfitting of Electric Shop for Cable

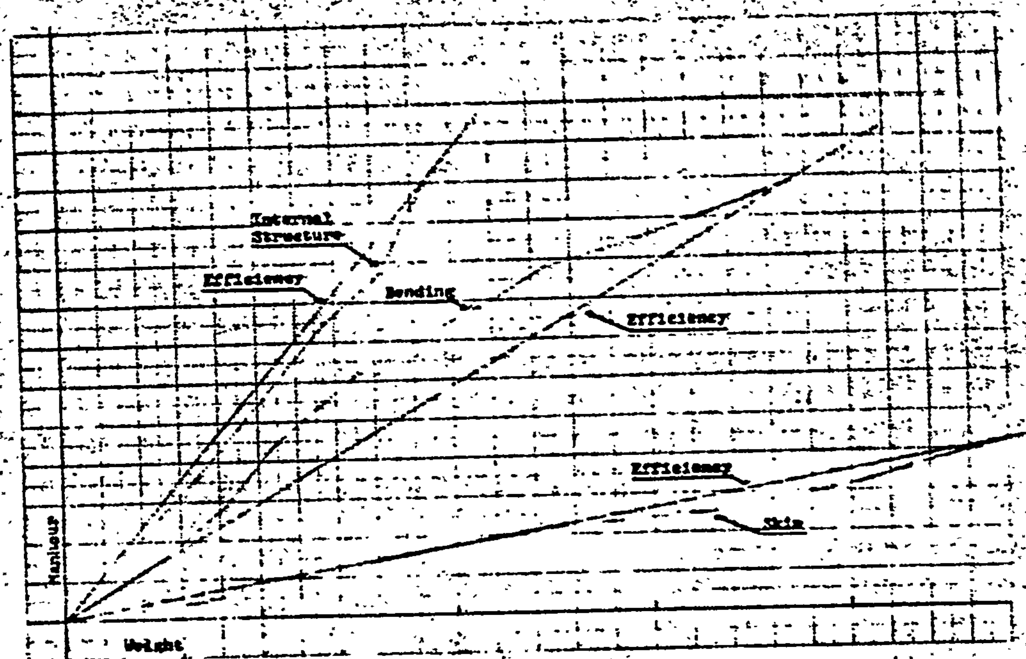


Figure 4.6 Production Efficiency in Manhour/Weight - Part Fabrication of Hull Construction

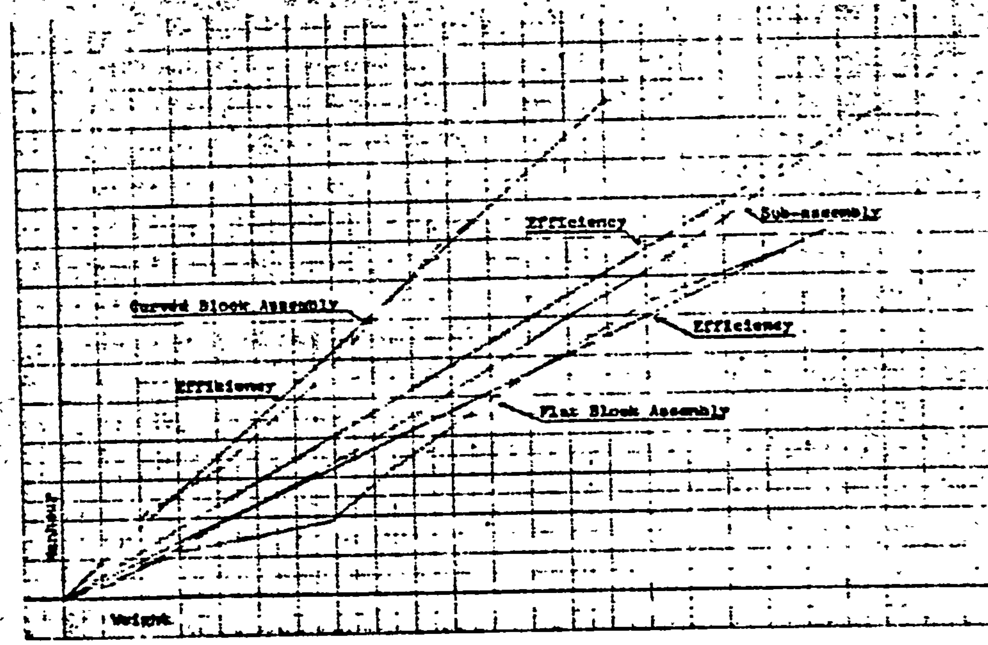


Figure 4.7 Production Efficiency in Manhour/Weight - Assembly of Hull Construction

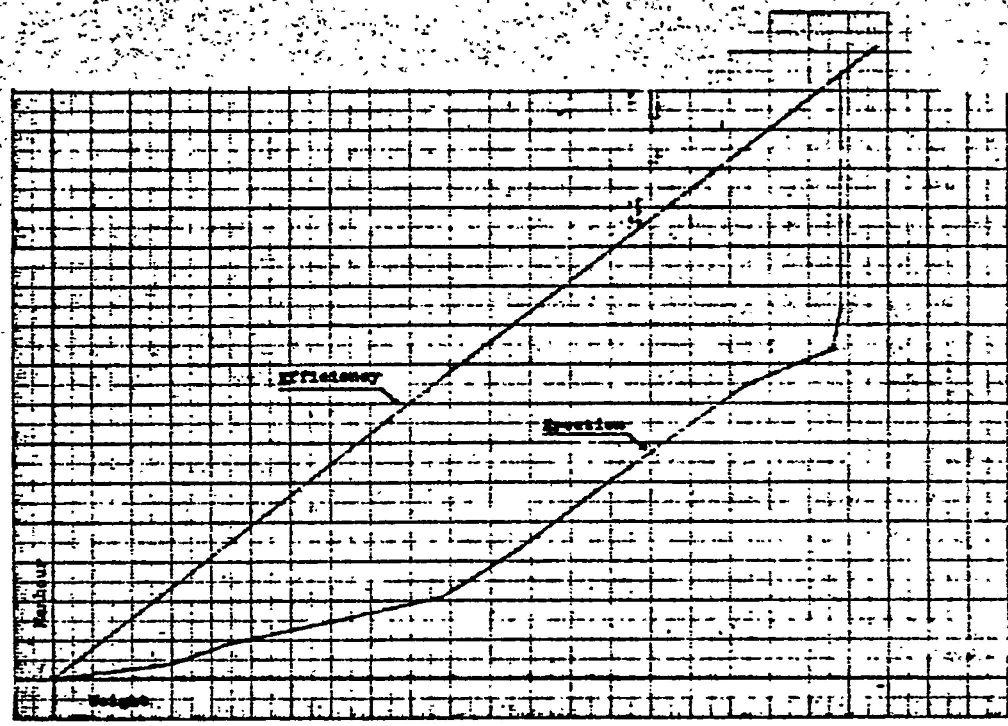


Figure 4.8 Production Efficiency in Manhour/Weight – Erection of Hull Construction

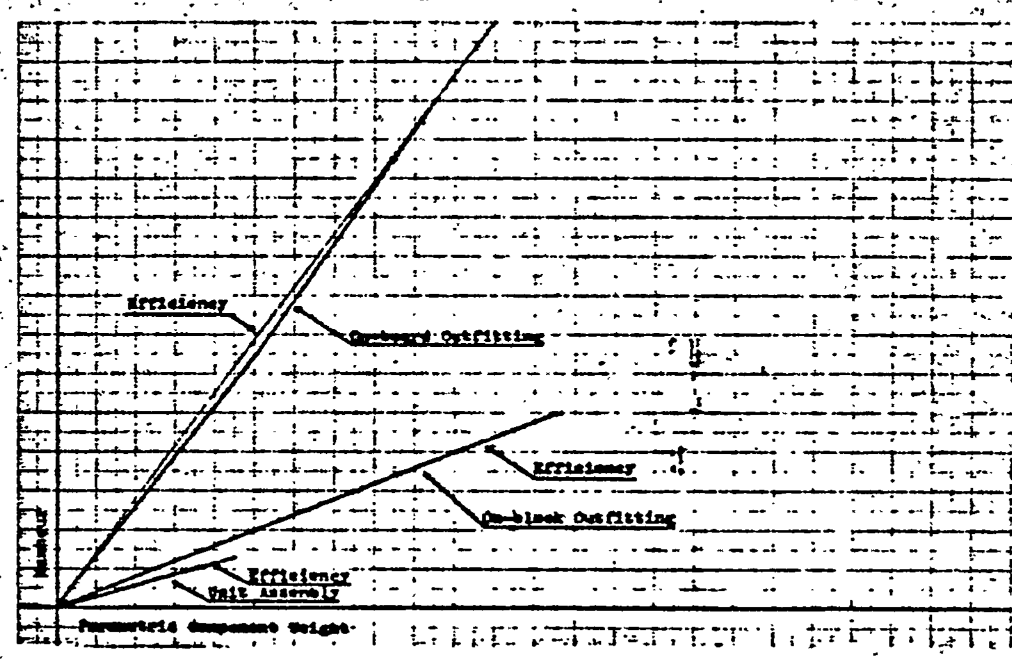


Figure 4.9 Production Efficiency Manhour/Parametric Component Weight – Outfitting of Electric Shop for All Components exept Cables

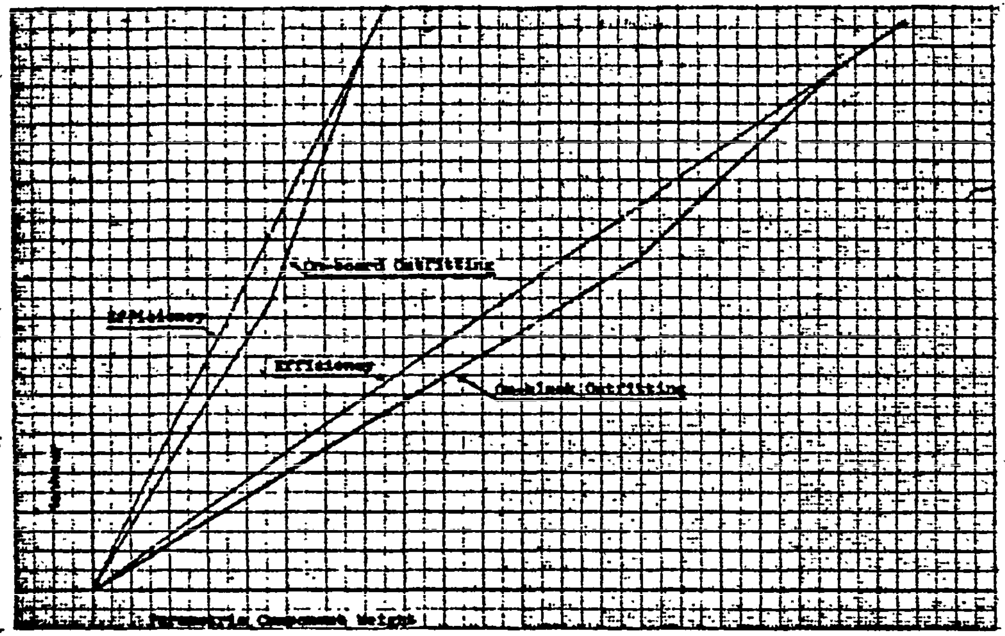


Figure 4.10 Production Efficiency Manhour/Parametric Component Weight - Outfitting of Electric Shop for All Components exept Cables

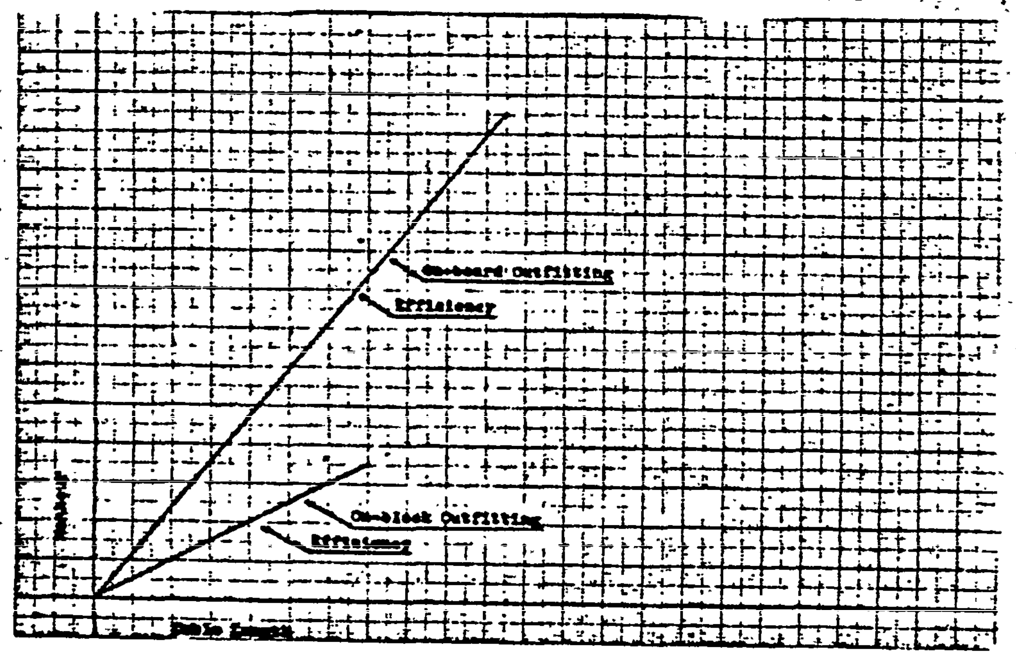


Figure 4.11 Production Efficiency in Manhour/Cables - Outfitting of Electric Shop for Cable Laying

APPENDIX C

EXAMPLE

HULL BLOCKING PLAN

UNIT DIVISION

The Object of Unit Division

How can we construct the huge, heavy, and complexed structure, like a ship, by limited manpower and limited facilities!?

To solve this problem, lots of trial and error have been done. After that, the shipbuilding method by unit division was established.

The unit division most appear as the most effective way to construct the ship in the shipyard.

The unit division should be the base of how to construct the ship.

B. The Basic Items to Divide the Ship

The basic items to be considered for dividing the ship should be as follows:

1. Division depended on actual capability of facilities.
2. Division to reduce the works on the ways.
3. Division to keep the constant flow of materials on slabs.
4. Division to make the unit construction method simple.
5. Division to make the outfitting jobs on the slabs easy.
6. Division to keep the important dimension of ship.

Descriptions for each item would be shown next.

1. Division Depended on Actual Capability of Facilities.

   1) The most important item to be prepared before starting unit division is to make the capability list. The items included in the list would be as follows:

      a. Minimum and maximum size of plate to be burned by planer.

      b. Capability of press and roller.

      c. Lifting capacity of crane for sub assembly.

      d. Lifting capacity of crane for final assembly or unit to unit.

      e. Maximum size of slab for unit.

   2) Depending on the capability list, decide the suitable size of each type of unit by zone.

2. Division to Reduce the Works on the Ways.

   The items to reduce the works on the ways would be separated as follows:

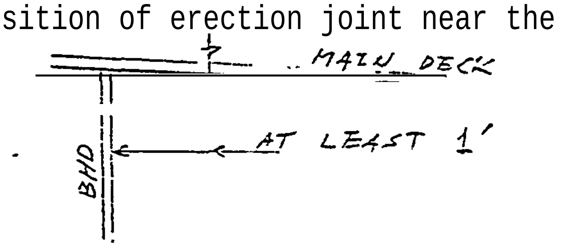
a. Make the cubic unit such as lower wing tank unit, or top side tank unit, because if the erection joints would be set in the tank, it will take more manhours to do the jobs for the joints on the ways than on the slabs. The wasted manhours will be estimated at least 3 times for the worst working conditions.

b. Reduce the erection joints using unit to unit method and without disturbing the material flow of assembly and fabrication.

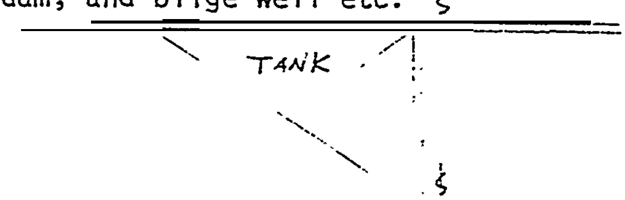
The only way to reduce the erection joints without disturbing the material flow of assembly and fabrication, is unit to unit method.

c. Set the position of erection joints at the most suitable place to be worked easy on the ways.

ex. 1. The position of erection joint near the bulkhead.



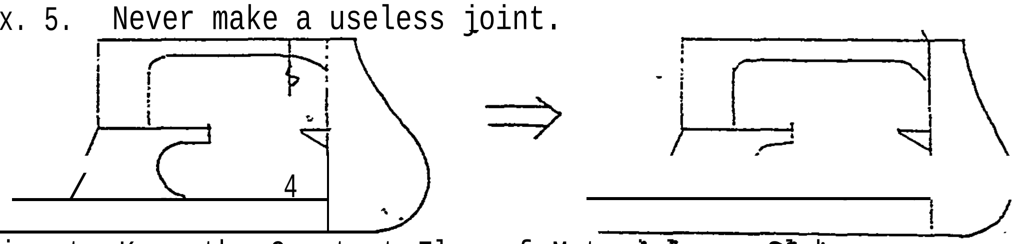
ex. 2. Never make the erection joints in the closed part such as tanks, cofferdam, and bilge well etc.



ex. 3. Turn aside the erection joints from the parts which have crowed internal structures.

ex. 4. The position of erection joints must be set at suitable place for shipping the materials, setting scaffolding, and supplying power.

ex. 5. Never make a useless joint.



3. Division to Keep the Constant Flow of Materials on Slabs.

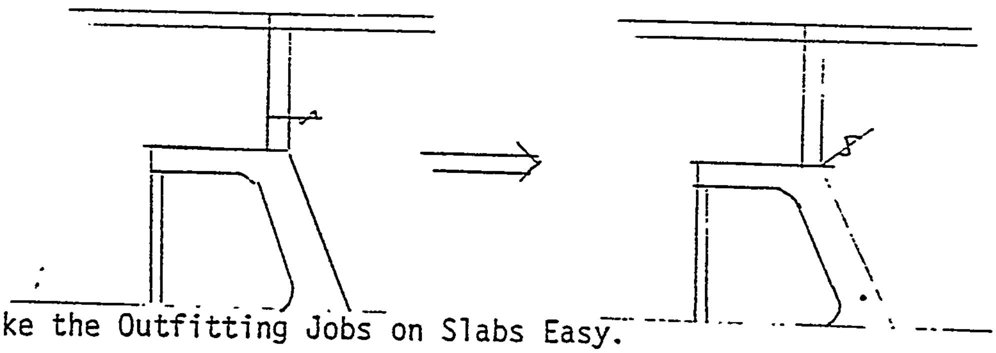
This item should be applied for units at Hold part, because the structures of this part are almost the same from aft to forward. Once the sizes of units are unified, the effects of repeat of construction would be great.

4. Division to Make the Unit Construction Simple.

a. The unit could be separated into more simpler parts, even if the unit were curved.

b. Divide the unit at knuckle part.

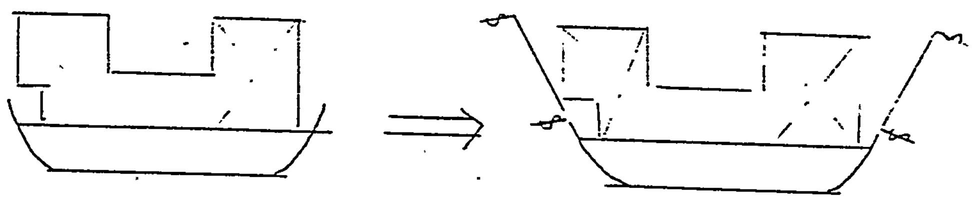
example:



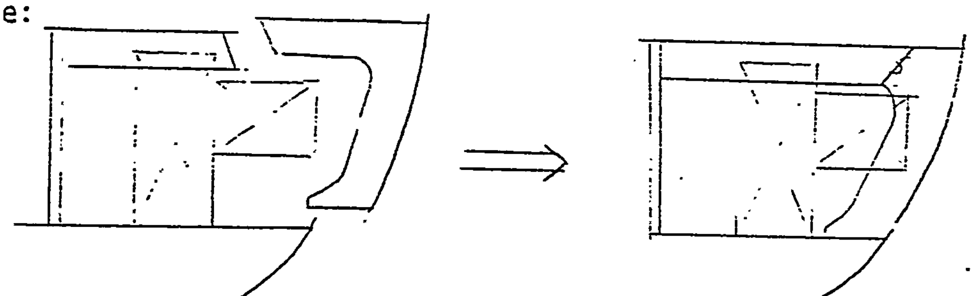
5. Division to Make the Outfitting Jobs on Slabs Easy.

This item should be applied for units at engine room part.

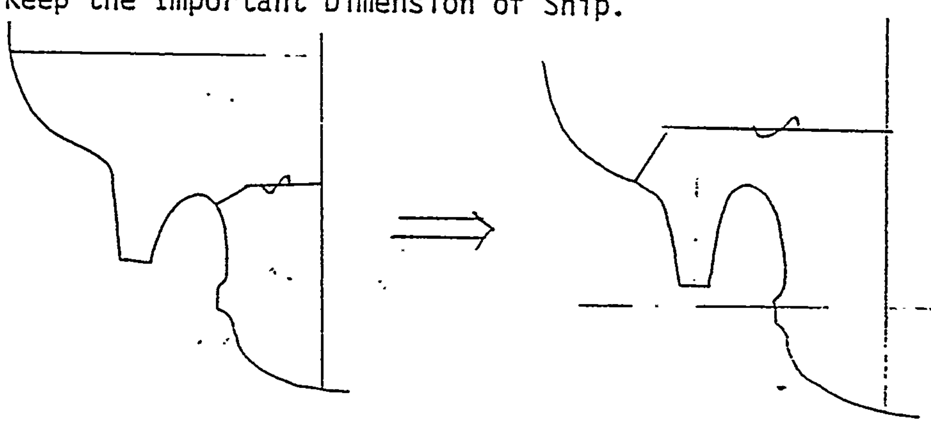
example:



example:



6. Division to Keep the Important Dimension of Ship.



In the above case, it is harder to keep the precise relation between rudder shaft center and shaft center.

In this above case, it is easier to keep the precise relation between rudder shaft center and shaft center.

C. Planning Steps

1. Basic steps to make the unit division.

	Steps	Appendix	Charge
I.	Make the Preliminary Unit Division	Capability List Mid Ship G/A M/A	Engineering
II.	Set the Preliminary Decision at Unit Division Meeting	Capability List Mid Ship G/A M/A	Engineering & Production Planning
III.	Make the Key Plans	M/S G/A M/A Structural Lines	Engineering
IV.	Investigation of Key Plans By Production Planning	C/L Key Plan M/S M/A	Production Planning
V.	Make the Final Decision at Unit Division Meeting	C/L Key Plan M/S M/A	Production Planning & Engineering
VI.	Make the Unit Arrangement	C/L Key Plan M/S M/A	Production Planning

Descriptions for each step are as follows:

Step 1. - Make the preliminary unit division.

Set the rough unit division on the sheet of mid ship and general arrangement as checking capability of shipyard.

Step II. - Set the preliminary division at the unit division meeting.

One of the most important items to set the unit division is to set the agreement between Engineering and Production Planning, because at the timing to decide the unit division, the basic ideas of constructing the unit should be settled concurrently. Therefore, this unit division meeting is very important.

Step III.- Make the Key Plans.

Depending on the preliminary unit division, the key plans will be prepared by Engineering.

Step IV. - Investigation of Key Plans by Production Planning.

This step is very important for Production Planning, because during investigating key plans, the production methods for each unit should also be established.

Step V. - Make Final Decision at Unit Division Meeting.

At this meeting, the key plans, the name of unit, and the construction methods for each unit should be decided.

Step VI. - Make the Unit Arrangement.

After deciding the unit division, the unit arrangement drawing must be prepared. (See Appendix 1)

The objects are as follows:

1) It is very clear to confirm the name of each unit, and the relation of each unit one to another.

2) This drawing is very effective in making production planning such as:

   Erection Master Schedule

   Preliminary' Add. Mat. Planning

   Baseline for Accuracy

   Preliminary Scaffold Planning

   Planning of Temporary Holes for Working

   Unit to Unit Planning

2. Detail Steps to Make the Preliminary Unit Division.

Step	I tern	Description
I.	Decide the Unit Division for mid ship part	On the copy sheet of mid ship.
	1) Set the suitable size (without length)	
	2) Set the basic idea of erection order.	
	3) Set the basic idea of unit fabrication	
II.	Decide the Unit Division for Hold part.	At aft and fw'd end of Hold part, several units would be curved. The basic structure is as same as another part. Should be treated as one zone.
	1) Set the suitable length of unit.	
	2) Set the suitable division for aft and fw'd part of Hold part.	
	3) Set the basic idea of erection order.	
III.	Decide' the Unit Division for Engine Room Part.	At the timing of planning preliminary plan, the precise dimensions of unit cannot be approved for this part, because there will be so many changes in the machinery arrangement after that.
	1) Set the rough size of unit.	
	2) Set the basic idea of erection order.	
	3) Set the basic idea of unit fabrication.	
IV.	Decide the Unit Division for Aft Peak Tank Part.	
	1) Decide the rough size of stern frame unit.	At this timing, make it clear the basic idea of casting and how to construct the stern frame part.
	2) Set the rough size of unit for other part.	
V.	Decide the Unit Division for Fw'd Peak Tank Part.	Fw'd deck part must be treated as fw'd peak tank part.
VI.	Decide the Unit Division for Deck House.	

Descriptions for each steps are as follows:

Step I.

As checking the basic items (refer B.), decide the position of erection joint. For the Bulker, there are some basic ideas about unit division as follows: (see Appendix 2)

i. Double Bottom Part

Never make the erection joint in the center duct part. Joint①

ii. Bilge Part

The shell plate of bilge part should be cut at the same level of tank top. Joint②

It is easier to construct this part on slab and to keep the precise tank top height.

iii. Side Shell Part

Upper joint of shell plate③should be set at near the part of cross point with top side bottom plate.

iv. Stool Part-

Depending on the weight of stool, it is possible to erect this unit in one piece, but adjust the alignment between internal structures of stool and internal structures of double bottom.

It is best to separate the unit into 2 pieces, and then Joint④ is necessary.

v. Corrugated Bulkhead Part

The width of this unit is huge. To construct this unit on slabs, it is best to separate the unit into 2 pieces, and then Joint⑤ is necessary.

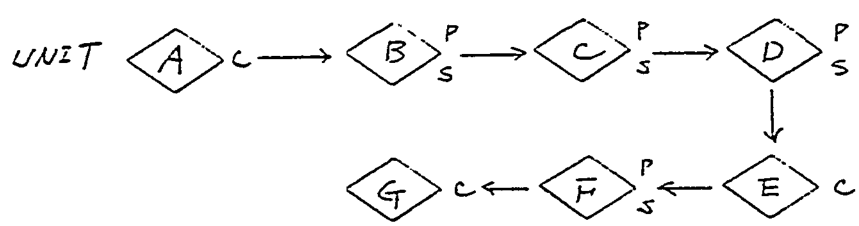
After checking the weight, this unit should be made in unit to unit before erection.

vi. Main Deck Part

To separate the center main deck from top side tank unit, Joint⑥ is necessary.

Top side tank must be completed on slabs.

vii. Basic Ideas of Erection Order



Step II. (See Appendix 3)

i. It is best to keep the butt joints one line from the bottom to the top of ship.

ii. It is necessary to make the units same length as much as possible.

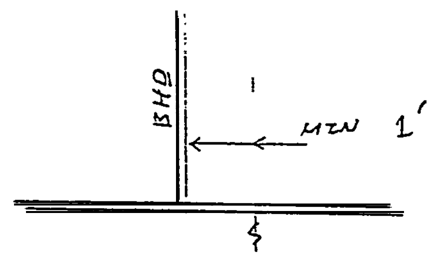
Note: The units of completely flat part must be divided in same size.

iii After rough division, these following items must be checked:

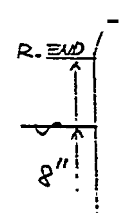
aa) Minimum distance from bulkhead

This item must depend on standard of shipyard.

Usually as follows:



bb) Minimum distance between radius end of hatch opening corner and erection joint.



cc) It is necessary to check the actual unit length of curved part whether this length would be over the standard size or not.

dd) It is necessary to check the position of outfitting equipments.

iv. After checking these items, correct the division once again, and then the final division for Hold part would be completed.

Step III. (See Appendix 3)

i. Double Bottom Part

aa) It is best to make the double bottom unit as big as possible. This part of the structure is complex and has slot of equipment on it. It is very difficult to make the joints at this part.

bb) As discussing with outfitting side, decide the position of joints on machinary arrangement. Joint ① cc) Never make the joints in narrow parts such as L.O. Sump Tank, echo sounder space, and *bilge* welJ ect. Joint(2)

dd) In case the main engine is diesel, it is best not to make the joint under the main engine sheet and reduction gear sheets. Joint(1)

ii. Shell Part

aa) The position of fwd butt joint, which is in contact with hold part, would be set just behind the main bulkhead keeping out the slant part of bulkhead. Joint(1)

bb) It is best to make the unit as big as possible. There are two (2) reasons as follows: Joint(2)

o The main job for this part on the ways should be outfitting works, because the outfitting works whould be critical of shipbuilding term. Hull construction works on the ways must be reduced for the sake of avoiding the mixed works between outfitting and hull construction in narrow space.

° The bigger the unit is, the better for installing equipment.

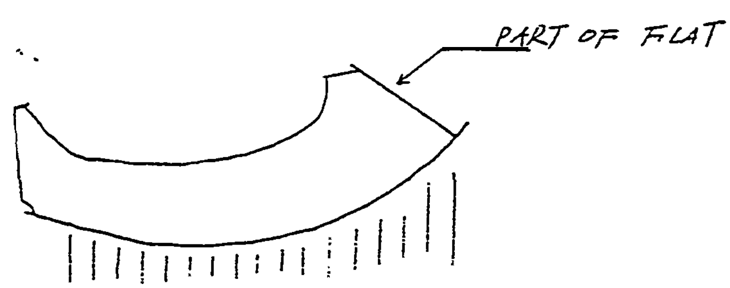
cc) It is very convenient for installing outfitting modules on tank top on slabs to put the shell plate which should be height enough to cover the height of modules. Joint(3)

dd) The seam joint must be set in parallel with engine flat. Joint(4)

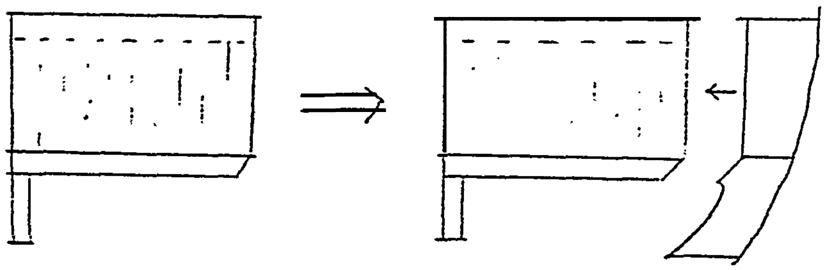
iii. Engine Flat

aa) This position of butt joints should be decided depending on the joints of shell plates.

bb) Usually these flats should be joined with shell plates. At this case, the part of flat would be joined with shell plate on slabs to keep the shape of curve.



cc) The control room or work shop should be comleted indedendently before jointing with shell part.



iv. Main Deck

aa) Basic ideas are the same as shell plate part and engine flat part.

bb) Considering the installation of main engine and other big equipment, make restored units. Unit(1)

cc) Never make the joint in closed part or in tank. Joint(2)

Step IV. (See Appendix 3)

i. The position of butt joints which are contacted with engine room part must be set at fwd part of aft peak tank bulkhead. Joint(5)

ii. It is better for constructing stern part to separate the rudder horn part from stern frame part for the first time. Joint(6) (And before erecting these, joint together.)

iii. The position of joint for stern part must be decided at best place to keep the accuracy of rudder center and shaft center on slabs. Joints(6)and(7)

iv. The unit at under part of S.G. flat must be one unit on slab, because this part has the complexed structures. Unit(8)

v. The unit at under part of main deck must be one unit on slabs with transom, because on the S.G. flat there are some equipments and slot of outfitting jobs. Unit(9)

Step V. (See Appendix 4)

i. The position of the butt joint which is contacted with hold part i must be set aft part of fwd peak tank. Joint(1)

ii. It is best to avoid the bell mouth part. Joint(2)

iii. To make it easy for the construction of the bulbous bow, the joint must be set just behind the non-tight bulkhead. Joint ③

iv. The unit at the chain lockers part must be big enough to install the chain lockers on slabs. Unit ④

v. The position of the joint on forecastle deck should be kept out from the place of windlass. Joint ⑤

vi. The unit at forecastle deck should be erected in one piece with bulwark plates on slabs. Unit ⑥

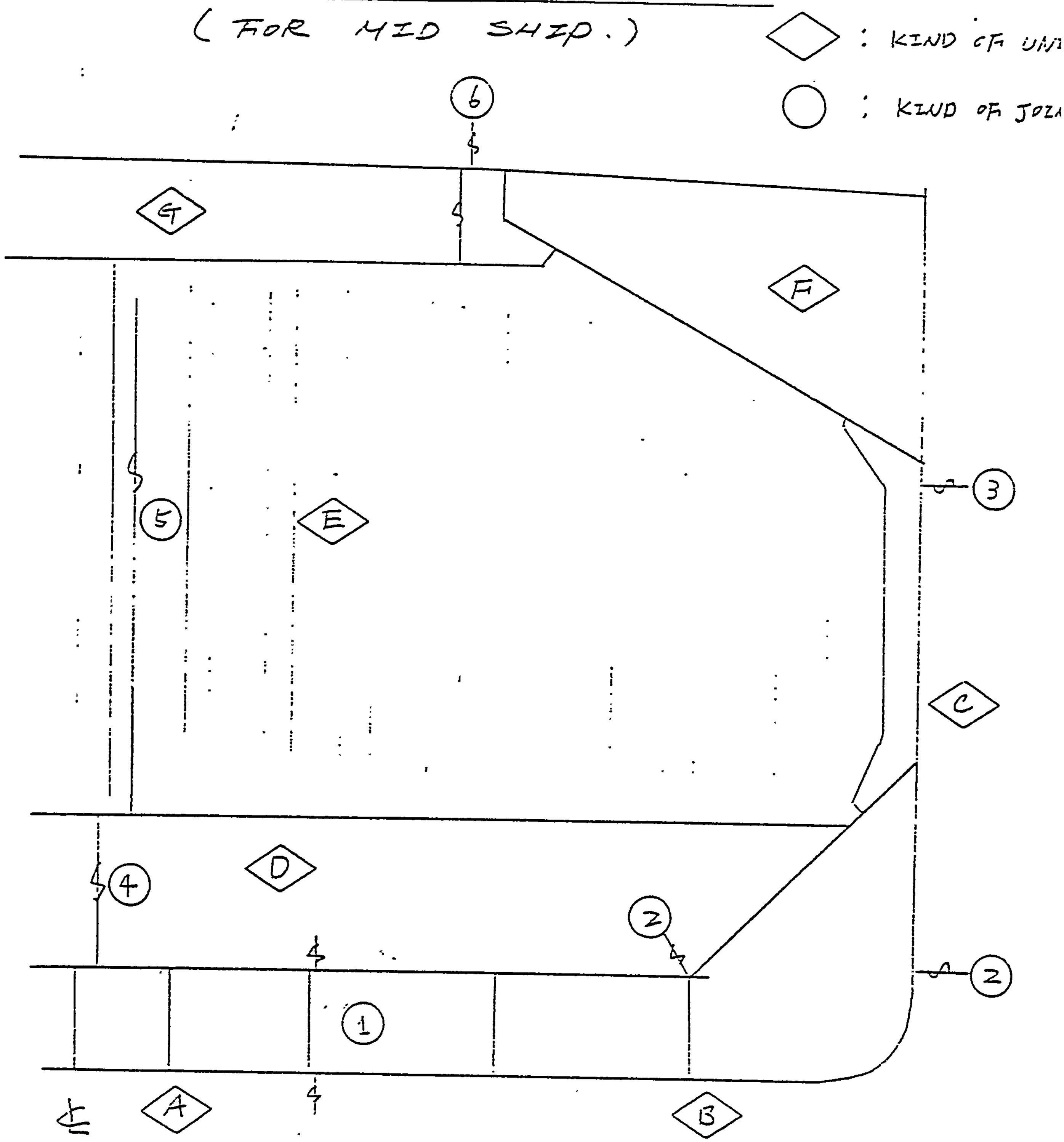
Step VI.

i. The walls must be joined with ceiling on slabs by unit.

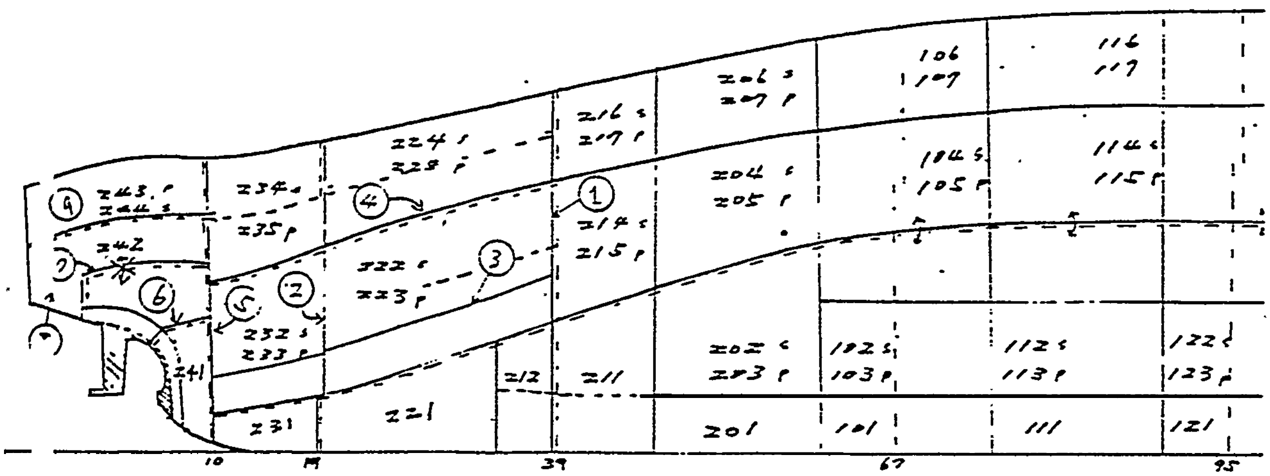
ii. It is best not to make the joints in CO_2 room, refrigerator room, or fan room etc.

APPENDIX - 2.

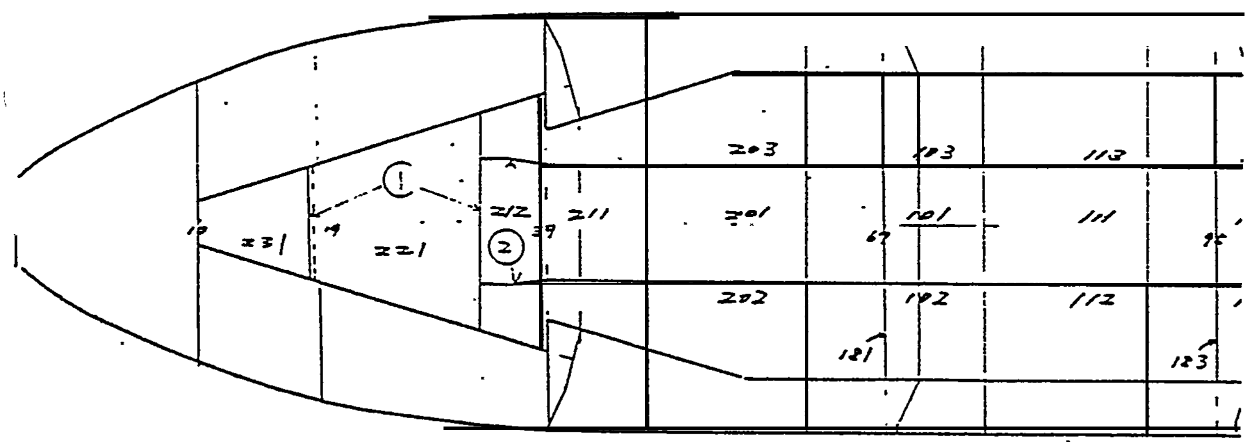
STANDERD UNIT DIVISION
(FOR MID SHIP.)



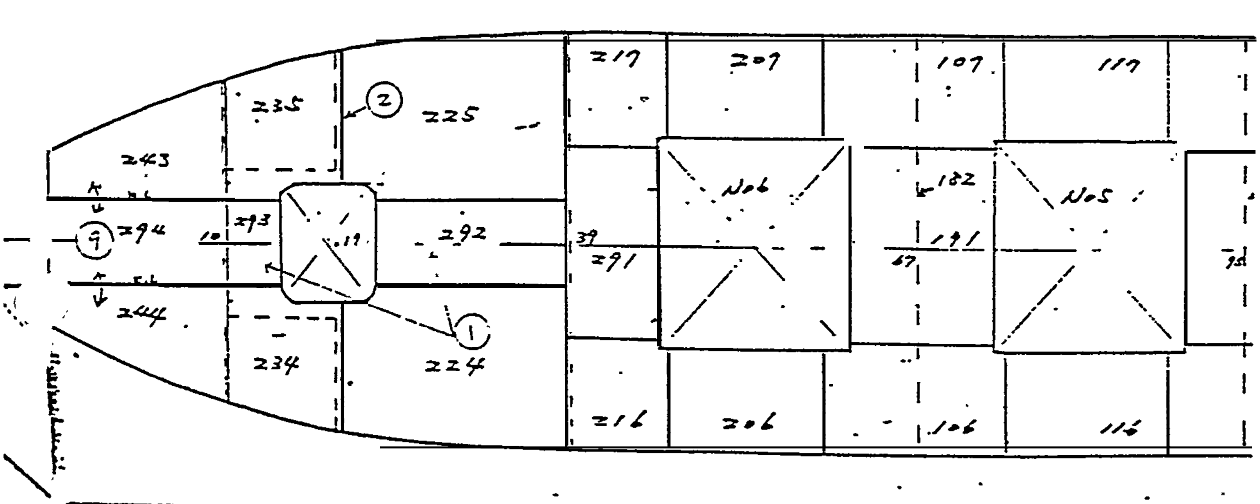
SHELL EXPANSION

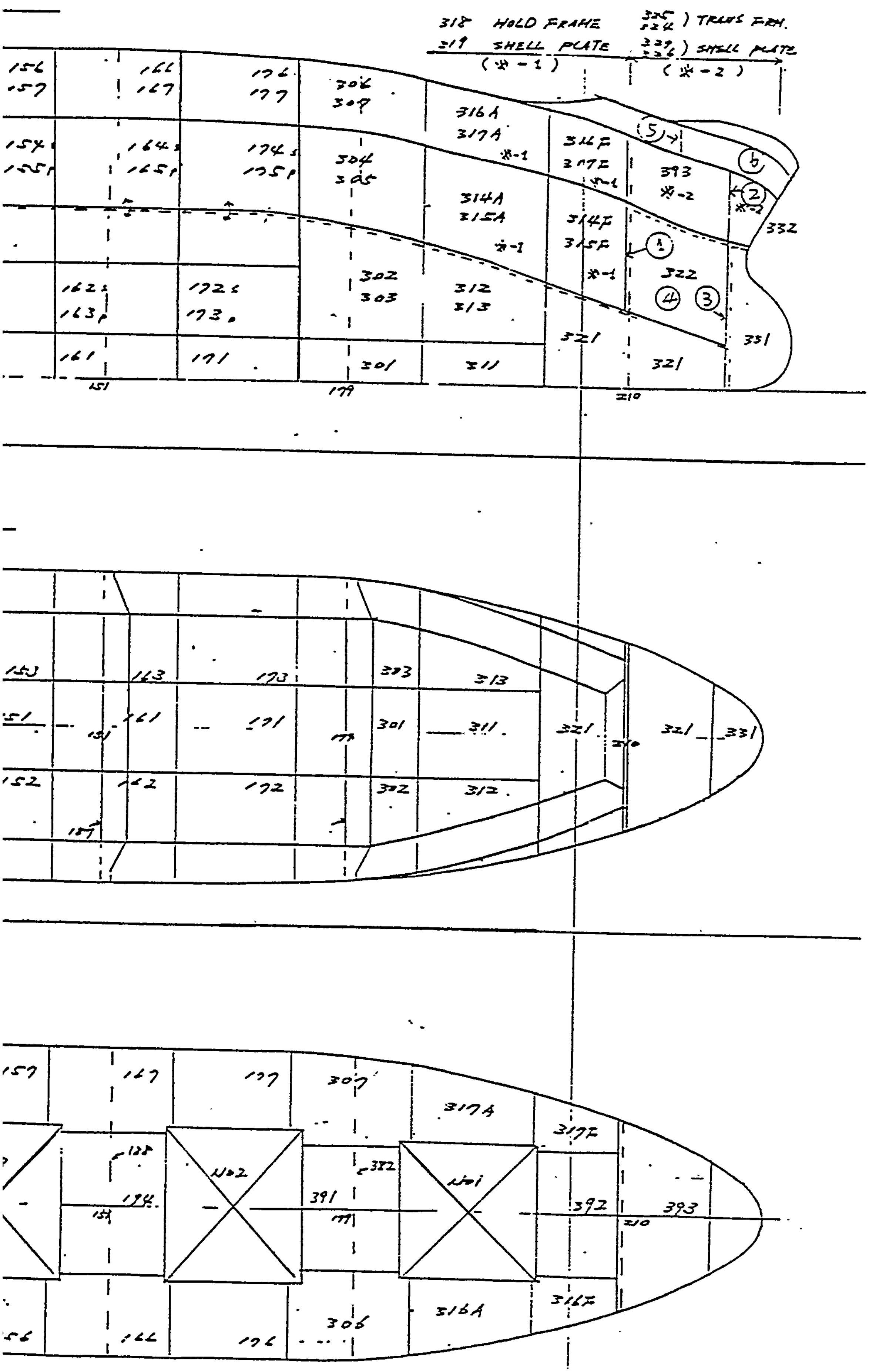


TANK TOP PLAN



MAIN DECK PLAN




318 HOLD FRAME
319 SHELL PLATE
(※-1)
) TRANS FRM.
) SHELL PLATE
(※-2)
No2
No1

APPENDIX D

EXAMPLE

BLOCK ASSEMBLY PLAN

IHI MARINE TECHNOLOGY. INC.

I. GUIDE TO CONSTRUCTION OF UNITS

FOR

ZONE -1

February 8, 1979

Prepared by:
Kazuo Chikara
IHI

2.) GUIDE TO CONSTRUCTION OF UNITS

A. Object

Before starting the detail planning, such as production planning or production scheduling, it is necessary to make an explicit guide of construction method for each unit using the Key Plans.

Because it is very easy to confirm the structures of each unit and study the best-way of unit construction.

B. Format

In this guide it is important to show the construction of each unit in 3 dimension by each construction step.

Also, it is necessary to show the descriptions of each step.

In the case of large units, it is better to calculate and check this rough weight of each unit.

C. To make this guide, the following abilities will be required.

1. To imagine the construction of the unit from Key Plans.

ii. To reproduce the construction of the unit on paper in 3 dimensions.

iii To be familiar with actual conditions of facilities.

iv. To be familiar with actual methods of production.

D. The basic and important ideas to decide the construction method.

i. To be the best way of construction for workers

a. Working Position

b. Condition of Working Stage

c. Lighting, Ventilation, Accessing

ii. To be the best way of construction for keeping the accuracy of unit.

iii. Separate complex units into as many simple parts as possible.

H 751

HOW TO CONSTRUCT

(FOR STUDY)

ZONE 1 —MODEL

by I.H.I

CONTENTS

NOTICE

1) This booklet is made from the reports which was discussed and agreed by ACCURACY CONTROL COMMITTEE.

2) We hope this booklet should be utillized as the base line
to examine plan (that is, edge preparation, joint shift position and weld. method)
to break down each scheme (that is, detailed plan, manual,)
And for each planning.

3). In case that the inconvenient points were found on engineering and planning,
this booklet should be revised and informed to the related persons.

LEVINGSTON SHIPBUILDING CO.	DATE	PC.	QTY.	SIZE	DESCRIPTION
					MATERIAL
TITLE	STD. DWG. GS-			ALT.	

D-3

H 751

How to Sub-Assemble, Assemble and Pre-Erect

(For Study)

Zone 1 — Model

By IHI

NOTICE

"▲" Mark shows Vital Point For Accuracy Control.

(W): Mark Means: Worker's measuring point

(AC): : AC Group's

LEVINGSTON SHIPBUILDING CO.	DATE	PC.	QTY.	SIZE	DESCRIPTION
		MATERIAL			

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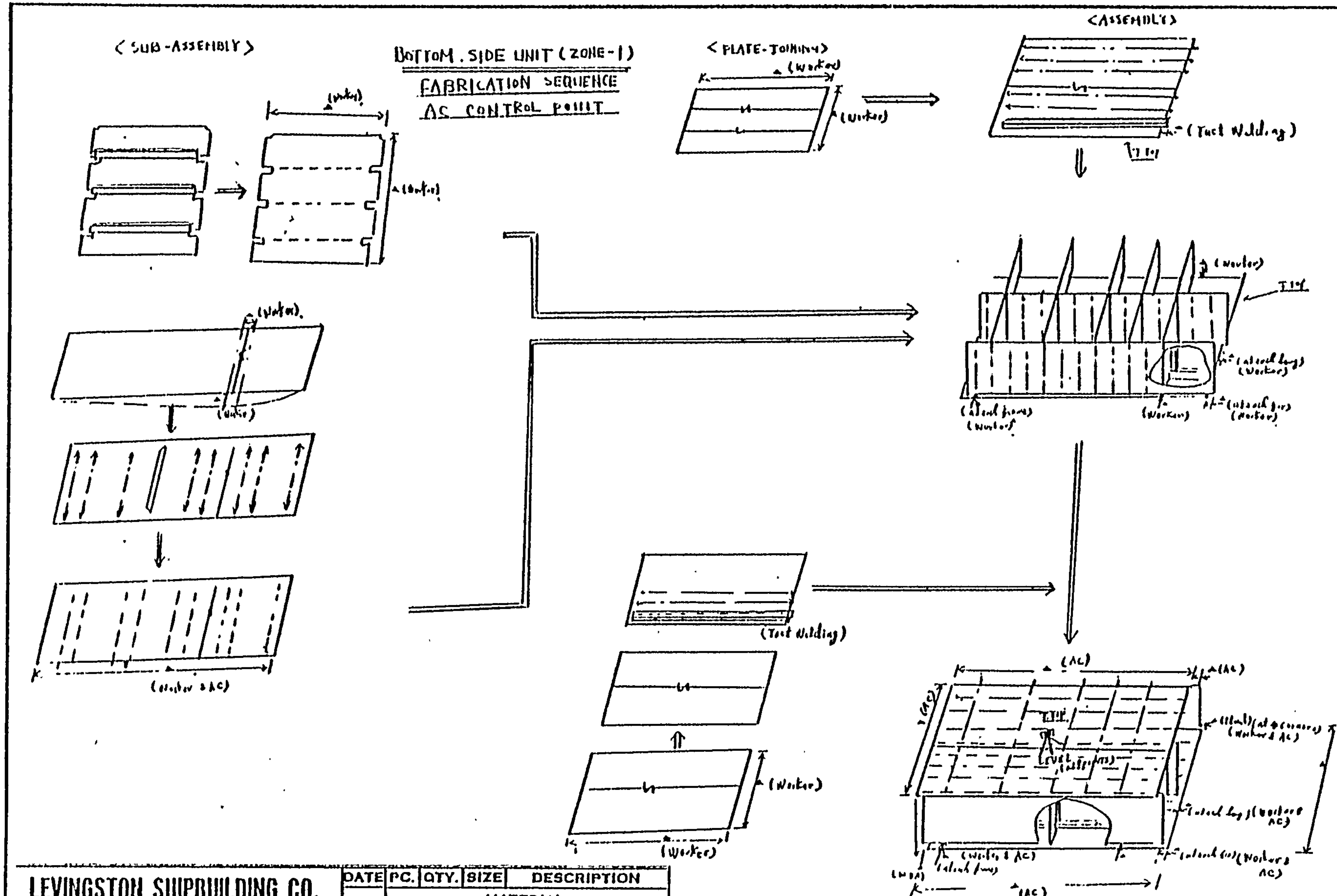

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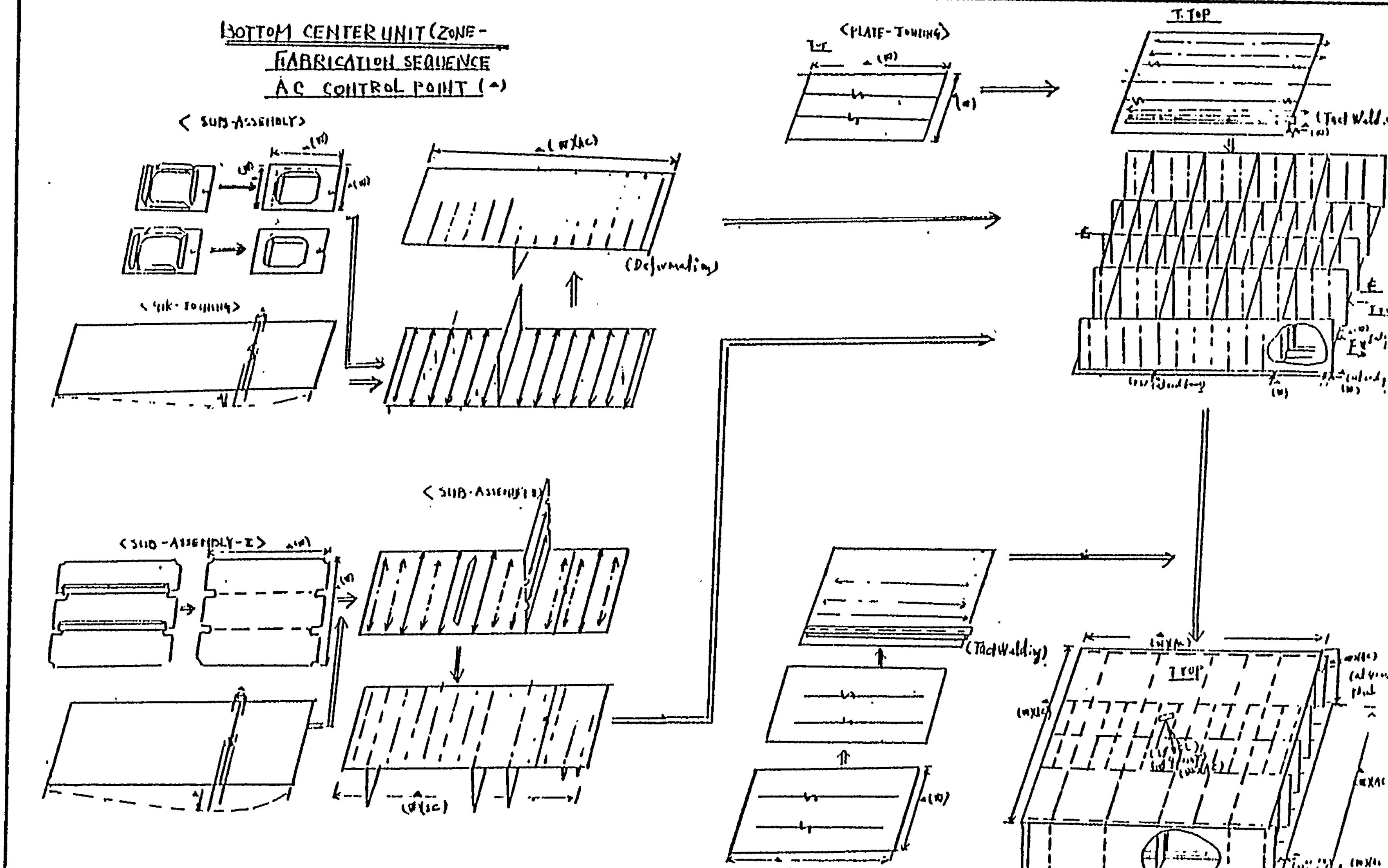

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TITLE B Unit [illegible] STD. DWG. GS- ALT.

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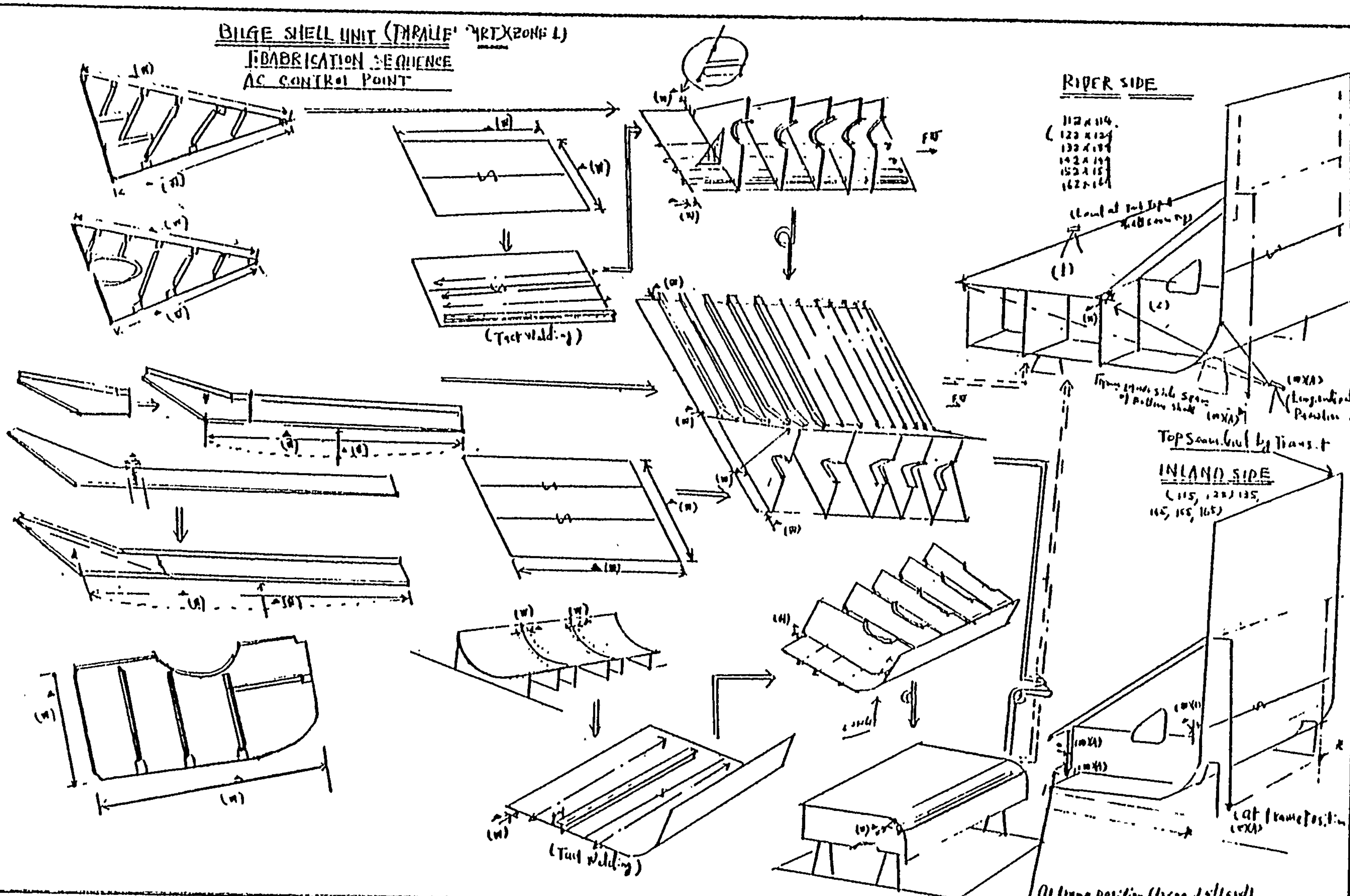
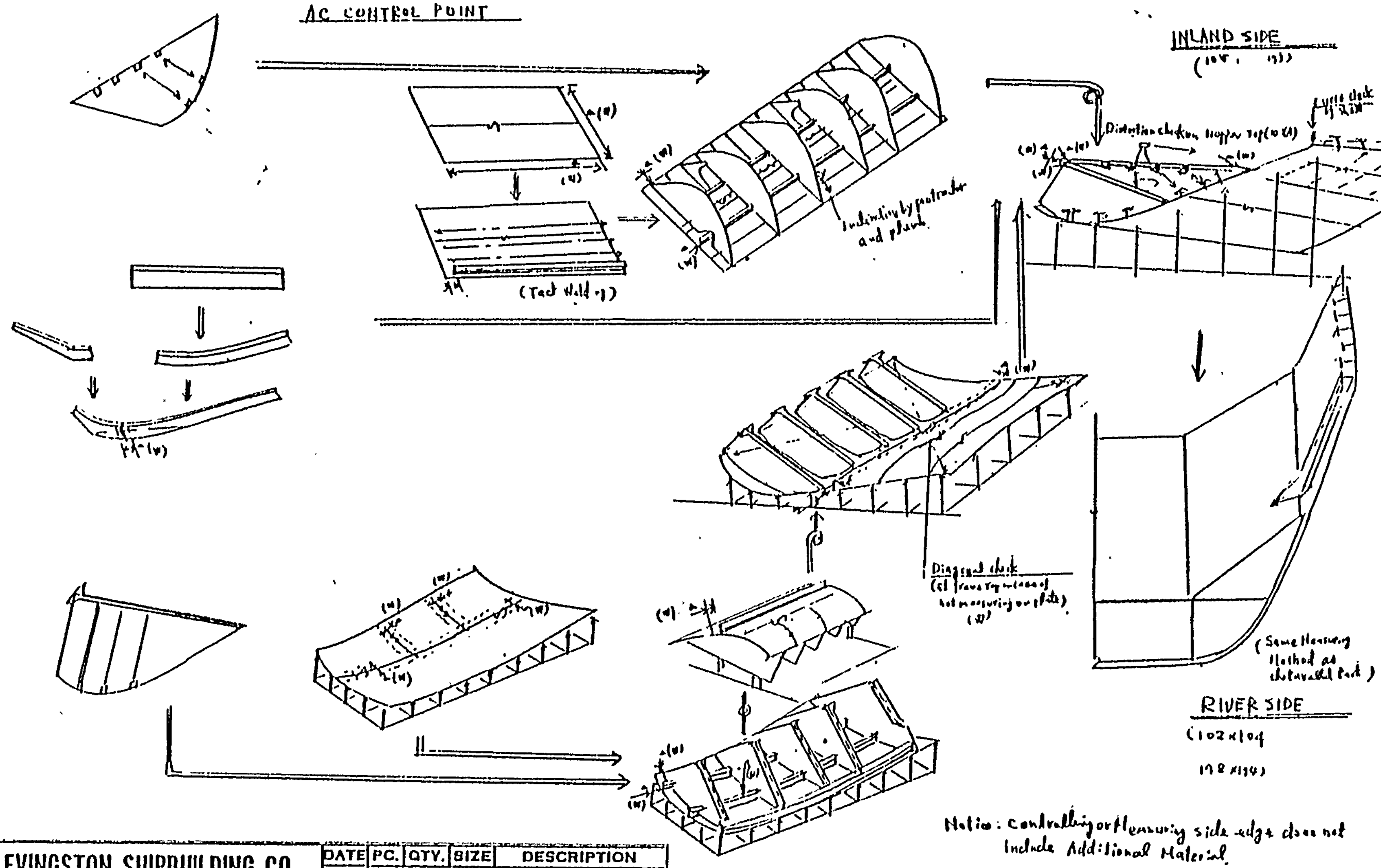


LEVINGSTON SHIPBUILDING CO.	DATE	PC.	QTY.	SIZE	DESCRIPTION
					MATERIAL
TITLE BILGE SHELL BLOCK (PARALLEL PART)(ZONE 1)	STD. DWG. GS-				ALT.

Notice: Controlling or Measuring side edge does not include Additional Material

P15

BILGE SHELL UNIT (C ED PART)(ZONE 1)
FABRICATION SEQUENCE
AC CONTROL POINT



Notice: Controlling or Measuring side edge does not include Additional Material.

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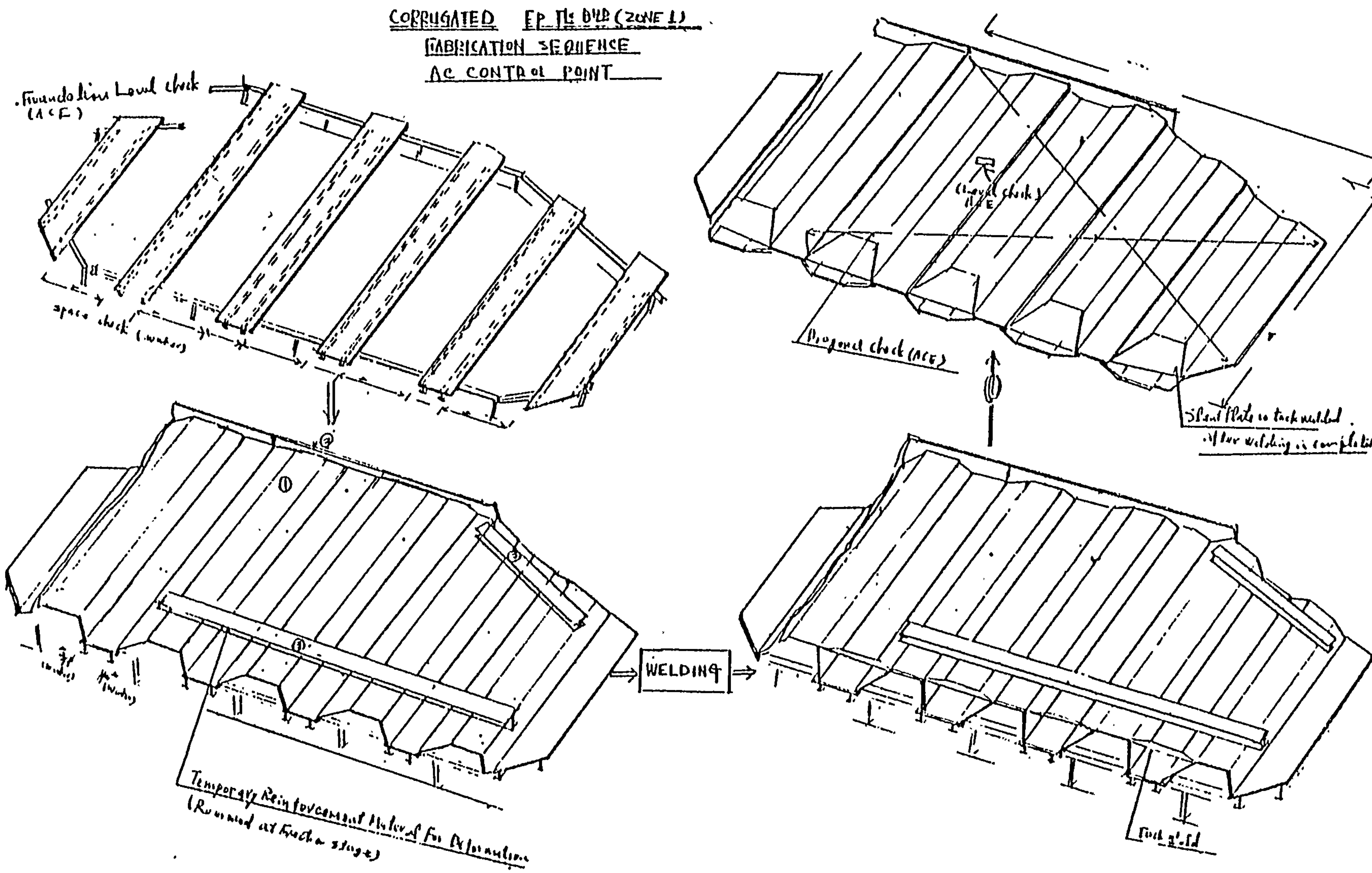
TITLE	STD. DWG. GS-		ALT.		P6



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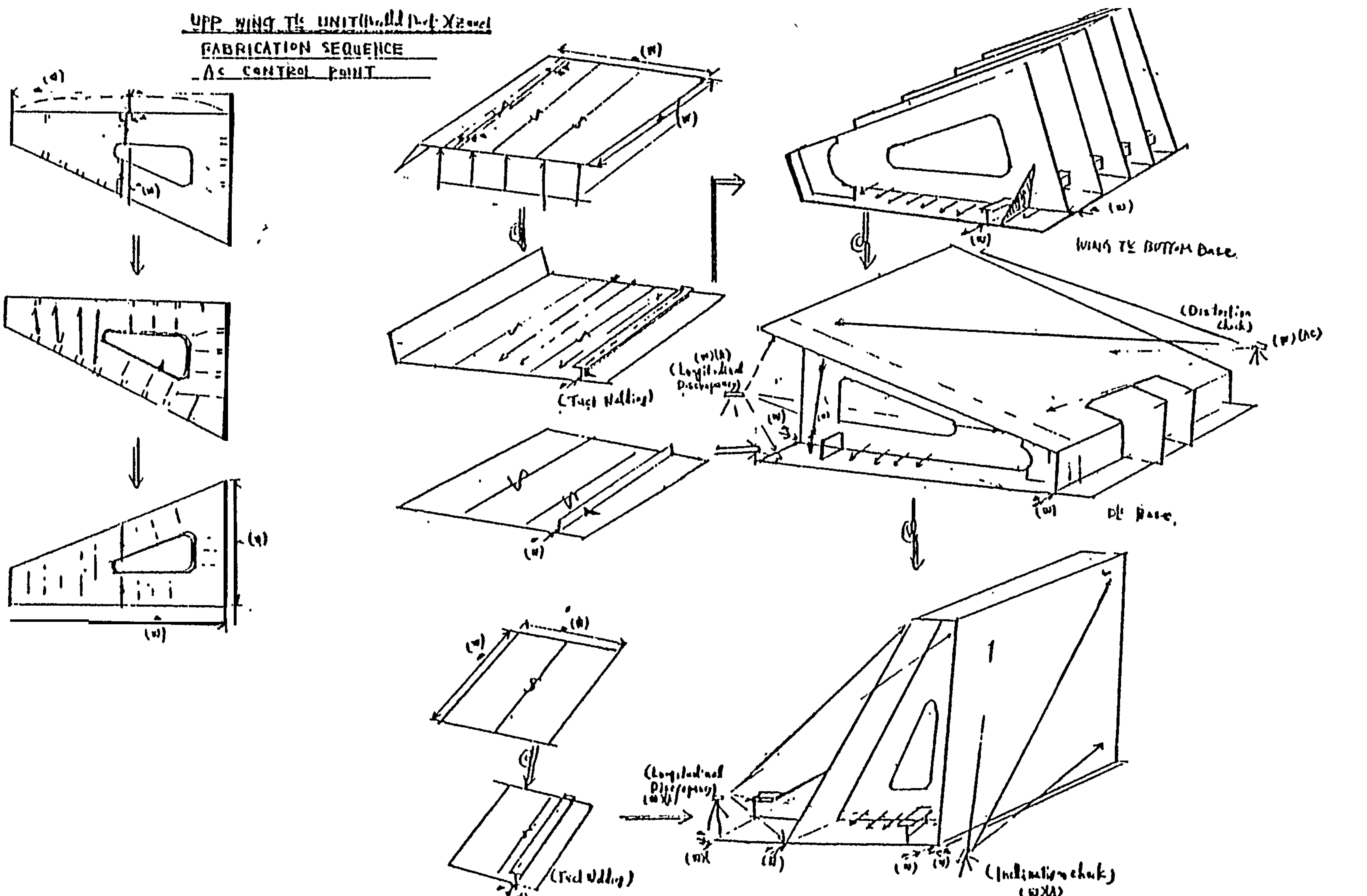
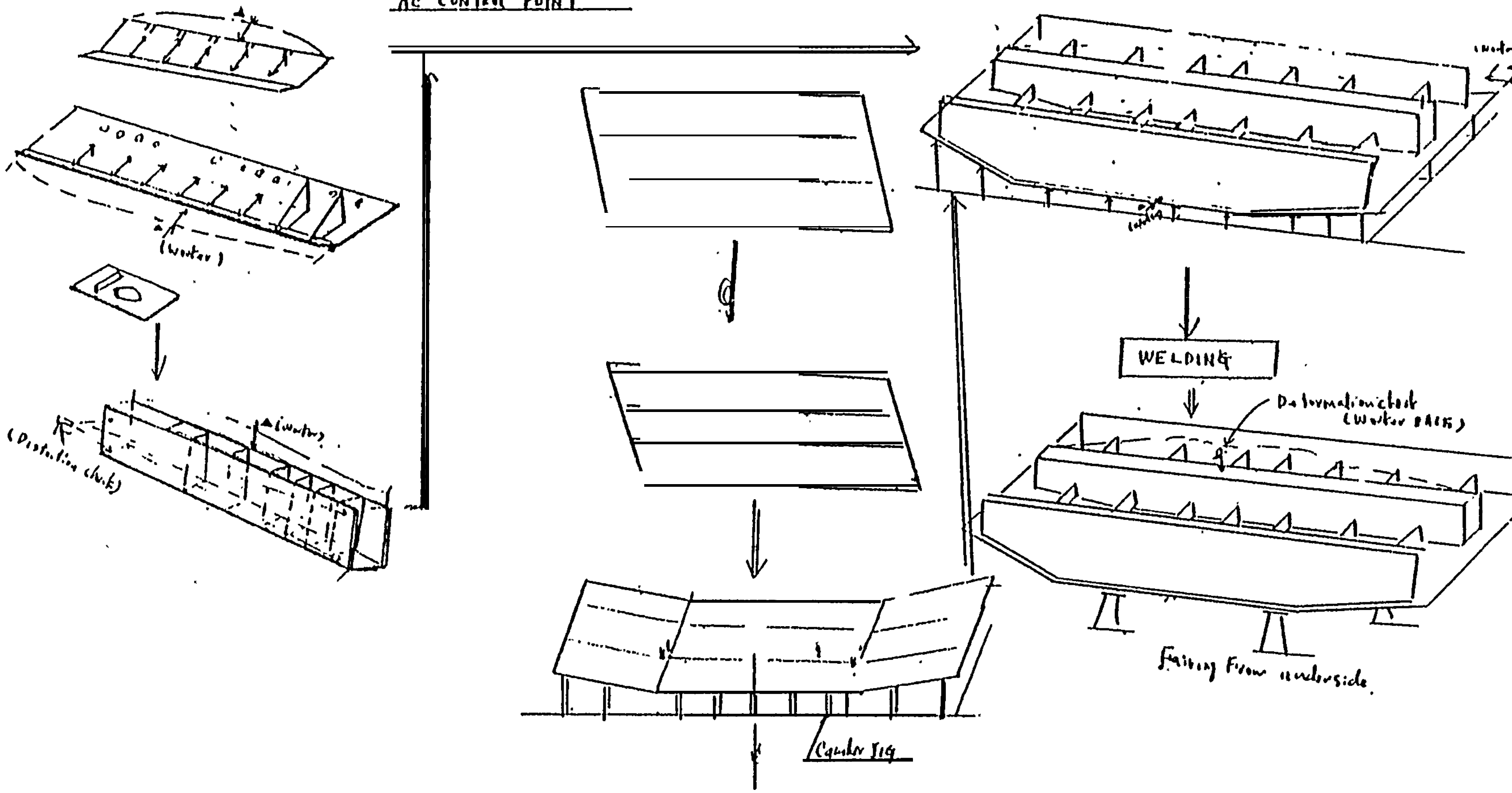
P8



LEVINGSTON SHIPBUILDING CO.	DATE	PC.	QTY.	SIZE	DESCRIPTION
			MATERIAL		

TITLE STD DWG GS- ALT

UPP DK CENTER UNIT ONE 1)
SEQUENCE OF FABRICATION
AC CONTROL POINT



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					MATERIAL

TITLE ... STD. DWG. GS- ... ALT.

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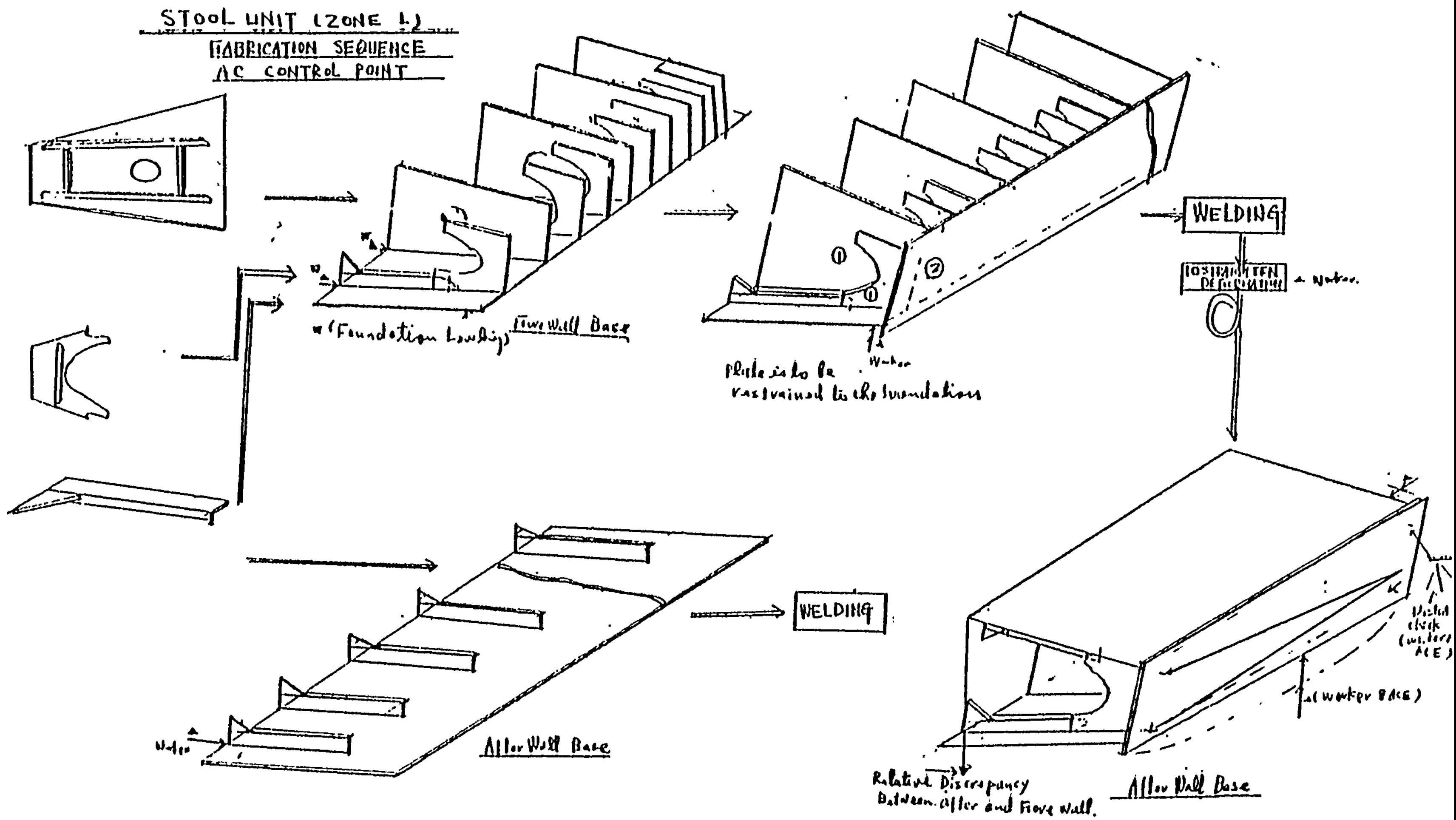


LEVINGSTON SHIPBUILDING CO.

DATE	PC.	QTY.	SIZE	DESCRIPTION
				MATERIAL

TITLE STD. DWG. GS- ALT.

P10

APPENDIX E

EXAMPLE

FIELD PLANS

CONTENTS

4. FIELD PLANNING

A. Object

To properly implement the earlier plannings, there is one additional activity called Field Planning. This planning will be prepared to give shape to production plannings as depending on actual conditions on slabs.

B. Kinds of Planning

Usually these planning activities could be separated into four (4) groups as follows:

a. Planning to prepare the good working environment.

1) Plan of temporary holes for construction purposes. (see Appendix - 1)

2) The study of ventilation and cooling on the ways. (see Appendix - 2)

3) Power source supplying and stools arrangement plan on the ways. (see Appendix - 3)

4) Plan of equipments for access and working stage. (see Appendix - 4)

b. Planning to make the production activities easier. safer and more precise.

1) Cribbing plan.

2) Supporting pillar and beam plan.

3) Necessary jigs and templets for curved units. (Refer to the documents of curved unit jig system)

c. Planning to make working guide lines.

1) Plan of layouting and construction method for curved units. (Refer to the document of curved unit jig system)

2) Shipwright method plan. (see Appendix - 5)

3) Initial hogging plan. (see Appendix - 6)

d. Planning to make the inspection items clear.

1) Tank arrangement and testing scheme.
(see Appendix - 7)

2) Final dimension check items.
(see Appendix - 8)

3) Disposal of temporary pieces for construction purposes. (see Appendix - 9)

SUBJECT: Plan of Temporary Hole for Construction Purposes

The attached documents on making the Plan of Temporary Hole includes the following:

(1) Object

(2) Considerations to Make the. Plan

(3) Concrete Examples

(4) Appendix -1 ,-2

OW to make the Plan of Temporary Hole for construction purpose,

1. Object

In the ship under construction on berth, the permanent holes are not enough to do any kind of work for construction, So, to make the workmanship easy, the temporary holes shall be prepared by the shipyard with the permission of class and owner.

2. Considerations to make the plan

A) Facilities of communication

Zone 1.

&. There are 3 ways to get into or out of the ship:
1) From berth to upper deck
2) From berth to tank top through side shell
3) From berth to tank top through bottom

MEANS:
1) No use.
2) At the last side shell unit (nothing in Zone 1).
3) Make the temporary holes in double bottom-at every other hold at least. (see the sample)

MEANS :

2. There are 2 cases to move in the hold mainly:
1) From aft to fore on tank top
2) From tank top to upper deck

1} Make the temporary holes at each steel .
2) No use.

zone 2

3. It is necessary to make the temporary hole at stale shell for the gate from the wharf. (see the sample)

4. It is necessary to make the temporary hole at bulkhead separated from hold. (see the sample)

5. At the walls of large tanks that have many jobs in it (ex. fresh water tank etc). (see the sample)

Zone 3

6. It is necessary to make the temporary hole at bulkhead separated from hold. (see the sample].

7. St is necessary to make the temporary hole at the side shell.

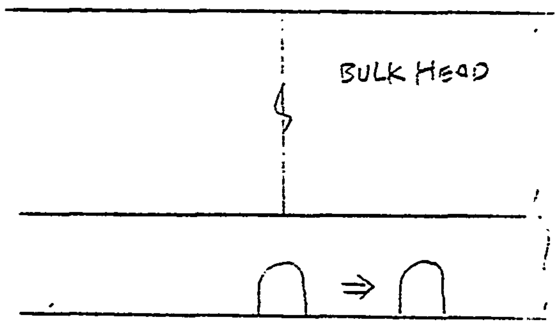
B) Zone 1, 2, 3

Generally speaking, the temporary holes for facilities of communication are useful for supply of power source. But it is better to separate the holes for men from those for power source.

C) There are 2 comments:

1. Suitable size to pass through safely.

2. In the cases that make the hole vertical, it's. safer to shift the position of the hole from the joints or/ from under the scaffolds where personnel usually gather, because sometime the parts or instruments fall down.



one 1, 2, 3

Generally speaking, the temporary holes for facilities of communication are useful for ventilation and lighting. In the large tank that has many jobs in it, it is necessary to make the temporary holes at both ends of tank for ventilation.

E) Basically every temporary hole shall be made at assembly stage, except the holes which stay on the erection joint, as such holes will make the unit weak.

3. Sample for making the plan

A) Considerations

1. Location: as clear as possible

2. size: more economical
more functional

3. Restoration: edge preparation
order of welding

B) Sample:

<u>Double Bottom</u>

1. Location: (see the sample)

2. Size: At least 4′ x 4′
Use erection joint both as erection and temporary hole.

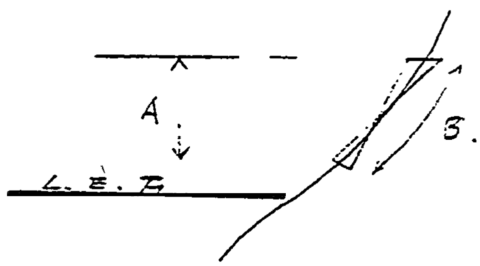
3. Restoration: (see the sample)
Side of edge preparation depend on production planning.

NOTICE: Take care for concermnent between restoration of holes and tank test.

Side Shell
(at aft part)

1. Location: Depend on concernment with the wharf.
At lower engine flat.
Check the equipment of outfitting,

2. Size: Keep the normal height from the flat. Do not keep the girth length.



Keep the height A
Do not keep the height B

3. Restoration: (see the sample)

NOTICE: It is enough to make the hole at one side. Decide the side (P or S) by Production Planning,

(at forward part)

1. Location: The position to get in to or out from the berth easi1y.
The position with few obstructions to make this.

2. Size: Keep the normal height from the flat.

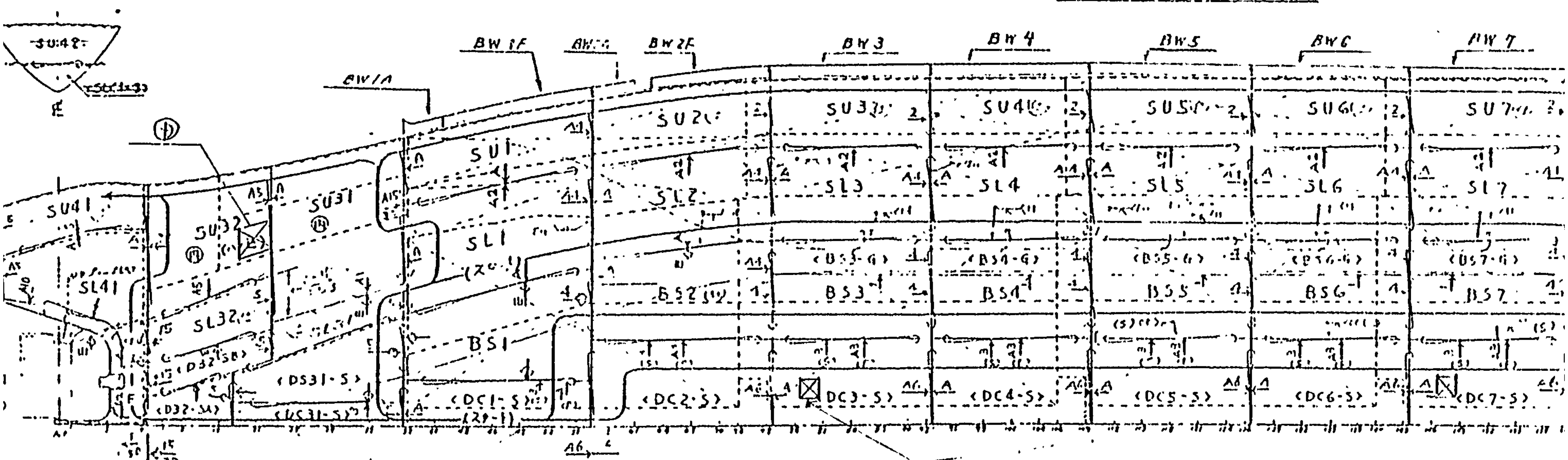
3. Restoration: (see the sample)

NOTICE: It is enough to make the hole at port side only,

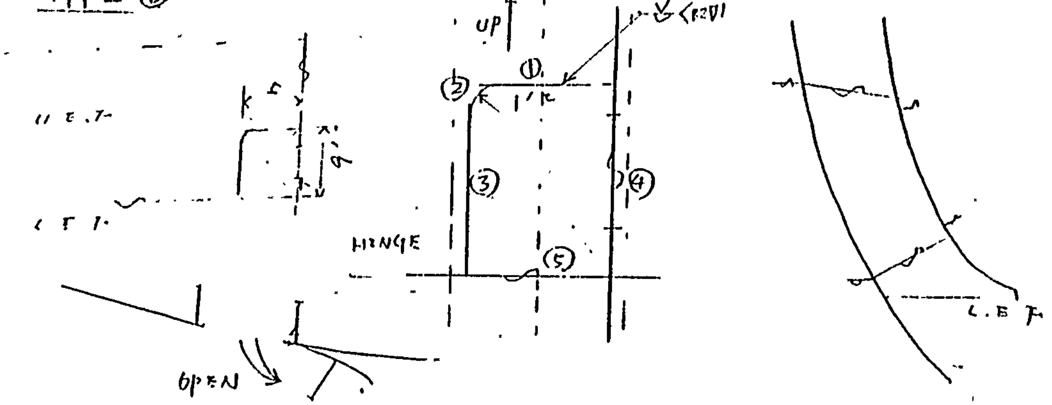
RANSOM SEC

PLAN OF TEMPORARY HOLE (SAMPLE-2)

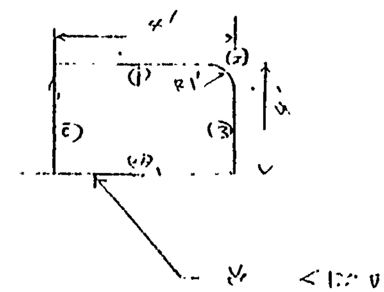
SHELL EXPANSION

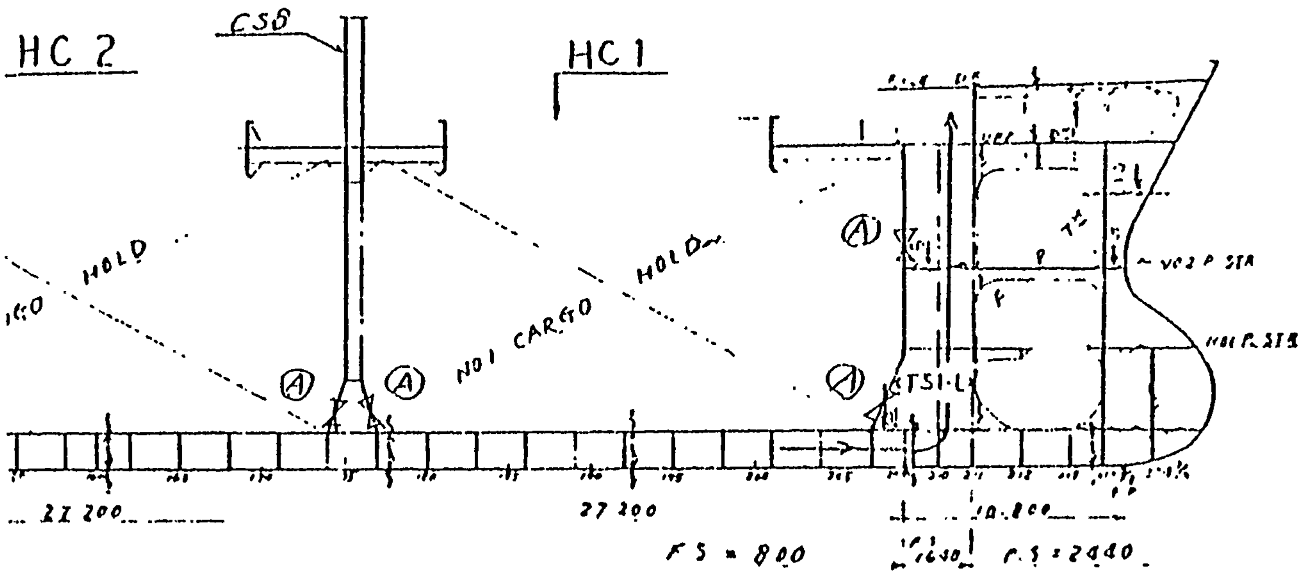


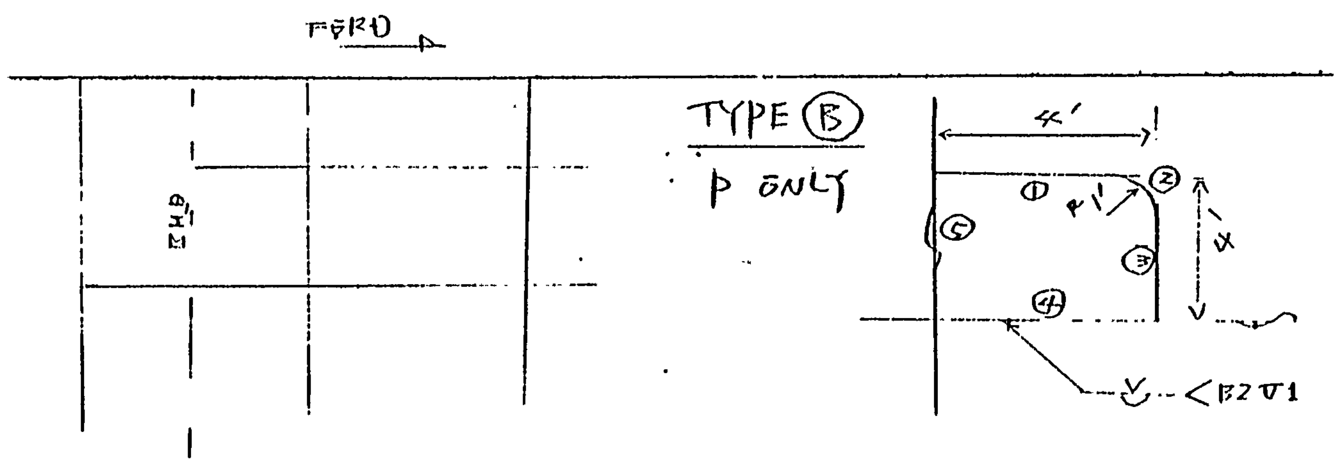
TYPE Ⓓ



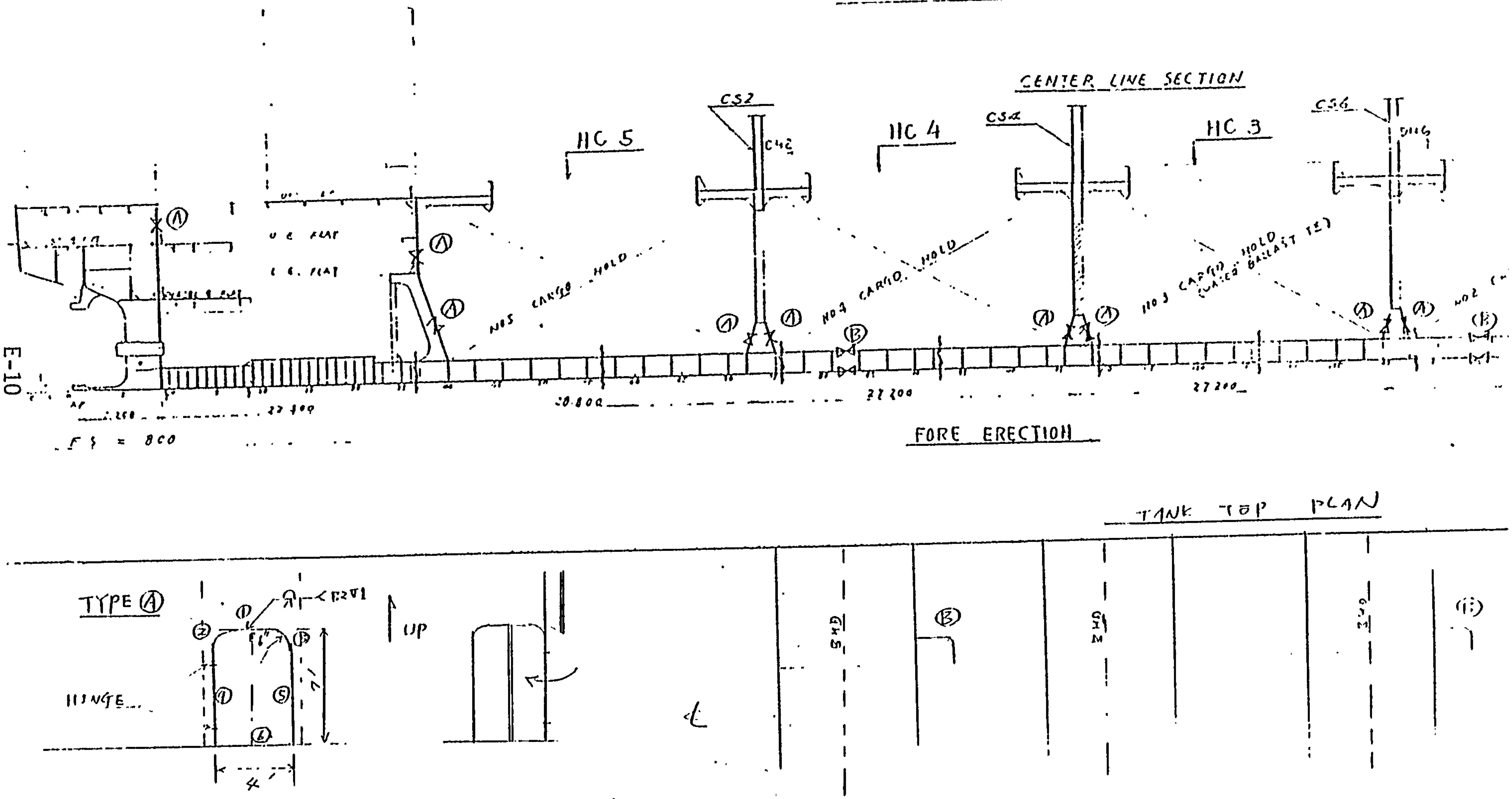
TYPE Ⓒ P ONLY

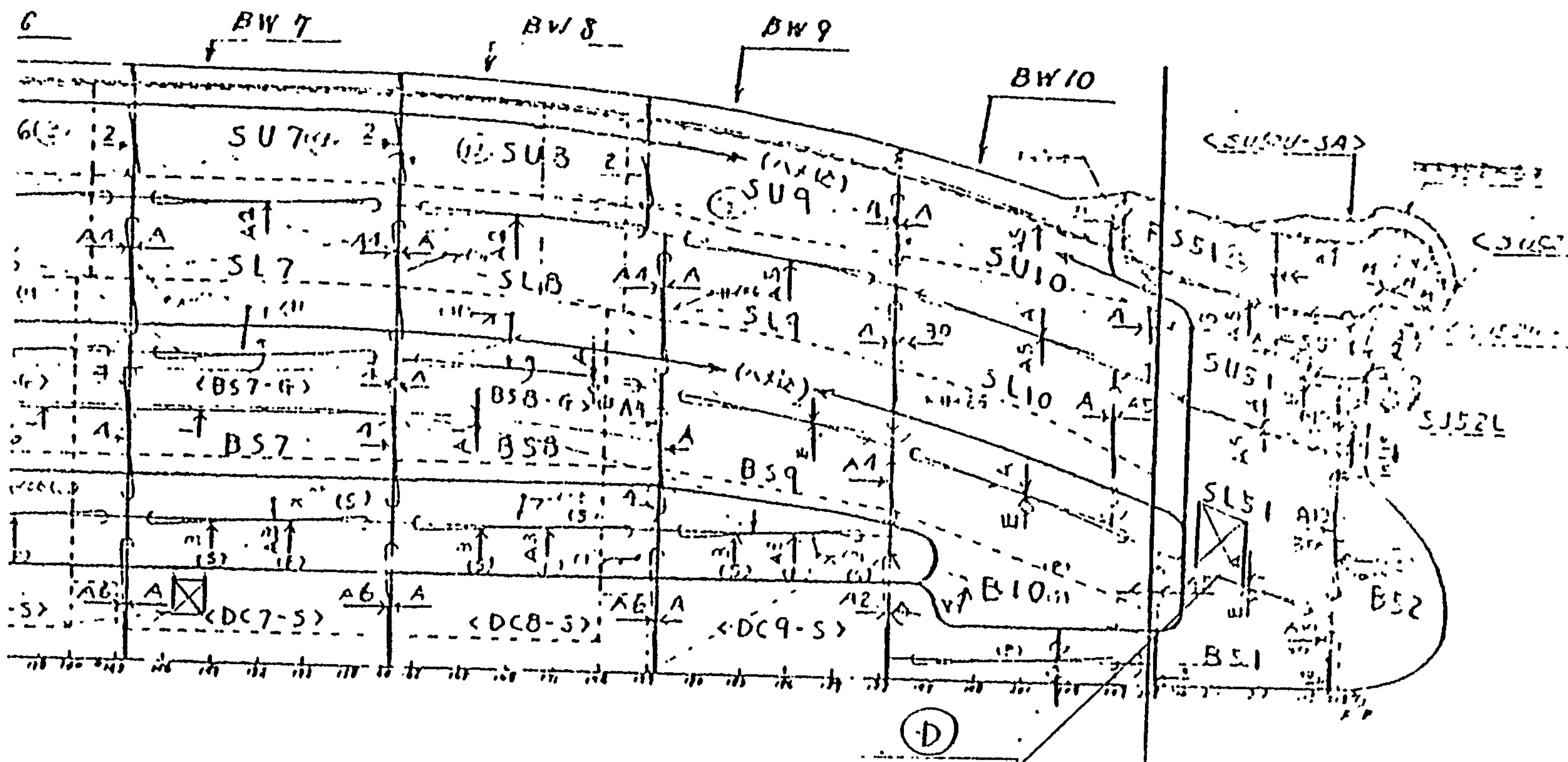



HC 2
CSB
HC 1
HOLD
NO1 CARGO HOLD
Ⓐ
TSI-L
22 200
27 200
10 800
FS = 800
1630
F.S = 2440

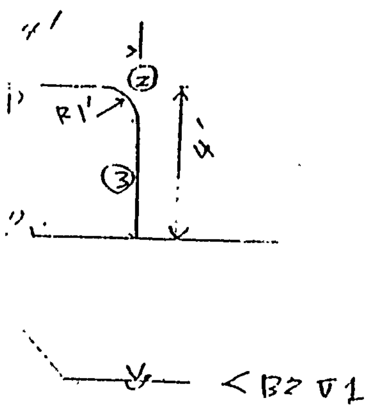

FWD
TYPE Ⓑ
P ONLY
4'
R1'
4'

PLAN OF TEMPORARY HOLE (SAMPLE-1)





P ONLY



TYPE (D)

AS SAME AS TYPE (D)

STUDY OF VENTILATION AND COOLING

This memo is the study to improve conditions of ventilation and cooling on the bulker on tune ways.

The necessary steps to be studied are as follows:

Step 1: Set the parts to be ventilatedted and cooled.

Step 2: Depending on Item 1, calculate the necessary amount of wind by part.

Step 3: Check the number of fans , capacity of each fan and the types of fans in LSCO.

Step 4:- Check the ventilation holes at present.

Step 5: Study the more effective methods to ventilate and cool by part, considering Items 2, 3, and 4.

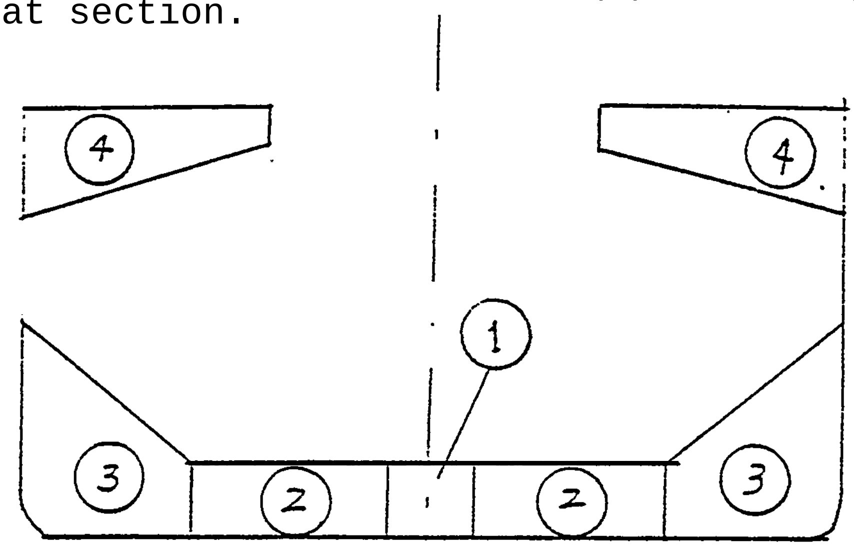
Step 6: Conclusion

Note : Concerning Step 3, it is very difficult to locate the information needed. Therefore, we just calculate the number of fans depending on the standard mean capacity. See page 6.

STEP 1 - - SET THE PARTS TO BE VENTILATED AND COOLED

The more suitable separation of parts to study the ventilation of Zone is as follows:

(1) Separate the tanks into four (4) kinds of parts at section.



(2) Separate each one with watertight bulkheads at' long' 1 direction.

STEP 2 -- CALCULATE THE NECESSARY AMOUNT OF WIND BY PART

(1) Calculate the volume of each part.

Part	Width	Length	Height	Volume
1	5' 3" x 2	73' 6"	5' 10 5/8"	
	1.6^M	22.2^M	1.8^M	64^{M3}
2	28' 10 1/2"	73' 6"	5' 10 5/8"	
	8.7^M	22.2^M	1.8^M	348^{M3}
3	12' 5 1/2"	73' 6"	5' 10 5/8"	
	3.8^M	22.2^M	1.8^M	152^{M3}
	12' 5 1/2"	73' 6"	12' 5"	
	3.8^M	22.2^M	3.8^M	160^{M3}
				Total 312^{M3}
4	22' 11 1/2"	73' 6"	14' 9 1/4"	
	7^M	22.2^M	4.5^M	350^{M3}

(2) Necessary amount of wind for each part.

Necessary amounts of wind: G M^3/Min.

Volume of part : S M^3

Times of Ventilation : N Times/Hour

Note: Usually 30~40 Times/Hour

$$G = \frac{S \times N}{60} \quad \text{CMM}$$

G1: Case 30 Times/Hour

G2: Case 15 Times/Hour

Part	S	N1	G1	N2	G2
1	64	30	32	15	16
2	348	30	174	15	87
3	312	30	156	15	78
4	350	30	175	15	87

STEP 3 -- NECESSARY NUMBER OF FANS

Part	G1 CMM	F1	G2 CMM	F2
1	32	0.7	16	0.4
2	174	3.7	87	1.8
3	156	3.3	78	1.6
4	175	3.7	87	1.8

Notice: F1: Necessary Number of Fans
Case 30 Times /Hour Ventilation

F2 : Necessary Number of Fans
Case 15 Times/Hour Ventilation

Standard Mean Capacity of Fan

1700 cm = 47.6 CMM

STEP 4 -- CHECK THE VENTILATION HOLES AT PRESENT

On July 10, 1979, we checked every ventilation hole at present and put them in the compartment and access drawing. See the attached drawing.

 : Permanent Hole

 : Temporary Hole for Ventilation and Access

 : Passage from Ground to Tank Top

STEP 5 -- STUDY THE MORE EFFECTIVE METHOD

(1) Preliminary Ideas

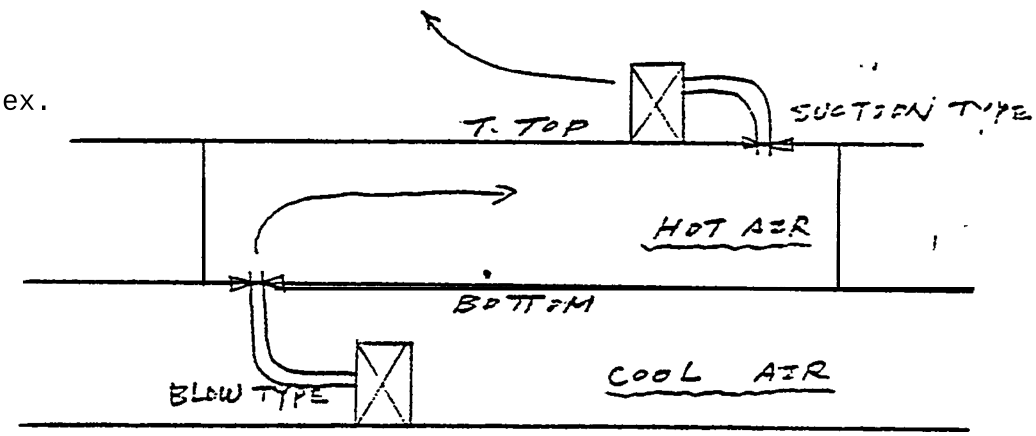
(a) Make the ventilation plan by closed Part and separate ventilation holes from traffic holes.

(b) Make at least two (2) ventilation holes by closed part.

(c) Set the two (2) kinds of fans by that part. One type of fan is the blow fan and the other type is the suction fan.

(d) Set the fans to suck cool air and to blow hot air.

ex.



NOTICE :
Another merit of this idea is that it will be able to reduce the number of fans on the tank top.

(2) Description About the Ventilation for Doublebottom .

Planning steps are shown as follows:

(a) Necessary capacity or number of fans for parts 2 and 3.

Part	Gl CMM	FI	G2 CMM	F2
2	174	3.7	87	1.8
3	156	3.3	78	1.6

Note: Fl: Necessary Number of Fans Case 30 Times/Hours Ventilation

F2 : Necessary Number of Fans Case 15 Times/Hours Ventilation

Used as Standard Mean Capacity of Fans

1700 CFM = 47.6 CMM

(b) Consideration

For Part 2:

It is necessary to set at least 2 fans and no more than 4 fans. Therefore 3 fans (mean) should be set. 2 fans which should be blow type have to be set at ground level to get cool air. A suck-type fan is needed and should be set on the tank top .

For Part 3:

The planning is almost the same as Part 2. 3 fans should be set for Part 3, same type fans as in Part 2 and located in the-same area as in Part 2.

At this condition, there are some problems in implementing this plan which are as follows:

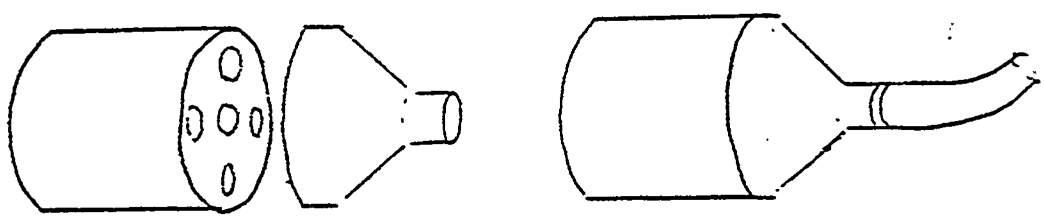
1. There is a different amount of work between the inland side and the riverside. Therefore, it is Possible to reduce the number of fans needed for the riverside.

For Part 2:	Blow Type -- 1 fan Suck Type —l fan
For Part 3:	No need

2. It is necessary to make new ventilation holes (the size of a manhole) at the bottom plate of every other tank on the inland side.

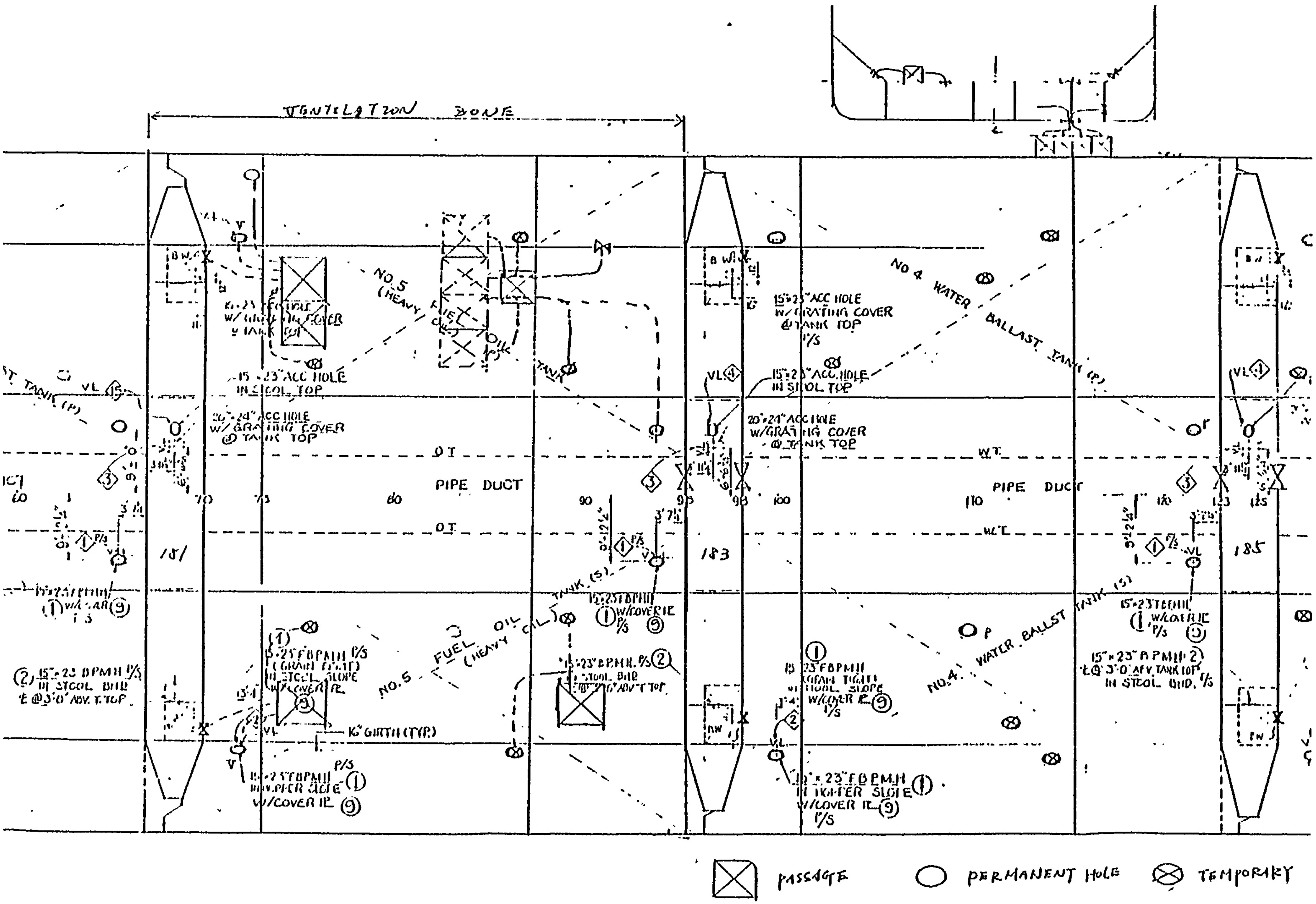
3. In order to increase suction efficiency, it is necessary to make the new holes near the top of the bottom-side tank.

4. It is necessary to make a new cover to gather the blown air into one pipe as shown below.



5. To maintain the efficiency of ventilation, it is necessary to cover the other holes, especially at L-13 (34′ 1/2″ off from centerline).

(3) According to these conditions, a sample ventilation plan is attached.



VENTILATION PLAN FOR STUDY

BY E.H.Z. 7.12.79.

PLAN @ HOLDS TANK TC

TANK TOP 5'-10 5/8" ABOVE BASE LINE

Power Source Supplying and Stools Arrangement plan on the Ways

Before starting erection, the study of the necessary number of welding machines and gas pipelines that must be set at suitable and effective places should be prepared. This includes checking the position of manholes and temporary holes. In addition, location maps for top of double bottom and main deck should be done.

Especially for the ship which has the narrow main deck, like bulker or container, this planning will be more effective to keep the best working environment on the ways.

NOTICE: To make the location maps, it is easy to put the ; necessary information on unit arrangement.

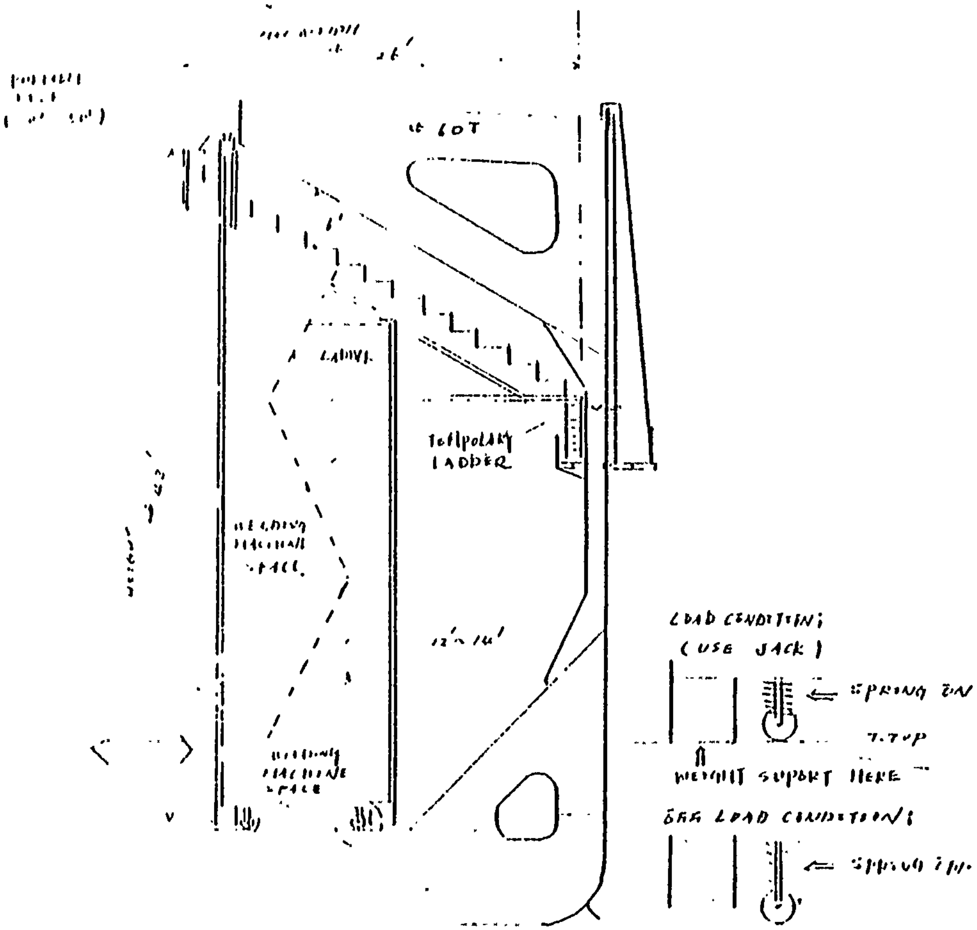
Equipment for Access and Working Stage

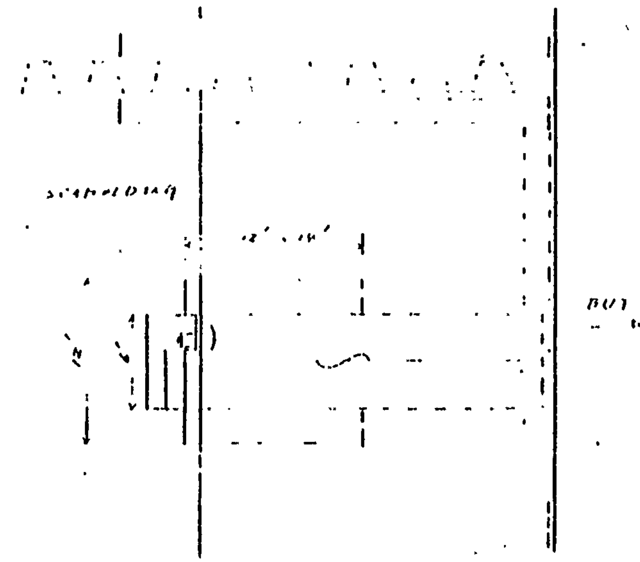
Before starting erection, it is necessary to prepare some equipment to keep the good accessing and good working conditions on the ways. This planning must be prepared with the total view of what is the best way for accessing and stage conditions on board.

Samples will be shown next.

IDEAL PLAN OF WORKING STAGE FOR TOPSIDE UNIT.

FEB 19, '79





U.D.E PLAN

<POINTS SHOULD BE STUDIED>

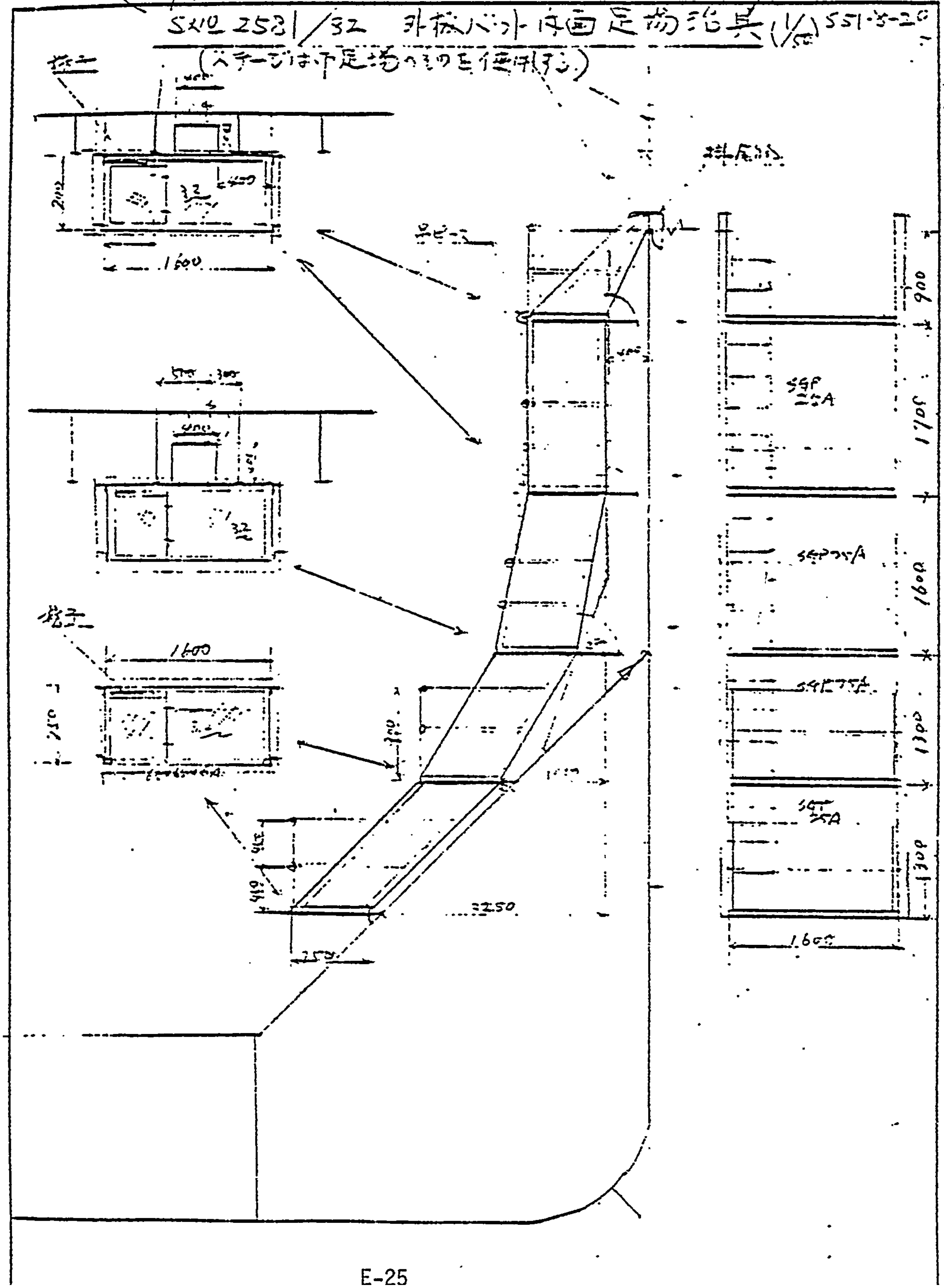
- THE FACILITIES OF COMMUNICATION
- STABILITY OF THE WORKING STAGE
- HOW TO SET OR TAKE OFF THE WORKING STAGE
- HOW TO SUPPLY THE POWER SOURCES.
- WORKING CONDITION
- MAX NUMBER OF WORKERS ON THE STAGE AT ONE TIME

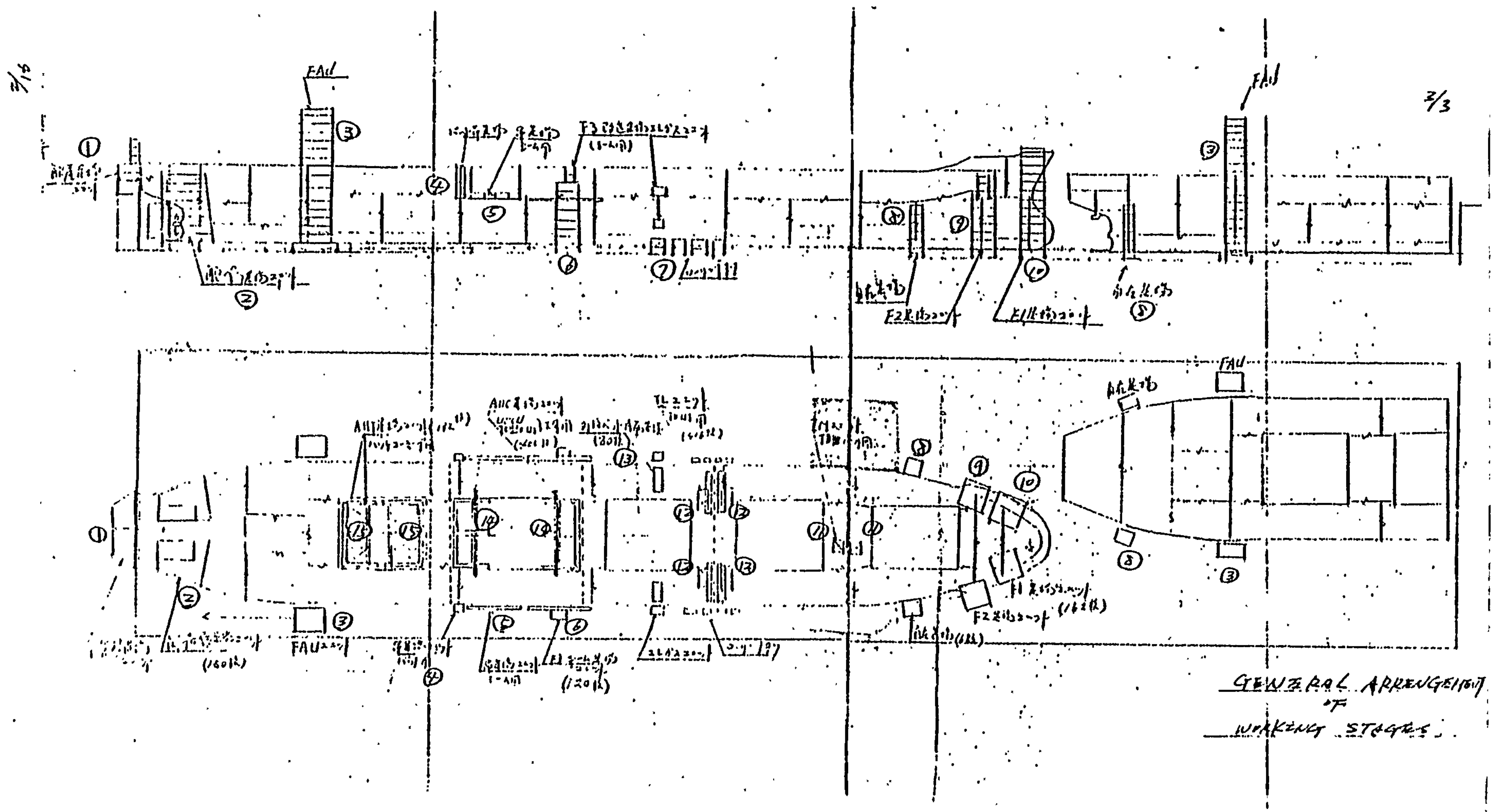
NOTICE;

<DESIGN CONDITIONS>

MAX LOAD ON SUPORT ⇒ 30T

〈TYPICAL STAGE FOR SLANT PART〉 別添3( )





GENERAL ARRANGEMENT OF WORKING STAGES

STANDARDIZATION OF SHIPWRIGHT

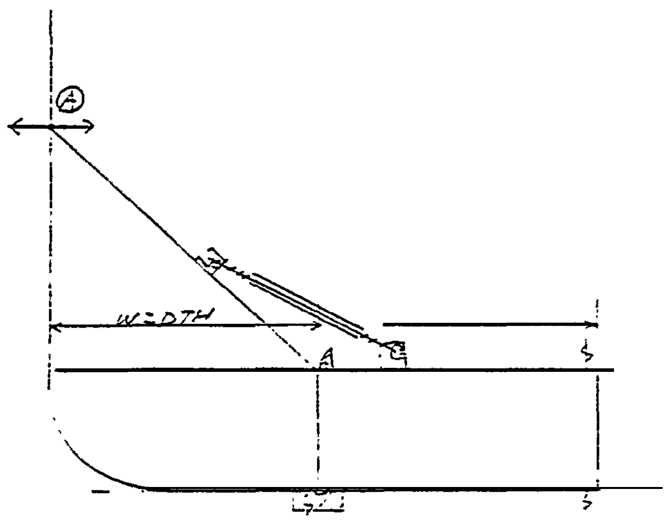
One of the most effective items to reduce manhours and also keep a high accuracy of the ship on the ways is to standardize the shipwright methods throughout the work force.

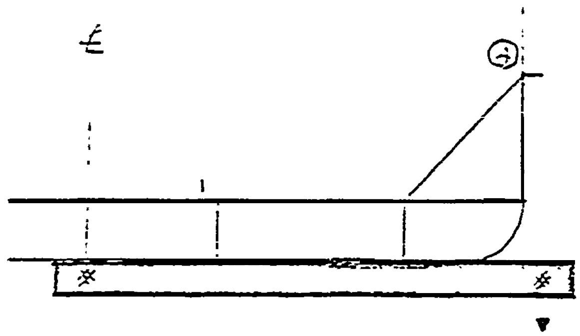
But the shipwright methods are influenced strongly by the conditions of the shipyard; therefore, we would like to hold a meeting with the appropriate personnel in Production and Production Planning to decide the standard methods.

Attached are sample sheets for Zone 1. With an in-depth study of this memo, we would appreciate your finding more suitable shipwright methods for LSCO.

SHIP WRIGHT SHEET

HULL NO	UNIT	ERECTION SEQ.	WEIGHT	NECESSARY EQUIPMENTS
751	145	135 → 145	51 T	STRETCH





HOW TO CHECK THE POINT Ⓐ

STEP	DESCRIPTION
	<BEFORE ERECTION>
①	SET THE CRIBBING AT RIGHT LEVEL
②	SET AND WELD THE WANDLE PIECES, STOPPERS, AND SUPORT PIECES.

<ERECTION>

① CHECK THE WIDTH AND CUT NEAT AT EDGE

② SET THE UNIT IN WIDTH DIRECTION

③ CHECK THE ALINEMENT AT EVERY FRAME

④ SET THE UNIT IN LONGITUDINAL DIRECTION

⑤ CHECK THE POSITION OF POINT Ⓐ

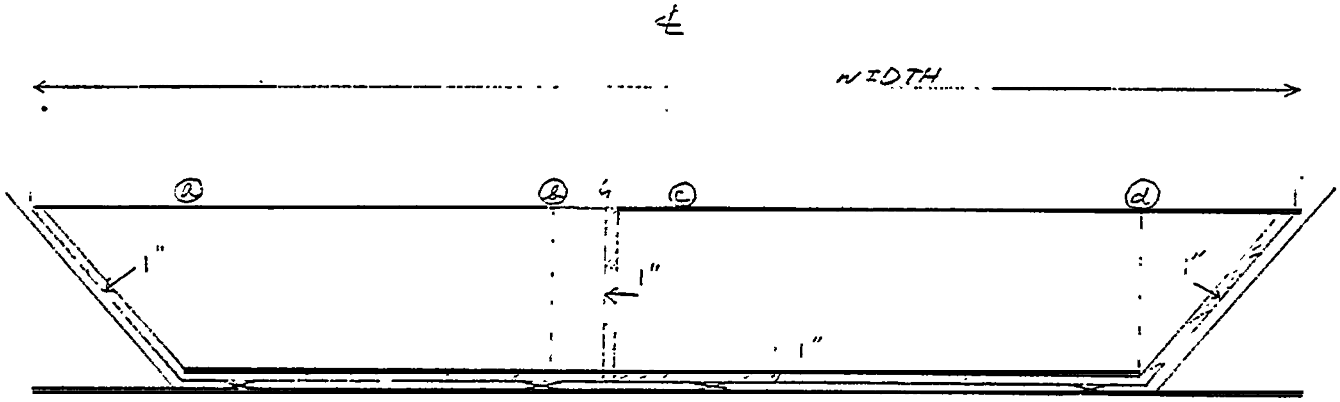
※ USE THE STRETCH AND PLUMB. SEE FIG Ⓐ

⑥ KEEP THE POINT Ⓐ AT RIGHT POSITION

ACTUAL DATA	AFT	MID	FORD
WIDTH			
DRAWING DIMENSION			
SIFT			
INCLINE			

SHIP WRIGHT SHEET

HULL NO	UNIT	ERECTION SEQ.	WEIGHT	NECESSITY EQUIPMENTS
751	183	125 → 183 124 →	T 34.5	LEVELER SPACER

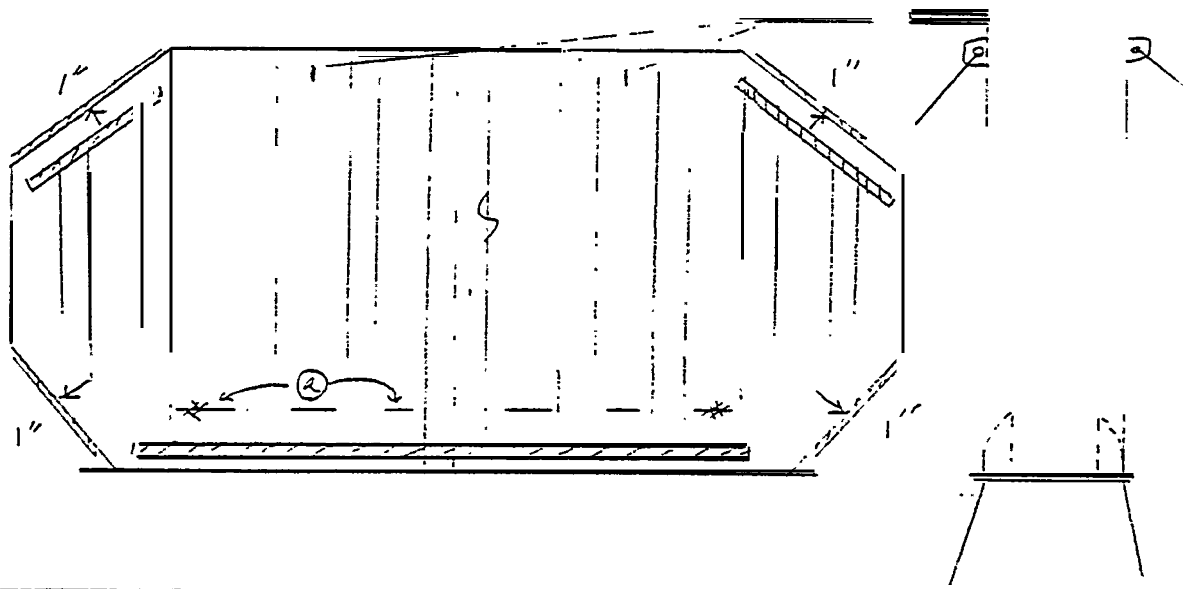


STEP	DESCRIPTION		NOTICE
	<BEFORE ERECTION>		
①	CHECK THE COMPLETION OF T.TOP	→	COMPLETION OF WELDING
②	LAYOUT THE POSITION	→	INCLUDE INTERNAL PART
③	SET THE SPACERS		

	<ERECTION>	ACTUAL DATA				
①	CHECK AND KEEP THE LEVEL ⓒⓓ→ⓐⓑ	LEVEL	ⓐ	ⓑ	ⓒ	ⓓ
②	" " THE WIDTH	WIDTH	DRAWING DIM.		ACTUAL DIM.	
③	JOINT P SIDE AND S SIDE					
④	CHECK THE HEIGHT	HEIGHT	ⓐ	ⓑ	ⓒ	ⓓ
⑤	CUT NEXT AT BOTTOM PART OF STOOL	※ NEED THE SAME HEIGHT AS OTHER STOOLS				
⑥	SLIDE IT DOWN AND SET IT AT RIGHT POSITION					
⑦	CHECK THE GAPS AT BOTH SIDE AND HEIGHT	HEIGHT	ⓐ	ⓑ	ⓒ	ⓓ
		GAP				

SHIP WRIGHT SHEET

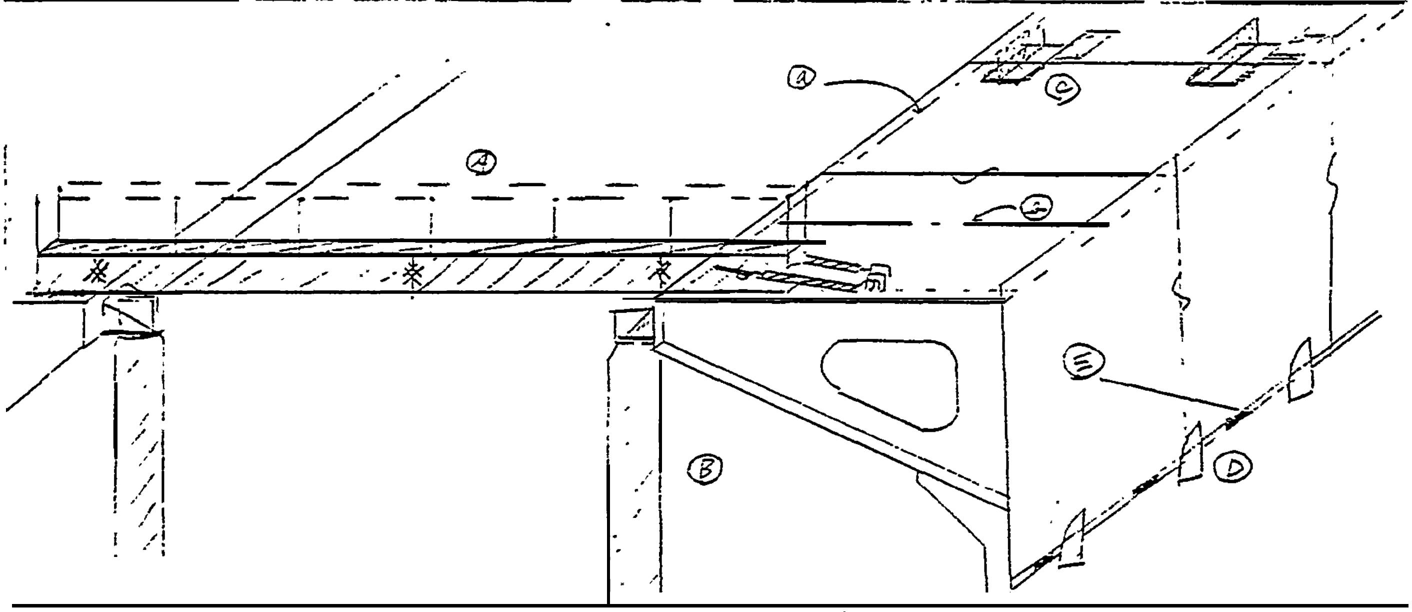
HULL . NO	UNIT	ERECTION. SEQ.	WEIGHT	NECESSARY EQUIPMENTS
751	184	183 → 184 S, P		



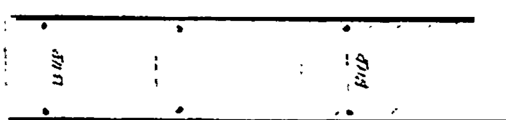
STEP	DESCRIPTION	NOTICE
	<BEFORE ERECTION>	
①	MARK THE BASE LINE ⑨ ON THE SCAB.	
②	CHECK THE HEIGHT AND CUT NEAT	
③	BUT AT 4 CORNERS KEEP ADD. MAT 1"	LAYOUT THE RIGHT POSITION
④	SET THE STRONG BACKS	
⑤	SET THE WIRE-PIECES AND WIRES	
⑥	SET THE GUIDE PIECES ON STOOL	
⑦	SET THE GAUGE	TO CHECK INCLINATION
	<ERECTION>	
①	ERECT THE P-SIDE UNIT	BECAUSE S-SIDE UNIT INCLUDING CENTER LINE
②	" S-SIDE UNIT.	
③	CHECK INCLINATION AND CORRECT	WITH TRANSIT AND GAUGE
④	CHECK THE WIDTH AND CORRECT	
⑤	CHECK THE HEIGHT AND CORRECT	

SHIP WRIGHT SHEET

HULL NO	UNIT	ERECTION STG.	WEIGHT	NECESSARY EQUIPMENTS
751	136×146	184S,P 117/127 → 116/125	120T	BEAM. 1 STOPPER 2 PILLER 1

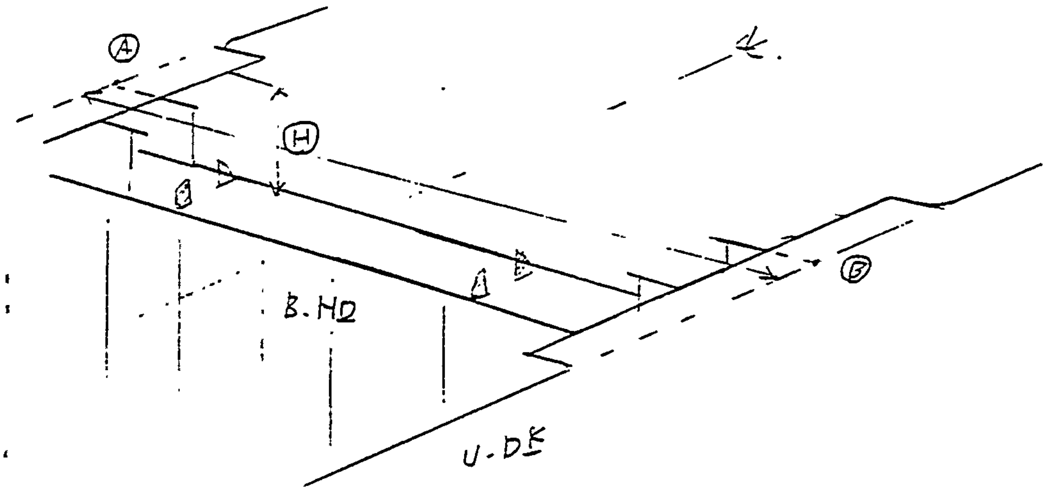


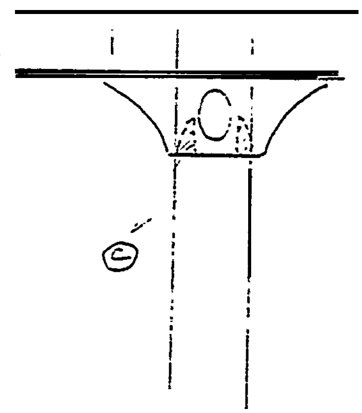
STEP	DESCRIPTION	NOTICE
	<BEFORE ERECTION>	
①	MARK THE BASE LINES ON UNIT	ⓐ BASE LINE TO CHECK WIDTH ⓑ " TO CHECK LENGTH MARK THE CENTER POINT & EDGE POINT:
②	PREPARE THE BEAM Ⓐ	
③	PREPARE THE PILLERS & JOINT PIECES Ⓑ	
④	SET THE GUIDE PIECES Ⓓ & STOPPERS Ⓒ	SPACER Ⓔ
⑤	SET THE SCAFOLDING	
	<ERECTION>	
①	SET THE UNIT LITTLE HIGHER ABOUT 1"	USE PILLER Ⓑ & SPACERS Ⓔ
②	CHECK & CORRECT THE WIDTH	USE BASE LINE ⓐ & BEAM Ⓐ
③	CHECK THE STRAIGHTNESS ON DECK	" "
④	CHECK & CORRECT THE HEIGHT AT FORE END	USE PILLER Ⓑ & SPACERS Ⓔ
⑤	CHECK & CORRECT THE LEVEL	USE PILLER Ⓑ & SPACERS Ⓔ
	※ CHECK 6 POINTS INCLUDING PRECEDE UNIT.	



SHIP WEIGHT SHEET

HULL No	UNIT	ERECTION SEQ	WEIGHT	NECESSALY EQUIPMENTS
751	192	126 127 > 192	30T	





STEP	DESCRIPTION
	< BEFORE ERECTION >
1	CHECK THE WIDTH BETWEEN POINT (A) AND (B) ON THE WAYS
2	CORRECT THE LAYOUT AND CUT NEAT THE EDGE OF THIS UNIT
3	CHECK THE HEIGHT (H) ON THE WAYS
4	CORRECT THE LAYOUT AND CUT NEAT THE BOTTOM EDGE
5	SET THE GUIDE PIECES (C) ON THE TOP OF BULKHEAD
6	SET THE SCAFFOLDING
	< ERECTION >
1	CHECK THE CENTER LINE AND CORRECT
2	CHECK THE LEVEL AND ALINEMENT OF THE JOINT

INITIAL HOGGING FOR AFT PART AND FORWARD PART

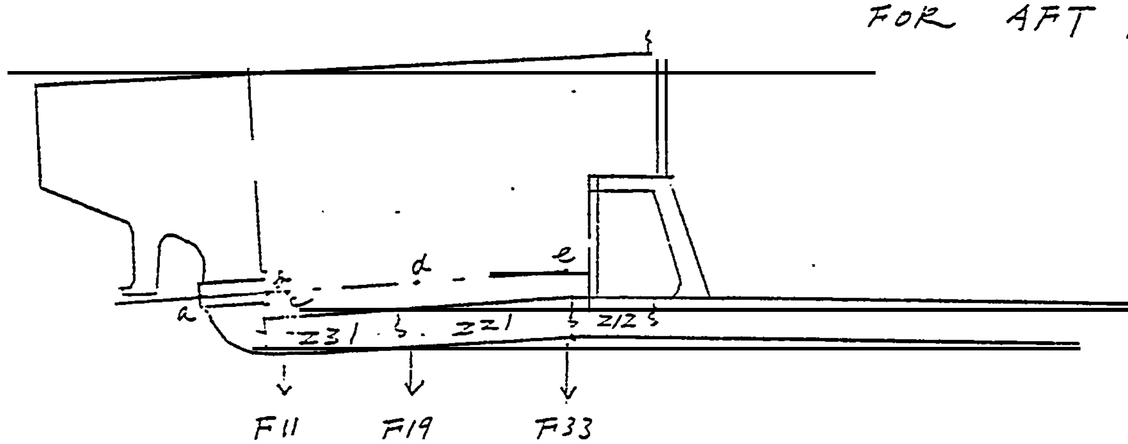
One of the most important items in constructing ships on the ways is in how to maintain accuracy of the shaft line at completion.

This attached memo shows two items, mainly concerning the aft part. One item is the final condition to be maintained on the ways and the other is the initial condition to be prepared.

With an in-depth study of this memo, we hope that you will discover a more suitable way to maintain the accuracy of the shaft line. Your immediate response would be appreciated.

< FINAL CONDITION OF INITIAL HOGGING >

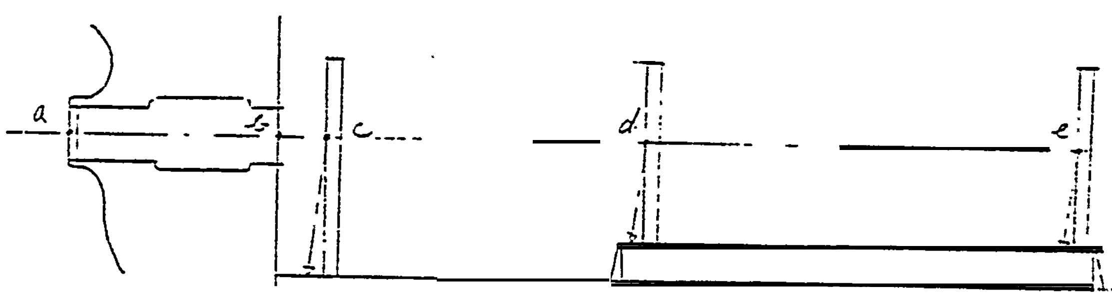
FOR AFT PART.



... 1½" 3/4" 0 (FINAL CONDITION)

1. KEEP THE POINTS (a, b, c, d, e) STREIGHT AFTER WELDING

2. KEEP THE INITIAL HOGGING 1/4" A FR11 AFTER WELD:



a: END POINT OF BOSS CASTING

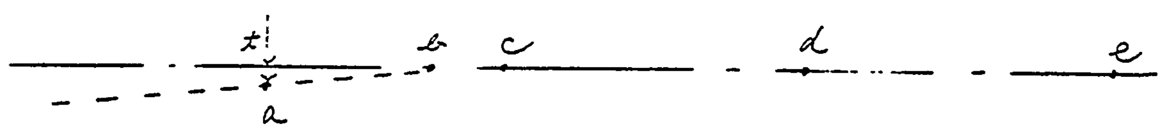
b: F'WD END POINT OF STERN TUBE

c: END POINT OF UNIT Z31 (F 11)

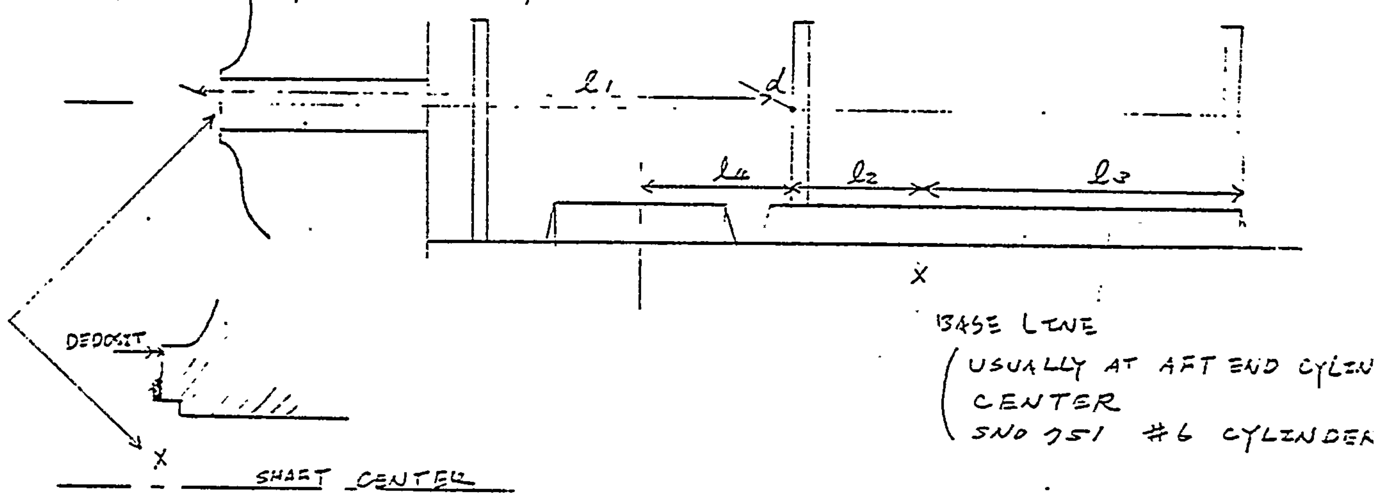
d: AFT END POINT OF MAIN ENGINE SEET (F 28)

e: F'WD END POINT OF " (F 32)

3. DEVIATION OF SHAFT LINE HAS TO BE KEPT LESS THAN 1/4" AFTER WELDING. $t \leqq 1/4"$

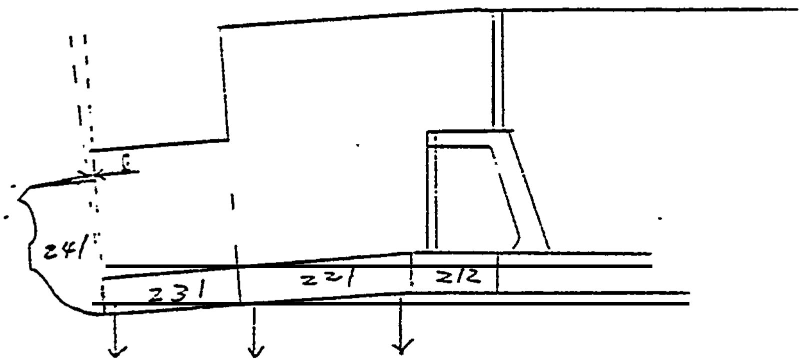


4. SHAFT LENGHT



- SHAFT LENGHT (L) = $l_1 + l_2$
- SHAFT LENGHT HAS TO BE KEPT L + 1/4" AFTER WELDING.
- MAIN ENGINE BED LENGHT ($l_2 + l_3$) [illegible] CHECKED AND ALSO THE POSITION OF REDUCT GEAR SHEETS (24), TOO.

(c) INITIAL CONDITION AND NOTICES TO GET THE NICE RESULTS.



FRAME NO	F11	F19	F33	ℓ (AT FLAT 26'11 1/16" A.BL)
UNIT SET CONDITION	1/16" × 22'/23' + 1 1/2" ≒ (1 1/2")	1/4" × 40'/50' + 3/4" ≒ (1 1/16")	0	3/8" (AT FLAT 26'11 1/4" A BL 1/8" (AT SHAFT CENTER
	↓	↓	↓	↓
AFTER WELDING	1 1/16"	3/16"	0	0

<NOTICES>

1. THE CRIBBING FOR UNIT 231, 221 MUST BE SET DEPENDING ON UNIT SET CONDITION SHOWN ABOVE.

2. SHAFT LENGHT (L) HAS TO BE KEPT L + 1/4" ~ 1/2" AFTER FITTING
   (SHRINK)

3. POSTS TO SET THE SHOOTING EQUIPMENTS (SCOPE, TARGET) SHOULD BE SET BEFORE SETTING UNIT 241.

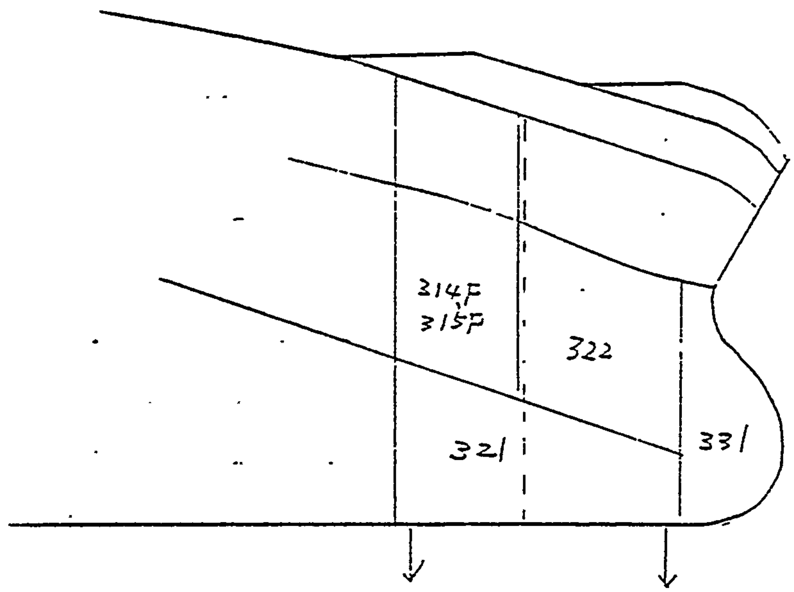
5. THE WELDING AT JOINT 241 X 232, 233 SHOULD BE DONE WITH THE GREATEST POSSIBLE CARE. BECAUSE EACH STEPS OF WELDING AT THIS PART BRING SERIOUS INFLUENCE ON ACCURACY OF SHAFT CENTER.
USUALLY THE STEP-BACK METHOD WILL BE APPLIED AT THIS JOINT.

6. BEFORE CHECKING THE SHAFT LENGHT, RECONFIRM THE INCLINATION OF POST (α).

7. MAIN ENGINE SHEETS
FOR THE FIRST TIME (SNO 751), IT IS BETTER TO SET THE MAIN ENG. SHEETS AFTER PRE SHOOTING LINE.
BECAUSE FOR SETTING THE LEVEL OF THE TOP OF MAIN ENG. SHEETS, TO USE THE PRE SHOOTING LINE AS BASE LINE IS EASIER THAN TO USE THE INCLINED TANK TOP AS BASE LINE.

8. AFTER COMPLETION OF UNIT 241, UNIT 242 CAN BE SET DEPENDING ON SHAFT LINE.

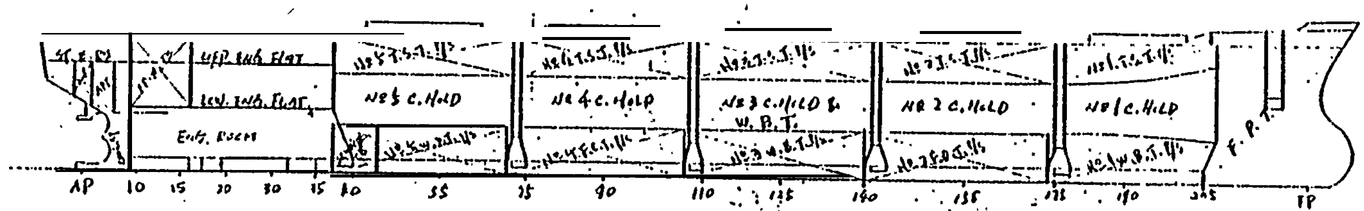
< FINAL CONDITION OF INITIAL HOGGING > FOR FOWARD PART.

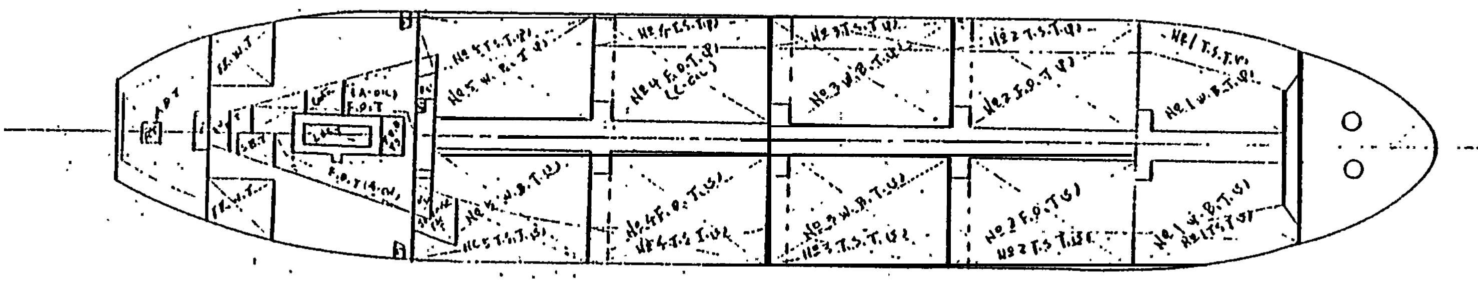


FRAME NO	F202	F213
UNIT SET CONDITION	0	$\frac{1}{4}'' \times \frac{48'}{50'}$ + 1" = $1\frac{1}{4}''$
AFTER WELDING	0	1"

NOTICE: THE CRIBBING FOR UNIT 321 MUST BE SET DEPENDING ON UNIT SET CONDITION SHOWN

SNo 2581/82 TANK ARRANGMENT & TESTING SCHEME



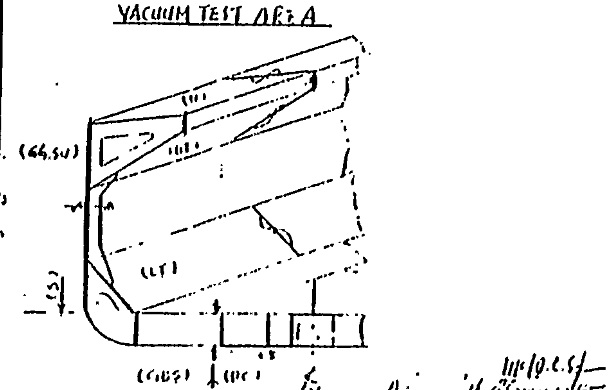


TANK NAME (AFT PART)	CAPACITY (LT)	PRESS. & W. HEAD	KIND OF WATER	ON BERTH KIND OF TEST
F.O. OV. FL. T.	12.2	ABOVE UDF 2.40	FR. WATER	HYD. TEST
L.O. SUMP. T.	14.6	〃	〃	〃
F. O. T. (P)	28.9	〃	〃	〃
〃 (S)	85.3	〃	〃	〃
SEP. SL. O. T.	11.0	〃	〃	〃
BILGE TANK	16.9	〃	〃	〃
D.B. VOID. / COFFERDAM.	50.1		〃	〃
COOL. S.P.	27.6		FR. WATER	〃
A. P. T.	264.9	ABOVE U.DK 2450	SEA WATER	〃
FR. W. TANK (P)	184.9	〃	FR. WATER	〃
〃 (S)	184.9	〃	〃	〃
SEWAGE TANK	83.5	ABOVE U. DK 2.40	SEA WATER	〃

TANK NAME (FORE PART)	CAPACITY (LT)	PRESS. & W. HEAD	ON BERTH KIND OF TEST	ON BERTH REMARK	AFLOAT KIND OF TEST	AFLOAT REMARK
No 5 W.B.T. P/S	5 687.1	ABOVE UDK 2.40 *	AIR TEST	VACUUM TEST 190		
No 4 F.O.T. P/S	706.7	〃 〃	HYD. TEST	〃		
No 3 W.B.T. P/S	715.3	〃 〃 *	AIR. TEST	〃		
No 2 F.O.T. P/S	697.5	〃 〃	HYD. TEST	〃		
No 1 W.B.T. P/S	673.9	〃 〃 *	AIR. TEST	〃		
No 5 T.S.T. P/S	528.1	〃 2450		〃	HYD. TEST	AFTER PAINT WITH SEA WATER
No 4 T.S.T. P/S	512.2	〃 〃 *	AIR. TEST	〃		
No 3 T.S.T. P/S	512.7	〃 〃		〃	HYD. TEST	AFTER PAINT WITH SEA WATER
No 2 T.S.T. P/S	511.7	〃 〃 *	AIR. TEST	〃		
No 1 T.S.T. P/S	314.3	〃 〃		〃	HYD. TEST	AFTER PAINT WITH SEA WATER
F. P. T.	1647.5	〃 〃 *	AIR TEST		HYD. TEST	〃
No 3 C. HOLD / No 1 [illegible]	9.718.1	2kg/cm²	HOSE TEST	T. B. [illegible]	HYD. TEST	[illegible]
PIPE DUCT / HOPPER VOID	SAME ABOVE	110⁻⁴/[illegible] 2kg/cm²	VACUUM TEST / HOSE TEST			

NOTE: 1) VACUUM TEST TO BE DONE BY SHIPYARD, AND DAILY APPLICATION NOT TO BE SUBMITTED.
2) * MARK DENOTES AIR PRESSURE OF 0.21kg/cm²

VACUUM TEST AREA



Final Dimension Check Items

Usually before launching the ship, the final dimension of the ship should be checked by Owner and Classification.

The checking items are as follows:

1. Conditions

   Time, Temperature, Weather

2. Bottom Alignment

   From A.P to F.P, at the center line, the strength of the bottom line will be checked as using special jigs.

3. Or-aft Marks Check

.4. Actual Dimensions

   Depth, breadth at mid ship section.
   Length between perpendicular.
   Hatch opening size at random.

Sample will be shown next.

OWNER'S INSPECTION RECORD (SUMPLE)

No. 1

Owner :

Date Inspected : Dec. 24. '76

Ship No.	Engine No.	Material	Drawing No.
2582			

Name of Article: BOTTOM ALIGNMENT AND SETTING OF DRAFT MARKS.

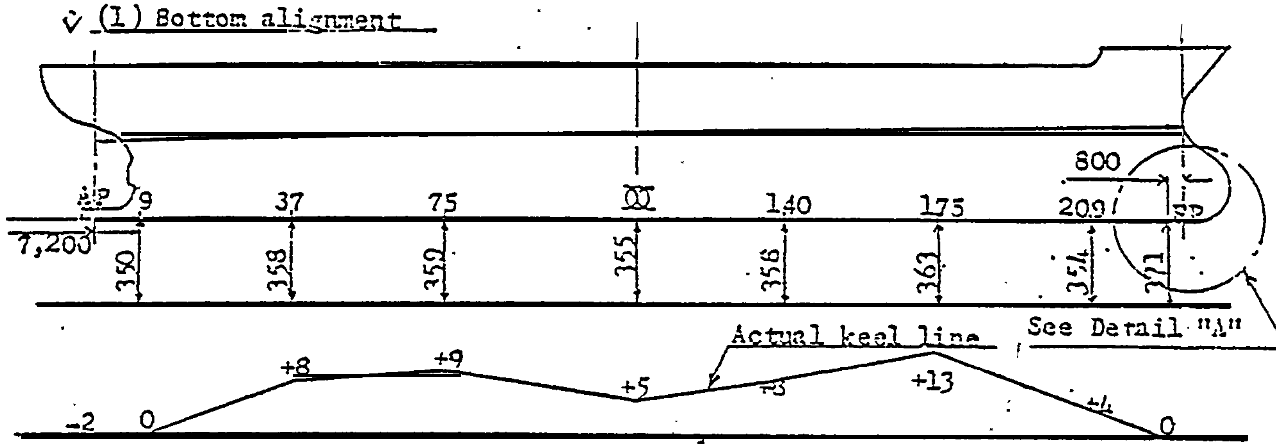
Subject

Attendance
✓ L.R.S Mr. D. A. Maxwell
✓ Owner Mr. S. H. Tseng

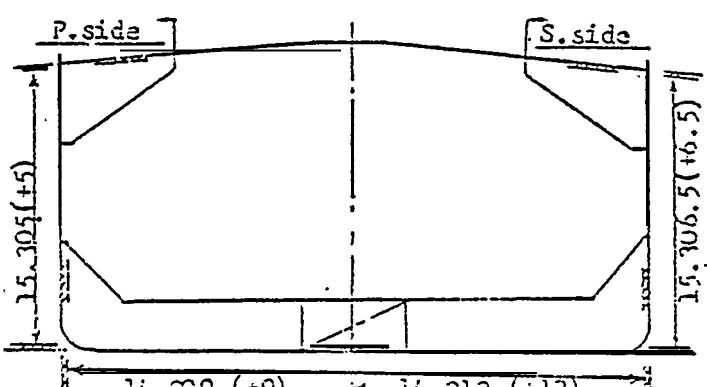
✓ Time. AM. 10:00
✓ Temp. 6°C
✓ Weather. Fine

Measuring unit in m/m

✓ (1) Bottom alignment



Midship section

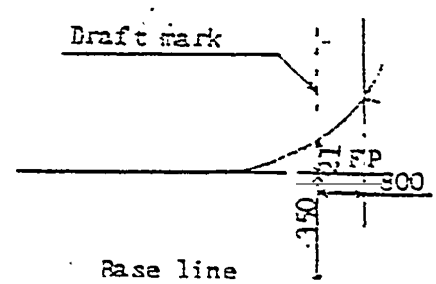


✓ (2) Moulded depth
✓ Designed depth 15,300
✓ Actual depth (P) 15,305 (+5)
✓ " " (S) 15,306.5 (+6.5)

✓ Designed breadth
✓ Designed breadth 28,400
✓ Actual breadth 28,421
✓ DESIGNED LENGTH
✓ ACTUAL LENGTH

(3) Standard point for draft marks
✓ Fwd. 2,000 FROM B.L
✓ Midship. 2,000 (P & S) "
✓ Aft. 3,600 "

Detail "A"

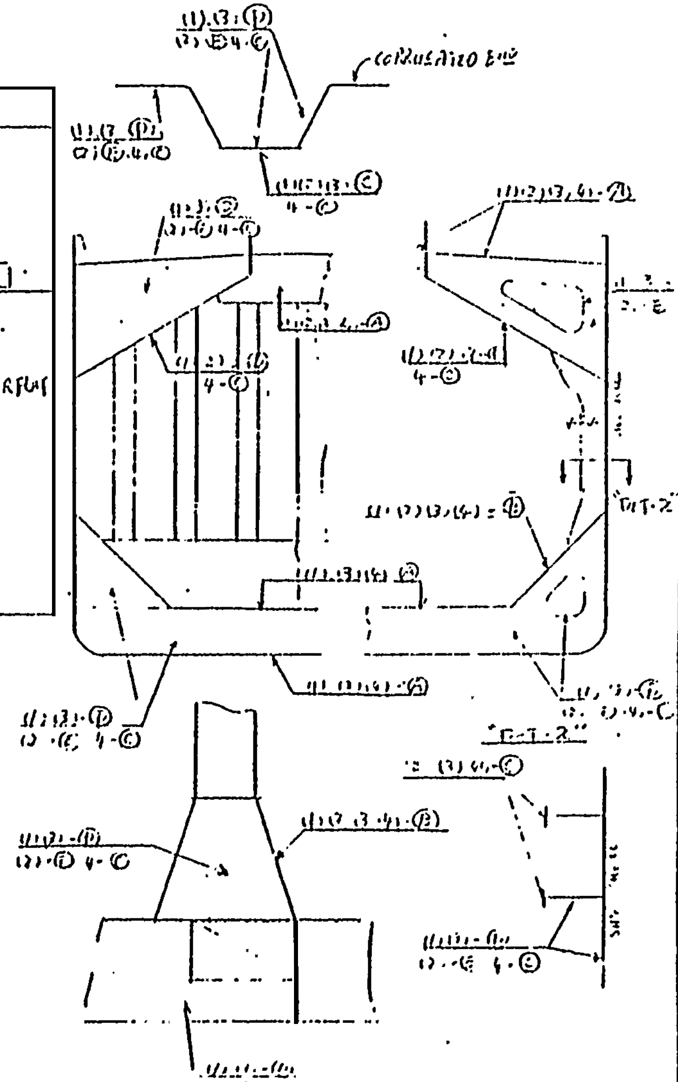


3/31/82

DISPOSAL OF TEMPORARY PIECES FOR CONSTRUCTION PURPOSES

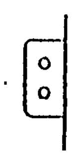
ACCO

[illegible]PACE	(A)	(B)	(C)	(D)	(E)
[illegible]HOD	PIECES ARE TO BE REMOVED COMPLETELY AND FINISHED BY GRINDING AFTER WELDING	PIECES ARE TO BE REMOVED AND FINISHED UP BY WELDING SMOOTHLY.	PIECES ARE TO BE. REMOVED AND FINISHED UP BY WELDING	PIECES ARE TO BE CUT AT THE TOP OF WELDING BEAD AND THE EDGE TO BE SMOOTHLY	PIECES ARE TO BE LEFT AS THEY ARE
[illegible]ATION	(1) (2) (3) (4) EXPOSED SURFACES OF HULL, DECK AND SUPER-STRUCTURE. (1) INSIDE SURFACE OF HATCH COAMING AND HOLD BATCH (2) VISIBLE PART FOR UP TO 2M ABOVE FLOOR IN ENG ROOM & STEERING GEAR FLAT	(1) (2) (3) (4) INSIDE HOLD. OF LOWER HOPPER AND L.T. BHD.	(4) UNDER FLR SPACE. (1) (3) (4) ENGINE ROOM & STEE. GEAR FLAT. GROUND UP. TOO MUCH REINFORCEMENT TO BE GROUND UP. (CORNER REQ.)	(1), (3) UNDER FLR SPACE	(2) UNDER. FLR SPACE. (2) ENGINE ROOM & STEER. GEAR FLAT



(1) LIFTING PADS.

(2) LUG FOR SCAFFOLDING



(3) TEMPORARY PIECES (ETC.) (COMPLETELY WELDING)

(4) TEMPORARY PIECES (ETC)

APPENDIX F

EXAMPLE
IMPLEMENTATION OF GATE SYSTEM IN LSCO.

1. Introduction

Fig. 1-1 Total Planning Flow for Hull Production

1. Introduction

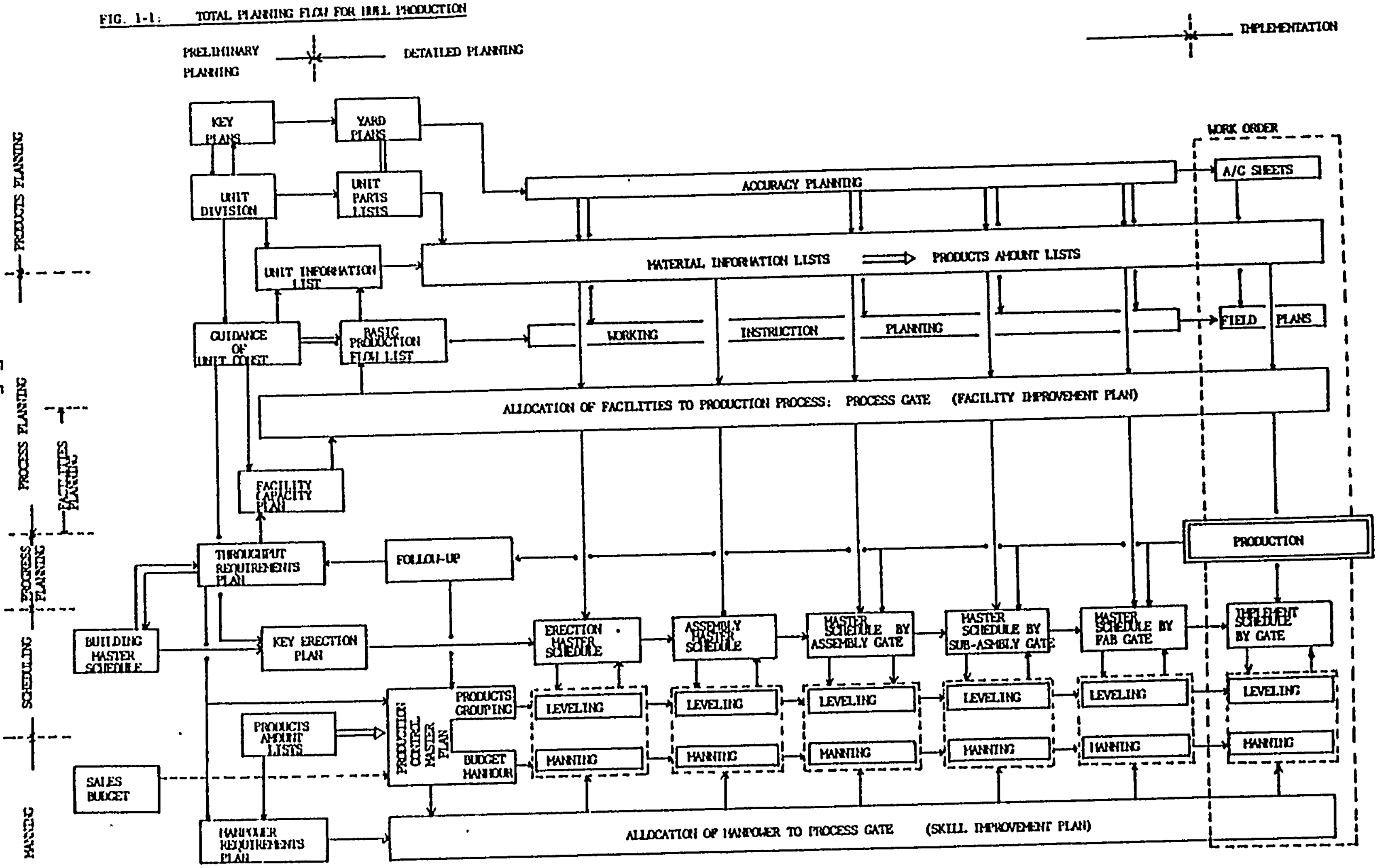
A ship, as final product, is consisted of a huge number and many kinds of pieces, components and units of hull steel structure as interim products. These interim products are fabricated and/or assembled from many materials by many manpowers on each facilities. As you already recognized, the Hull Unit Construction method is a key of shipbuilding for obtaining an optimum production flow.

In order to keep the smooth production flow in Production, the adequate Production Engineering about the hull construction process, namely planning and scheduling, should be executed beforehand for the stages of material procurement, fabrication, sub-assembly, assembly and erection as follows:

1) Products Planning
   - Unit Division
   - Unit Parts List
   - Accuracy Planning
2) Process Planning
   - Guide to Construction of Unit
   - Basic Production Flow List
   - Unit Information List
   - Material Information List
   - Working Instruction Planning
3) Facility Allocation Planning
4) Scheduling
5) Manpower Allocation Planning

Total planning flow for hull production is shown in Fig. 1-1

FIG. 1-1: TOTAL PLANNING FLOW FOR HULL PRODUCTION



2. Aim and Concept of Gate System

2. Aim and Concept of Gate System

2-I) Aim:

In LSCO, a new Management Information and Control System, which is workable, economical and appropriate to the size and scope of company operation, was developed by Management Task Force in September, 1978. As stated in this Task Force Report, the system is designed to allow planned and controlled expenditures for labor and material plus organized use of facilities and equipment.

In the implementation and the continuing operation of this system, the Production Control Department is playing an important role based on the Work Order System. In this Work Order System, to perform effective control with resources (labor, time, material and facilities), the entire vessel is divided into controllable units of work as follows:

1. Major Events
2. Zones
3. Work Groups (Units)

These work groups which are to be produced as the end product are further divided into specific assignments of work as work orders. The planning of work orders is determining how the objective is to be achieve, utilizing what resources and within what time frame.

Work orders describing specific tasks to be performed are issued to the responsible foreman, according to the schedule produced by the network planning. So the work order package contains drawings, specifications, resources (i.e. labor and time) budgeted, bills or lists of materials, facility usage requirements (i.e. where the work will be performed and, eventually using what heavy equipment) and information needed to record actual costs.

As described in the above, the Work Order System in LSCO is a well organized system but still System-Oriented manner instead of Product-Oriented one.

In other words, although the work group, such as unit, is a key of this system and an end product of the vertical combination of work breakdown structure, it is necessary to further divide into work order as interim product, which is produced with resources.

Therefore, the work order is a key of Product-Oriented System obtaining an optimum production flow, which is essential to take into consideration as follows:

The classifying of interim product from the work breakdown of work group (vertical structure).

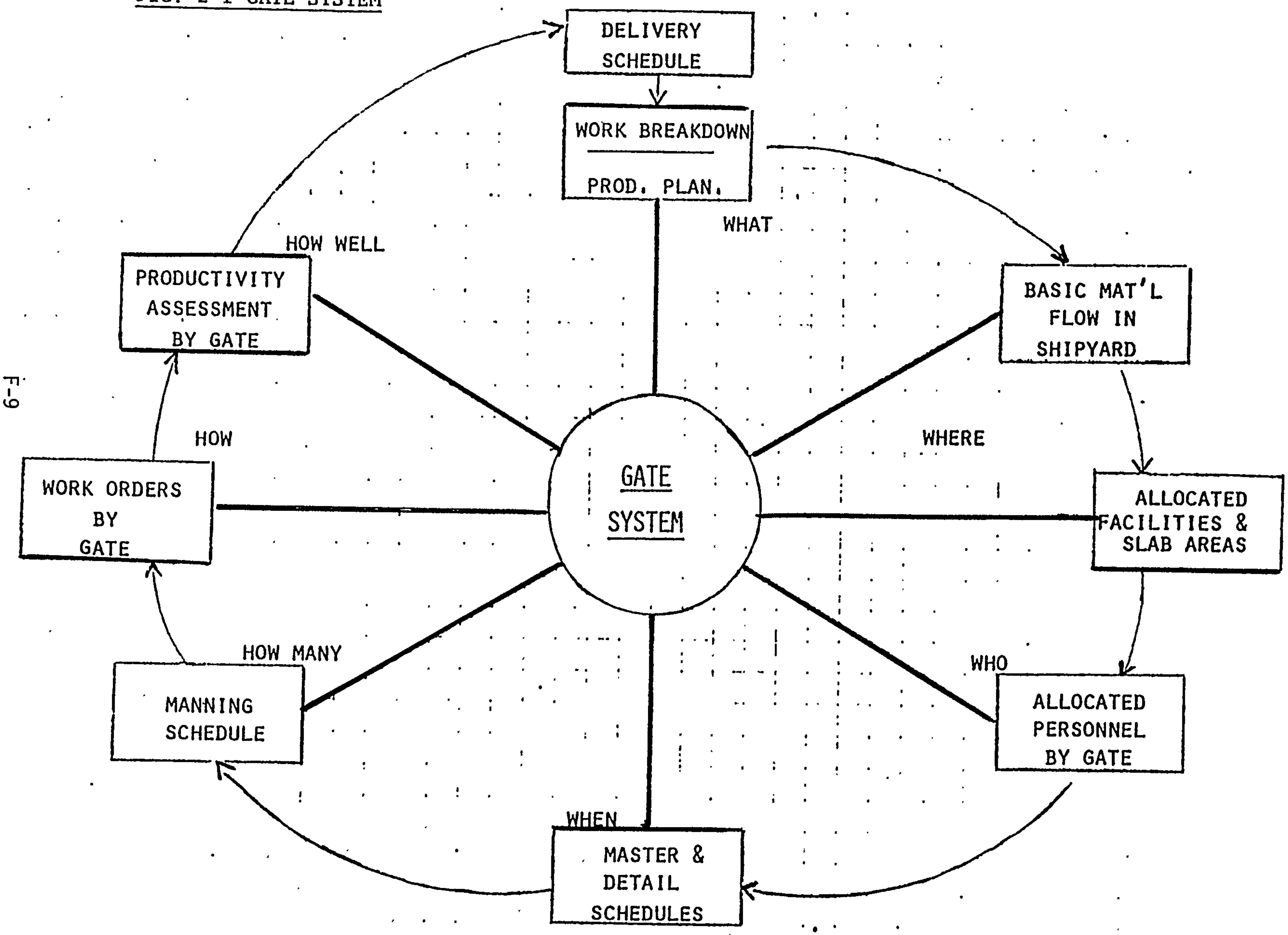
The horizontal combination of the work breakdown structure.

The allocation of interim product into facility.

The allocation of manpower into facility.

As mentioned in the above, the work order is indicating what product is to be performed in where, by whom, within what time frame (when), with how many manhour, how and how well, as shown in Fig. 2-1, namely Gate System.

FIG. 2-1 GATE SYSTEM



2-2. Concept:

As shown in Fig. *2-2* , the basic operating concept of the Gate System consist of the following major elements and aspects.

a) Allocation of facilities and slab areas.
   - Work breakdown according to pre-determined facility assignment.
   - Scheduling by area.
   - Man-loading by area.
   - Transportation/crane requirements planned for each area.
   - Facility improvement requirements readily identifiable.

b) Standard work flow in each area.
   - Detail schedules/procedures for each area.
   - Organized work patterns.
   - Housekeeping by resident group.
   - Flexibility in worker use and methods.

c) Identified skills, equipment and tools.
   - Fixed manpower requirements.
   - Skills available when needed.
   - Fixed equipment/tools requirement.
   - Equipment/tool maintaining by resident group.

d) Assigned Foreman and Workers for each gate.
   - Increased efficiency thru non-movement.
   - Group Development.
   - Responsibility/Recognition identification.
   - Tighter supervisor control.
   - Escalating skills/methods.
   - Schedule communication.
   - Workers active towards schedule/quality achievement.
   - Group responsibility for area/product.

e) Scheduling/Productivity analysis.

Master schedule by gate.

Detail schedule within gate (by station).

Overtime used to recover schedule.

Output of each gate and station can be measured against plan.

Chronic problems identifiable to specific gate or area.

Productivity recognizable by workers.

In other words, the Gate System is the integrated system with facility, work flow, equipment, schedules and people.

Each area of yard is designated for specific types of work and putting people in small groups under assigned foreman.

Therefore in this system, Planning and Scheduling revolves around work breakdown, allocated areas, and allocated personnel.

In order to implement this system smoothly, the following will be taken into consideration.

a) Allocation of facilities:

i) Shipyard areas in shops and on slabs are designated for particular work.

ii) Gates (Areas) as process are selected on the basis of:
- Optimum work/material flow
- Crane requirements
- Other equipment requirements

iii) Work is brought to workers by most efficient means.

iv) Objectives:
- Minimize people/material movement
- Optimize work area and methods
- Maintain schedule

b) Allocation of People:

i) Foremen are designated for each gate.

ii) Small groups of workers are assigned to each area within a gate.

iii) Facility/Equipment/Tools confined to each gate.

iv) Journeyman (Skill Worker)/Apprentice (non or low-skill worker) ratio is balanced according to skill requirements.

v) Absenteeism is balanced by added people in each group.

vi) Foreman/Journeyman responsible for OJ.T of Apprentices.

vii) Productivity standards can be established and measured by Group.

Through the implementation of this system, the following benefits will be expected.

Benefits of System:

i) Vastly improved production control

ii) Simplified scheduling and manpower planning

iii) Allows improvement of skill/methods

iv) Allows removal of senior personnel (for ship repair) without jeopardizing new construction.

v) Allows realistic appraisal of productivity (i.e. by Group-by Area)

vi) Allows precise scheduling of transport equipment/cranes

vii) Provides product-oriented system

FIG 2-2: BASIC OPERATING CONCEPT

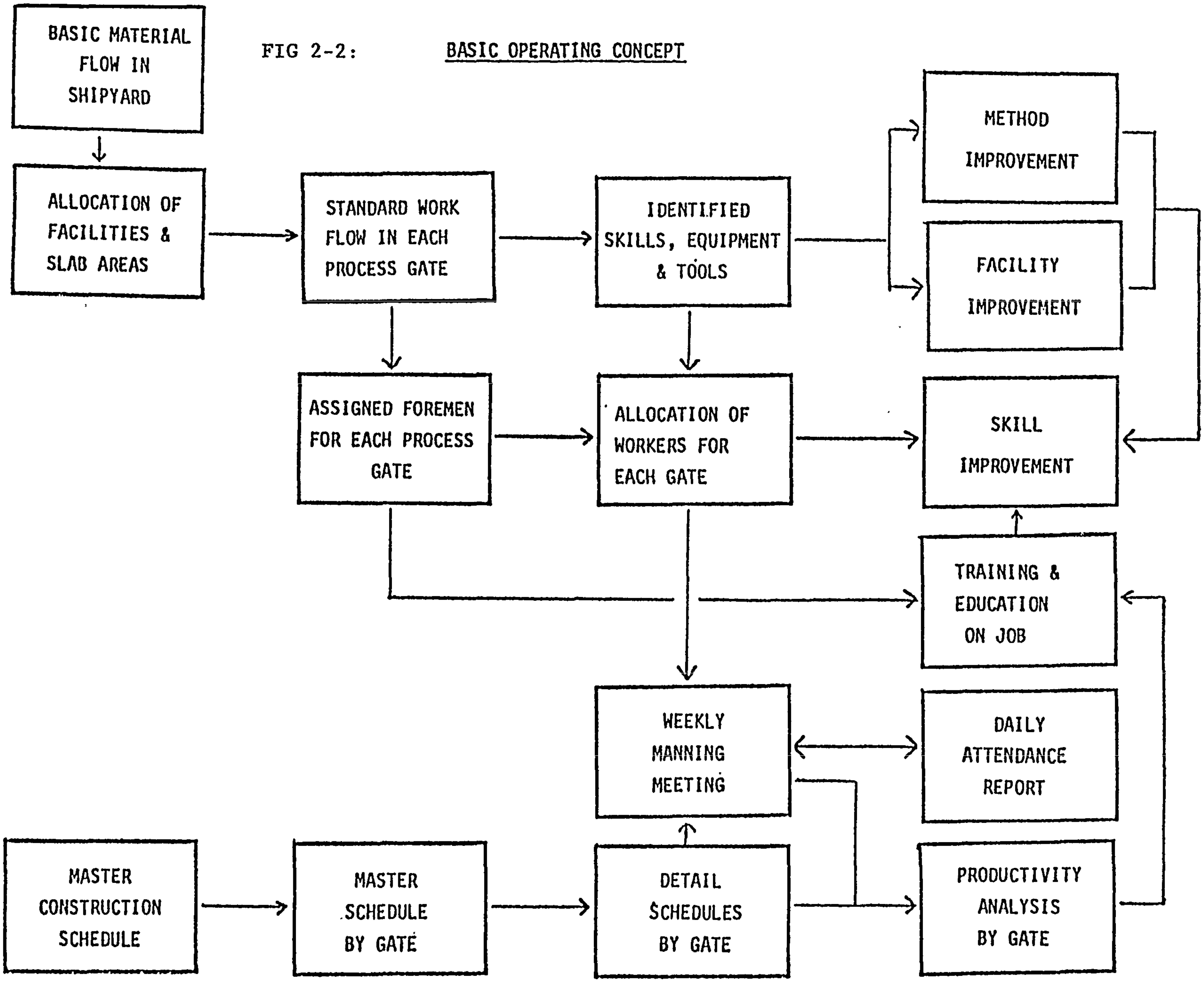


Fig. 2-3

ASPECTS OF SYSTEM ELEMENTS

ALLOCATION OF FACILS. & SLAB AREAS	STD. WORK FLOW IN EACH AREA	IDENTIFIED SKILLS, EQUIP. & TOOLS	ASSIGNED FOREMEN & WORKERS FOR EACH GATE	SCHEDULING/ PRODUCTIVITY ANALYSIS
Work breakdown according to pre-determined facil. assignment	Detail schedules/ Procedures for each area	Fixed manpower requirements	Increased efficiency thru non-movement	Master schedule by gate
Scheduling by area	Organized work patterns	Skills available when needed	Group development	Detail schedules within gate (by Station)
Man-loading by area	Housekeeping by resident group	Fixed equipment/ Tools requirement	Responsibility/ Recognition identification	O/T used to recover schedule
Transporatation/ Crane requirements planned for each area	Flexibility in worker use & methods	Equipment/Tool maint. by resident group	Tighter supr. control	Output of each gate & station can be measured against plan
Facility impr. requirements readily identifiable			Escalating Skills/ Methods	Chronic problems identifiable to specific gate or area
			Schedule Communication	Productivity recognizable by workers
			Workers active toward schedule/quality achievement	
			Group responsibility for area/product	

3. Work Breakdown of Hull Structure

1) Preliminary Breakdown Planning
2) Detail Breakdown Planning

3-1. Products Planning: Unit Parts List
1) Designation of Piece/Part
2) Kind of Common Piece/Component
3) Grouping of Breakdown Structure

3-2. Process Planning: Material Information List

3-3. Products Amount List
1) Preliminary Products Quantity List/Table
2) Detailed Products Quantity List/Table

Fig. 3-1 Total Planning Flow for Hull Production (Fig. 1-1)
Fig. 3-2 Model Breakdown Structure of Hull Unit
Fig. 3-3 Unit 131 Breakdown Structure
[redacted]
Fig. 3-10 Unit 131 Parts List
Fig. 3-11 Unit 132/133 Parts List
[redacted]
Fig. 3-17 Block Parts List in IHI
Fig. 3-18 Coding System of Hull Structure Piece in IHI
Fig. 3-19 Piece Naming
Fig. 3-20 Common Parts List (Standard Index)
Fig. 3-21 Typ. Midbody Framing Assembly Booklet

3. Work Breakdown of Hull Structure

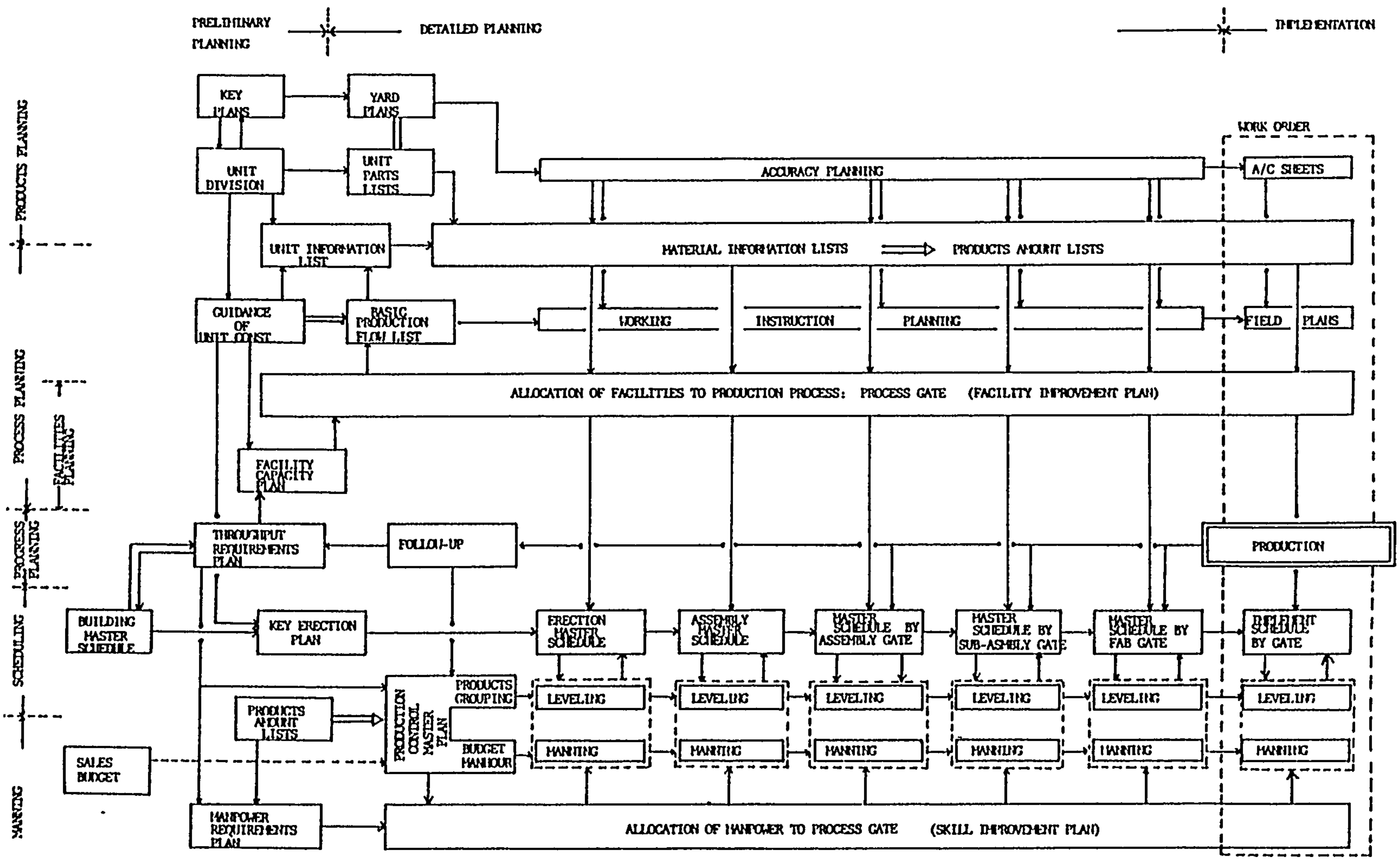
In the hull unit construction method, since the breakdown structure of hull is a key factor of maintaining highest productivity, it will be taken into consideration of the following major objectives:

How to divide into units, components and parts/pieces
: Products Planning

How to produce from raw materials to a ship thru parts, components and units : Process Planning

From the above point of view, the work breakdown of hull structure with product-oriented manner is a key of planning, scheduling and controlling for Production, as shown in Fig. 3-1.

FIG. 1-1: TOTAL PLANNING FLOW FOR HULL PRODUCTION



1) Preliminary Breakdown Planning

After contract of ship, in early stage, this preliminary breakdown planning is necessary to carry out from the key plans with Engineering and Production Control in order to develope the detailed construction drawing and the production planning.

The main subjects of this planning are:

How to divide a hull into units to meet the requirements of erection work well and safely.: Unit Division
(Refer to our Mr. O. Togo's final report)

How to assemble each component to unit in high productivity and quality.: Guide to Construction Unit
(Refer to our Mr. O. Togo's final report)

The division of hull into unit and assembly component is necessary to make an adequate size of unit and/or component assembled at the assembly slab and/or shop before erection, in other words a size of unit and/or component is taking account of the facilities, the equipment and etc of the yard.

Therefore the following size of unit or component is a most economical and workable size in the medimum size of shipyard.

Size : average 40'-0" x 40'-0"
maximum 50'-0" x 50'-0"

Weight: average 30 Tons - 40 Tons

The above optimum sized division will lead to avoid the variety of the working time and the shape.

On the other hand, since the main objectives of unit division is to reduce the work on the building way, the pre-erection, such as "Unit-to-Unit" to enable more applicable and more satisfactory than if unit is biger, for the following reasons:

Avoiding deformation during assembly due to too big size to move

Accuracy keeping during over-turning and transportation

2) Detail Breakdown Planning

Following to the preliminary Planning, the Engineering drawings are developed by more detailed breakdown including the products information, such as piece number, size of piece, its material grade, joint condition and etc.

During the breakdown of unit in engineering drawing, a material list is to be provided for each unit with piece number of each part.

In this step, the huge number of parts, which are composed of unit, are to be grouped from the structure-wise in order to minimize the handling of materials through the production flow.

In this purpose, the major consideration are as follows:

To divide a unit into the main structure components and the internal structure components, and then furthermore into parts respectively.

To assemble a few parts to a part of component as pre-subassembly.

3-1 Products Planning : Unit Parts List

Through the development of hull unit construction plan in Engineering, the part and/or component of hull strufture are naming one by one for identification of consisted material, in a unit.

In the hull unit construction method, the most important objectives are what materials are consisted of "a unit" as interim products.

These breakdown structure of unit for interim products are shown in Fig. 3-2 as model and in Fig. 3-3 as typical units of mid section in Bulker.

There are five levels of interim products and two more levels up to ship level, such as:

- Piece/Part
- Pre-Sub Part
  Sub-Assembly (Internal Structure Component)
- Panel Component
- Main Structure Component
- Unit
  Unit to Unit (Grand Unit)

Therefore, the distinction of each level is essential for products planning.

From the above point of view, several samples of Unit Parts List in Bulker are shown in Fig. 3-10 modification of present piece list, which is described on the construction drawing, and the IHI’s format is shown in Fig. 3-17.

There consisted from the following items

- Unit Number
- Component Number
- Piece Number
  Size (if, necessary description)
- Net Weight instead of Gross Weight
- Item and Sub-Item

This list is a basic list for cost identification of material and all composed materials, such as interim products, of unit.

FIG. 3-2 MODEL BREAKDOWN STRUCTURE OF HULL UNIT

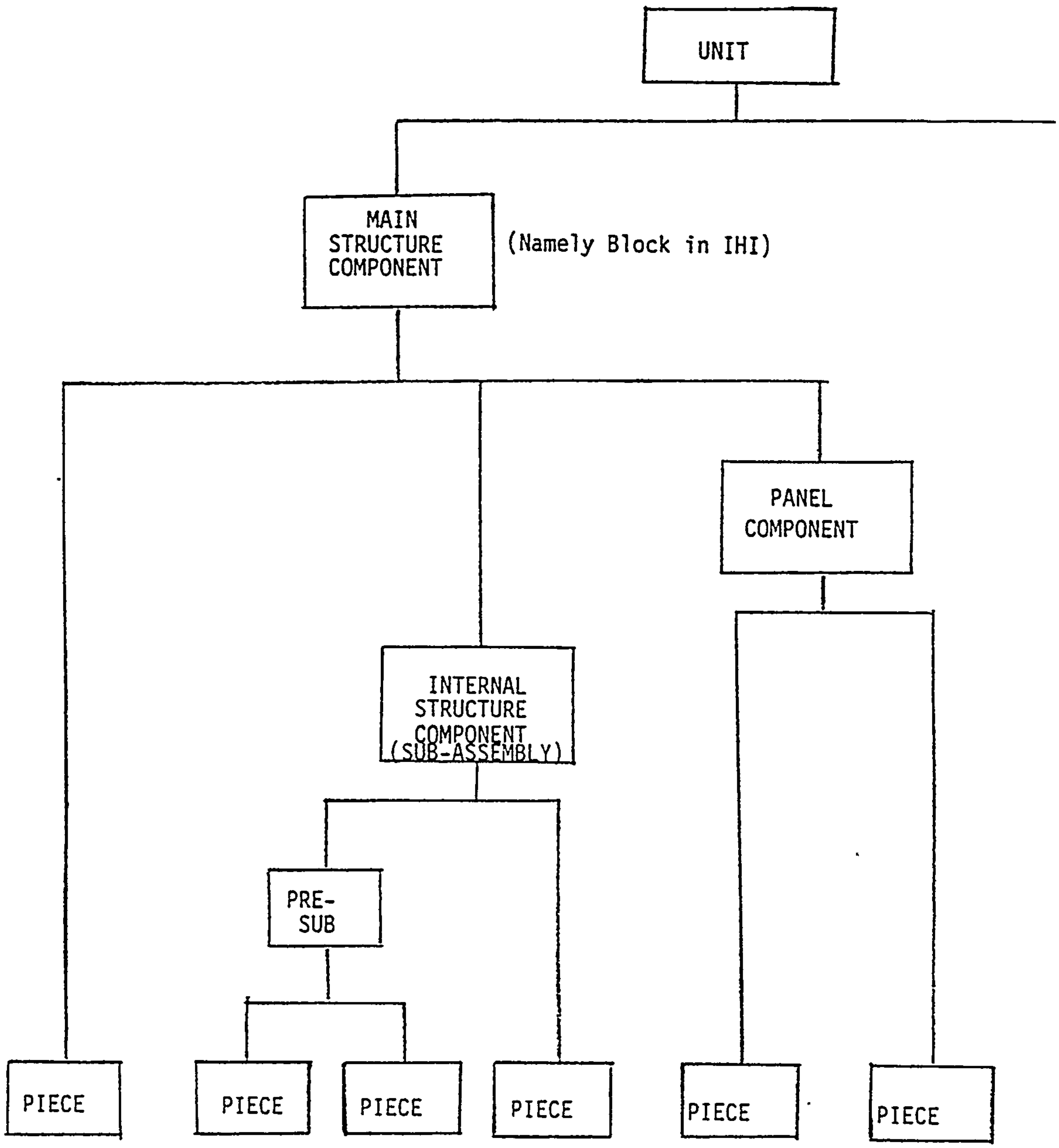
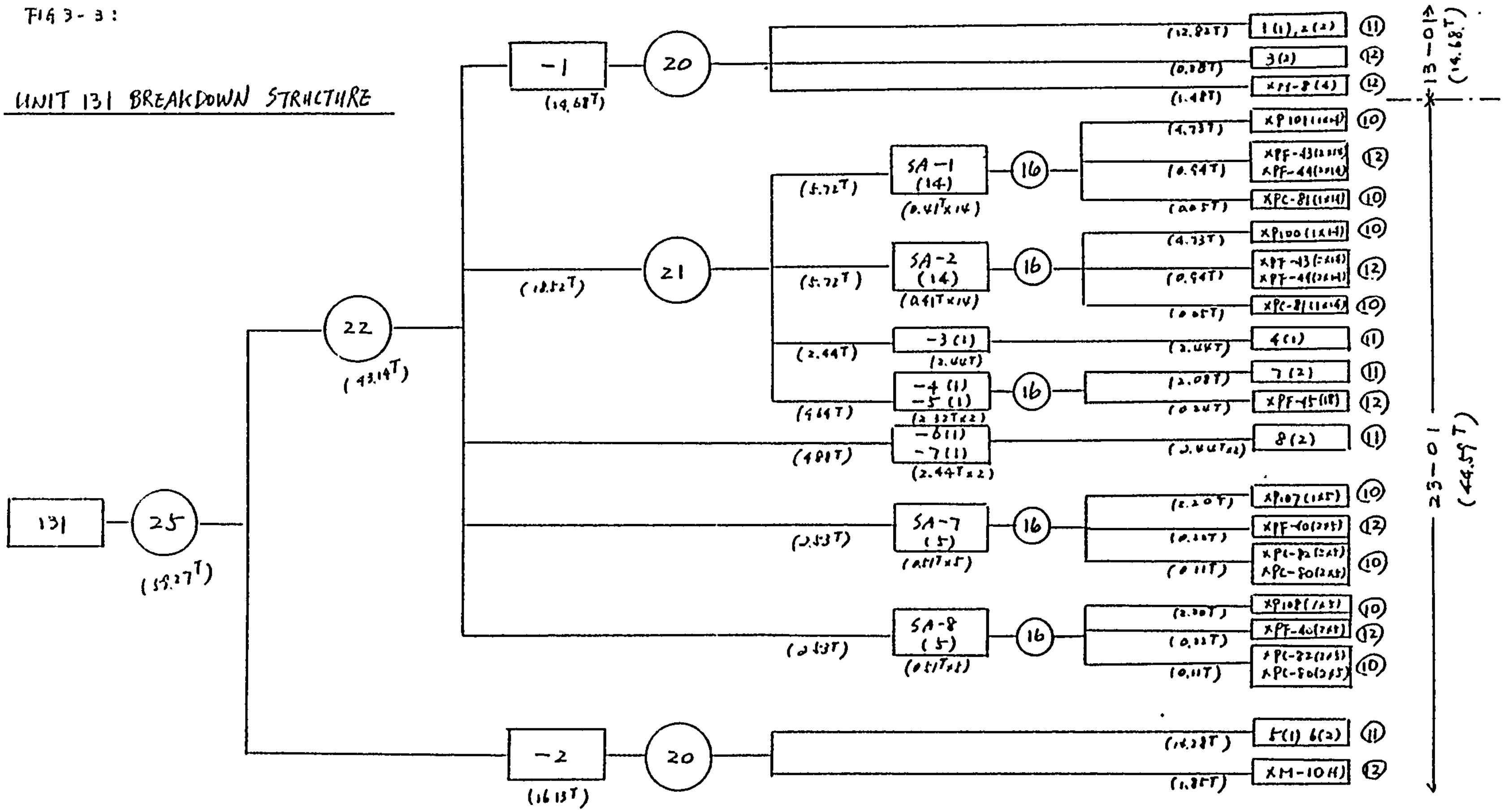


FIG 3-3:

UNIT 131 BREAKDOWN STRUCTURE



		13-01	23-01
⑩ :	14.18T	0	14.18T
⑪ :	34.06T	12.82T	21.24T
⑫ :	6.27T	1.86T	4.41T

FIG 3-10 : UNIT 131 PARTS LIST

DRW. NO.	COMPT NO OR SUB-ASSY NO	PC NO	DESCRIPTION OF PIECE	QTY P	QTY C	QTY S	QTY T	NET WEIGHT UNIT	NET WEIGHT TOTAL	ITEM & SUB-ITEM
T-31-10-H13-4	131-1		(TANK TOP)		1		1			13-01
		1	PL .7087 × 7'-3" × 36'-10½"		1		1			↓
		2	PL .6102 × 9'-9" × 36'-10½"	1		1	2			
		3	FB ⅝" × 6" × 36'-10½"	1		1	2			
		XM-8	WT 9 × 20 × 36'-10½"	2		2	4			↓
	-2		(BOTTOM SHELL)		1		1			23-01
		5	PL .7087 × 8'-11" × 36'-10½"		1		1			↓
		6	PL .7087 × 8'-11" × 36'-10½"	1		1	2			
		XM-10	WT .105 × 25 × 36'-10½"	2		2	4			
	-3				1		1			
		4	PL .5512 × 5'-10⅝" × 36'-10½"		1		1			
	-4(S)			1		1	2			
	-5(P)	7	PL 15/32 × 5'-10⅝" × 36'-10½"	1		1	2			
		XPF-45	FB .4688 × 6" × 5'-7⅝"	9		9	18			
	-6(S)			1		1	2			
	-7(P)	8	PL .5512 × 5'-10⅝" × 36'-10½"	1		1	2			
L-31-10-H12-1	SA-1(P)			14		14	28			
	SA-2(S)	XP101/100	PL .5512 × 5'-10⅝" × 5'-2 7/16"	14		14	28			
		XPF-43	FB .9688 × 4" × 3'-2⅛"	28		28	56			
		XPF-44	FB .4688 × 6" × 5'-0 3/16"	28		28	56			
		XPC-81	FB .5512 × 4" × 0'-3½"	14		14	28			
L-31-10-H12-2	SA-7(P)			5		5	10			
	SA-8(S)	XP107/108	PL .4688 × 5'-10⅝" × 7'-10"	5		5	10			
		XPF-40	FB .4688 × 6" × 4'-3¼"	10		10	20			
		XPC-82	PL .5512 × 7 5/16 × 0'-7½"	10		10	20			
		XPC-80	PL .5512 × 7 5/16 × 0'-8½"	10		10	20			↓
										13-01 23-01

FIG 3-11 : UNIT 132/133 PARTS LIST

DRW NO.	COMPT NO. OR SUB-ASSY NO	PC NO	DESCRIPTION OF PIECE	QTY P	QTY C	QTY S	QTY T	NET WEIGHT UNIT	NET WEIGHT TOTAL	ITEM & SUB-ITEM
T-31-10-H14-4	-1(P)		(TANK TOP)	1		1	2			
	-2(S)	1	PL .6102 × 10'-6" × 36'-10½"	1		1	2			13-01
		2	PL .6102 × 10'-6" × 36'-10½"	1		1	2			↓
		XM-8	WT 9 × 20 × 36'-10½"	6		6	12			↓
	-3(P)		(BOTTOM SHELL)	1		1	2			
	-4(S)	3	PL .7087 × 10'-6" × 36'-10½"	1		1	2			23-01
		4	PL .7087 × 10'-4⅝" × 36'-10½"	1		1	2			↓
		XM-10	WT 10.5 × 25 × 36'-10½"	6		6	12			↓
	-5(P)			2		2	4			
	-6(S)	5	PL 15/32 × 5'-10⅝" × 36'-10½"	2		2	4			23-01
		XPF-45	FB .4688 × 6" × 5'-7⅝"	18		18	36			↓
L-31-10-H12-8	SA-15(P)			5		5	10			
	SA-16(S)	XP-115/116	PL .4688 × 10'-5½" × 5'-10⅝"	5		5	10			23-01
		XPC-82	FB .5512 × 5½" × 0'-7 5/16"	10		10	20			↓
		XPC-89	PL .5512 × 7 3/16" × 0-8½"	10		10	20			
		XPC-87	PL .5512 × 7 5/16" × 0-7½"	15		15	30			
		XPF-40	FB .4688 × 6" × 4'-3¼"	15		15	30			↓
	SA-17(P)			5		5	10			
	SA-18(S)	XP-117/118	PL .5906 × 10'-5½" × 5'-10⅞"	5		5	10			23-01
		XPC-82		30		30	60			↓
		XPC-80		30		30	60			
		XPF-40		15		15	30			↓

BIBLIOGRAPHY

These lists are issued for each block/ship, and for Sub-assembly, Assembly and Erection Stages. And those lists are used for the material preparer of each stage to colour the completion and collection of parts and pieces and instruct transfer of them.

DATE	/	/	/	/	/
ALT.No	Δ	Δ	Δ	Δ	Δ
MOLD LOFT					
C . P					
A . P					
W T					
FAB. OFFICE					
KEY P					
TOTAL					

MIDIUM ASS.	P/S	TOTAL W.T.	SKIN	SEPARATE PARTS	B.U.P	SUB-ASS.

BLOCK WEIGHT (UNIT. TON)

P/S	TOTAL	SKIN	SEPARATE PARTS	B.U.P	SUB-ASS	MIDIUM ASS.	SUB→ EREC.	SUB DRAU B.U.P	LONGI.	
									INV. ANGLE	SLAB

MANAGER		S.No	WORK No		QUANTITY
DEPUTY MANAGER					
CHIEF		BLOCK PARTS LIST	CLASS	ITEM	SCALE
ENG'R IN CHARGE		- BLOCK NO.			
CHECKED BY					
DRAWN BY			DWG. NO.		
DATE DRAWN	DATE ISSUED				

IHI Ishikawajima-Harima Heavy Industries Co., LTD. SHIPBUILDING DIVISION
SHIPS DESIGN DEPT.

(K1038) A4

TOTAL NO. OF SHEETS: 1/

Fig. 7-10 BLOCK PARTS LIST

BLOCK PARTS LIST

· I — SIZE LIST
C — COMPUTER OUTPUT

STAGE

No.	PART SPEC. NO.	SIZE L (M)	SIZE W (MM)	SIZE T (MM)		PART WT (KG)	[illegible]	Q'TY P	Q'TY C	Q'TY S	[illegible]	[illegible]	[illegible]	
01														
02														
03														
04														
05														
06														
07														
08														
09														
10														
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41														
42														
43														
44														
45														
46														
47														
48														

(4730)

Y M D

STAGE LIST

S. NO. BLOCK N.

· MEDIUM ASS.

P

42

1) Designation of Piece/Part

Each hull steel piece/part is fabricated from steel raw materials, such as steel plate and/or shape.

There are several kinds of piece of hull structure fabricated from them-and its related symbols such as:

- Standard Shaped Raw Material:
  - a) Angle Stiffner : A
  - b) Angle Longitudinal : AL
  - c) Slab Longitudianl : SL
  - d) Bulb Plate : BP
- Special Shpaed Raw Material:
  - a) Pipe : P
  - b) H Bar and I Bar : H
  - c) Round Bar : RB
  - d) Channel : CH
  - e) Cut T Bar : CT
  - f) Square Bar : SB
- Plate Raw Material for Internal Structure:
  - a) Trans Web, Floor, Girder, Stringer: W
  - b) Face Plate : T
  - c) Flat Bar : F
  - d) Bracket : B
  - e) Flange Bracket : K
  - f) Collar Plate, Closed Plate : C
  - g) Doubling Plate: D
  - h) Ring Plate : R
  - i) Others : E
- Plate Raw Material for Main Structure:

  Shell, Bulkhead, Tank Top, Deck etc.

The above designated symbol in piece number is useful for realization of kind of piece instead of just series number.

In this relation, the coding system of hull structure piece in IHI is shown in Fig. 3-18 and 3-19.

FIG. 3-18

CODING SYSTEM OF HULL STRUCTURE PIECE IN IHI.

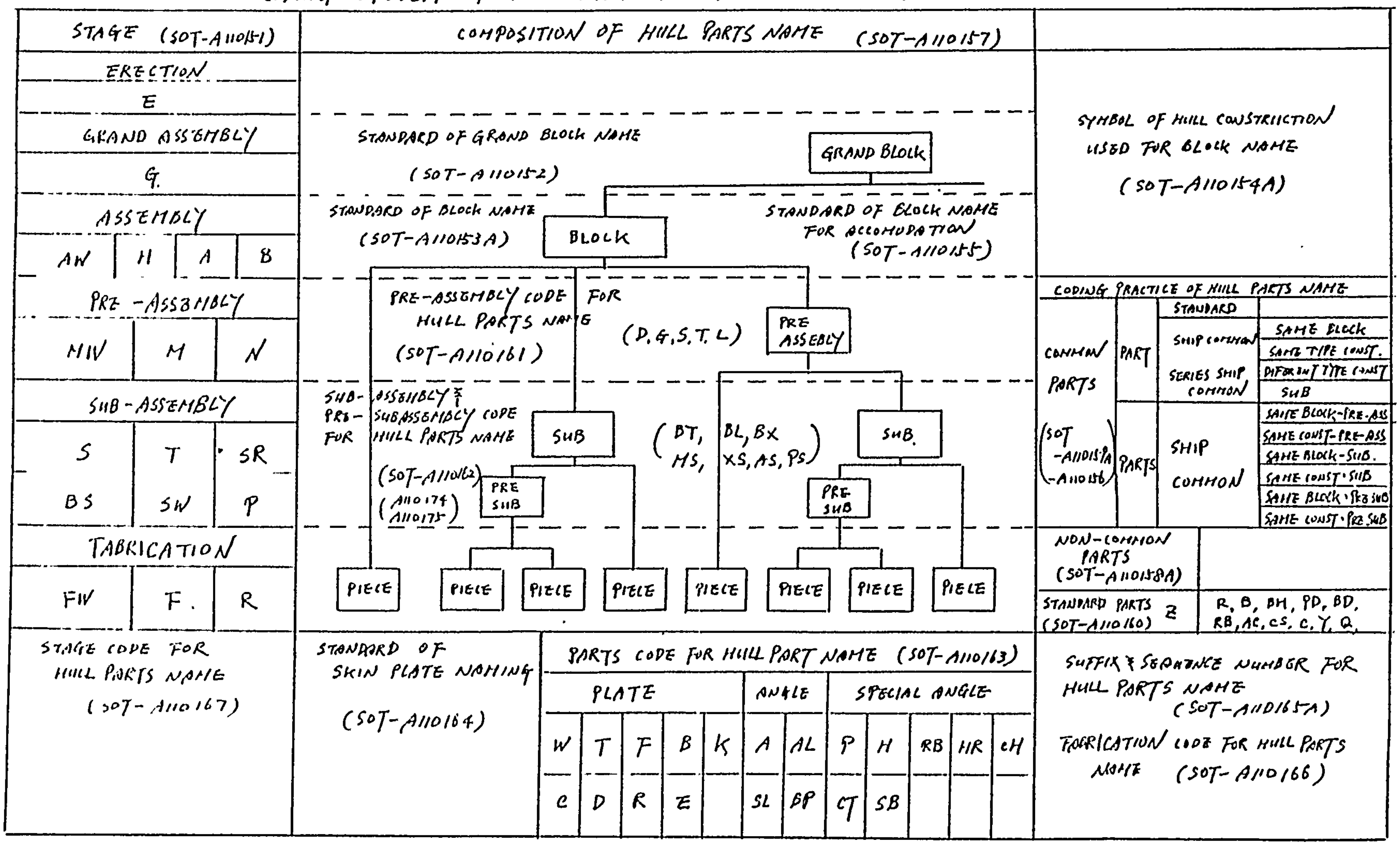


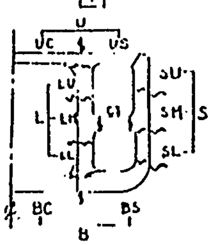
FIG. 3-19 PIECE NAMING

ASSEMBLY				PRE ASSEMBLY			SUB. ASSEMBLY					
HULL STRUCTURE	SEQ. NO.	SPARE	—	HULL STRUCTURE	SPARE	—	HULL STRUCTURE	SEQ.NO.	SPARE	PAINTING	NEXT STAGE	—
Cf. [1]	Cf[2]	Cf[3]		[illegible]	Cf[3]	—	Cf. [5]		[illegible]		Cf[6]	—

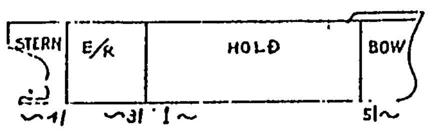
PIECE										
SIGN OF PRE SUB ASSEMBLY	STRUCTURE OF PRE SUB ASSEMBLY	SEQ NO. OF PRE SUB ASSEMBLY	SIGN OF CONSTR. PIECE	KIND OF PIECE	SEQ.NO. OF PIECE	SPARE	BENDING	PAINTING	NEXT STAGE	POSITION
	Cf [5]			Cf.[7]			Cf[8]		Cf[6]	Cf[9]

W [illegible]
U [illegible]
V [illegible]

[1]



[2]



[3]

SIGN	MEANING
A	AFTERWARD
M	MIDDLE
F	FORWARD
U	UPPERWARD
M	MIDDLE
L	LOWERWARD

[4]

SIGN	MEANING
T	TRANS. BHD
L	LONGL. BHD
D	DECK
S	SHELL
G	BILGE & GUNWALE

[5]

SIGN	MEANING
MS	マク板 サブ
XS	BOX SUB.
AS	ANGLE SUB.
PS	PILLAR SUB
BS	BUILT UP (T)
BL	BUILT UP (L)
BX	BOX SUB

[6]

SIGN	MEANING		
I		AFTER GAS CUTTING	AFTER SUB ASS'Y
S	SUB ASS.		
T	先付 (サブ)		
M	PRE ASS.		
N	中組 直付		
H	拝組		
A	ASS.		
B	B 直付 (ASS)		
G	GRAND ASS.		
E	ERECTION		

[7]

SIGN	MEANING	SIGN	MEANING
W	WEB.FRAME	CH	CANNEL BAR
T	FACE PLATE	CT	T BAR
F	FLAT BAR	BP	BULB PLATE
B	BRACKET	AL	ANGLE LONGL.
K	FLANGE BKT	SL	SLAB. LONGL.
C	COLLAR PLATE		
D	DOUBLING PLATE		
P	FILLING PLATE		
E	ETCETRA		
A	SUB. ANGLE		
H	H PILLAR		
HK	HALF ROUND BAR		
RB	ROUND BAR		
SB	SQUARE BAR		
P	PIPE		

[8]

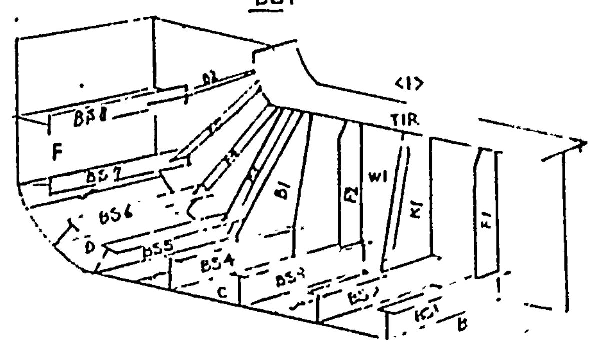
SIGN	MEANING
K	KNACKLE
R	BEND & TWIST

[9]

SIGN	MEANING
P	PORTSIDE
C	CENTER
S	STARBOARD

PIECE NAME OF TYPICAL HULL STRUCTURE

BS1



SHELL	LONGL.	SUB. ASS.
		BS1-1-W1
		BS1-1-TIR
	BS1-BS1(A)	BS1-1-F1
	BS1-BS2(A)	BS1-1-F2
	BS1-BS3(A)	BS1-1-F3
	BS1-BS4(A)	BS1-1-F4
BS1-B(A)	BS1-BS5(A)	BS1-1-F5
BS1-C(A)	BS1-BS6(A)	BS1-1-K1
BS1-D(A)	BS1-BS7(A)	BS1-1-B1
BS1-F(A)	BS1-BS8(A)	BS1-1-B2

2) Kind of Common Piece/Component

After breakdown of Hull Structure into parts, several types of commonness are existed on parts and components and classified as follows:

a) Standard Par/Piece in shipyard.

Ribs

Bracket for pillar

Non-tight collar plate

Tight collar plate

There are mostly small but standard size for all ship built in this shipyard.

Therefore, these pieces/parts are able to be fabricated separately as stock from scraped materials like working piece (such as lifting pad, fitting work piece, etc.)

Both of them are assigned to non-zone work group.

But it is important to prepare a standard material list including the following items:

- Standard Piece Number
- Unit Number
- Quantity

b) Common Part/Piece or Component by ship or series ship.

As already applied in this shipyard, there are realized several types of common piece and common sub-assembly component such as non-unit piece as follows: as shown in Fig. 3-20

- Multiple cut piece (Fabrication Stage)
  - Ž XP : For Plates (Type Floor, Girder, Web and etc.)
  - . XPB : Floor Plate, and etc."
    For Bracket Plates
  - . XPF: For Flat Bar Plates
  - . XPC : For Collar Plates
  - . XA : For Angles
  - . XM : For Shapes (Channels, Wide Flanges, Round Bars, and etc.)
  - . XT : For Fabricated Tee Shapes
- Common Sub-Assembly Component
  - . SA : Composed of common pieces to assembly an component

There are also necessary to prepare a list, as shown in Fig. 3-21.

FIG. 3-20: COMMON PARTS LIST (STANDARD INDEX)

REVIEWED JUN 22 1979

APPROVED BY: | DATE

OWNER LEVINGSTON FALCON I SHIP. CO.

AMERICAN BUREAU OF SHIPPING

UNITED STATES COAST GUARD

LEVINGSTON SHIPBUILDING CO.

ORANGE, TEXAS

PLANNING & SCHEDULING DEPT. RECEIVED JUN 22 1979

F-32

E.S.C.

DATE: 12-14-78	SCALE: NTD.
DRAWN: K. BROUSSARD	HULL: 751, 752, 753
TRACED:	PROJECT NO. 78.65
CHECKED: BAKER	APPROVED: EM / [illegible]

584'-0" x 93'-2" x 50'-2½"

36,000 DWT BULK CARRIER

LEVINGSTON FALCON I SHIPPING COMPANY

HULL STRUCTURAL STANDARDS & DETAILS BOOK

CONSTRUCTION

SHEET OF SHEETS

LSC DRAWING NO.

S-31-10-H11 ALT 10

SHEET NO. A

SHT. NO.	DESCRIPTION	ALT.	DATE
A	[illegible]		
B1-E3	STANDARD INDEX		
C	GENERAL NOTES		
D	ALTERATIONS		
1	SD-20 ~ N.T. NOTCH FOR TEE		
2	SD-21 ~ W.T. NOTCH FOR TEE		
3	SD-22 ~ SLAB LONG'L NOTCH		
4	SD-23 ~ N.T. NOTCH FOR FLG. PL		
5	SD-24 ~ W.T. NOTCH FOR FLG. PL		
6	SD-25 ~ 1½" RAD WATER STOP		
7	SD-26 ~ TYPICAL CHAMFER @ PL SEAM		
8	SD-27 ~ WELDING ACCESS THRU W.T. STRUCT.		
9	SD-28 ~ POCKING PLUG		
10	SD-29 ~ N.T. NOTCH FOR F.B. STIFF		3-23-79
11	SD-30 ~ N.T. NOTCH FOR F.B.		3-29-79
12	SD-31 ~ DRAIN HOLE		
13	SD-32 - CARGO HATCH OPN'G CORNER		3-23-79
14	SD-33 ~ DRAIN HOLE		
15	SD-34 ~ DRAIN HOLE		
16	SD-35 - ANGLE SNIPE		
17	SD-36 - "T" SNIPE		
18	SD-37 - TYP. HEADER COPE		
19			

BRUNING 44-122

DWG. NO. S-31-10-H11

HULL STRUCTURAL STANDARD TITLE: STANDARDS INDEX

LEVINGSTON SHIPBUILDING CO.

STD. NO. | ALT NO 10

DATE | SHT. NO. B1

FIG. 3-21:

TIK MIDBODY FRAMING SUB-ASSEMBLY BOOKLET (L-31-10-1112) ½

Hold	Position	-1/-2	-3/-4	-7/-8	-39/-40	-41/-42	-5/-6	-9/-10	-87/-86	-89/-88	-11/-12	-13/-14	-15/-16	-17/-18	-19/-20	-21/-22	-33/-34	-35/-36	-31/-32	-23/-24	-25/-26	-27/-28	-29/-30	-71/-72	-73/-74	-75/-76	-45/-46	-47/-48	-49/-50	-65/-66	-51/-52	-53/-54	69	70	-55/-56	-57/-58	-59/-60	-63/-64	-61/-62	-38	
		xx 1 DOUBLE BOTTOM CENTER							xx 3 (P) / xx 2 (S) DOUBLE BOTTOM SIDE																		xx 5 / xx 4 LOW WING TANK								xx 7 / xx 6 UPPER WING TANK						
	L-31-10-1112-X	-1		-2	-3	-4	-5	-6	-34		-7		-8		-9		-10		-13	-14		-15		-27	-28	-29	-16	-17	-18	-19	-21	-22	-23		-11	-12		-25	-26	-36	
#1 HOLD	31X																																								31X
#1 HOLD	30X	7/7		1/1		2/2		2/2																												7/7					30X
#2 HOLD	17X	14/14		5/5									5/5													5/5			6/6				10/10		2/2	12/12	8/8				17X
#2 HOLD	16X	14/14	1/1		1/1	1/1	1/1	1/1			1/1	1/1			1/1	1/1	2/2		1/1	1/1				1/1	1/1		2/2		9/9			1/1	13/13		2/2	12/12	11/11		1/1	1/1	16X
#3 HOLD	15X	14/14	5/5								5/5	5/5															5/5		9/9				14/14		2/2	12/12	12/12				15X
#3 HOLD	14X	14/14		1/1	1/1	1/1		2/2					2/2	1/1	1/1	1/1	1/1	1/1	1/1			1/1	1/1				2/2	2/2	7/7	2/2		1/1	7/7	6/6	2/2	11/11	10/10	1/1	1/1	1/1	14X
#4 HOLD	13X	13/14		5/5									5/5	5/5														5/5	9/9					14/14	2/2	12/12	12/12				13X
#4 HOLD	12X	14/14	1/1		1/1	1/1	1/1	1/1			1/1	1/1			1/1	1/1	2/2	1/1	1/1	1/1	1/1						2/2	2/2	7/7	2/2	/	1/1	7/7	6/6	2/2	11/11	10/10	1/1	1/1	1/1	12X
#5 HOLD	11X	14/14	5/5								5/5	5/5															1/1		9/9				16/14		2/2	12/12	12/12				11X
#5 HOLD	10X	14/14		1/1	1/1	1/1		2/2	1/1	1/1			2/2	1/1	1/1	1/1			1/1			1/1	1/1						5/5				11/11		2/2	11/11	11/11		1/1	1/1	10X
#6 HOLD	20X	14/14		5/5																															2/2	11/12	11/11			1/1	20X
#6 HOLD	21X	4/4				1/1																																			21X
Total No		214	24	36	8	14	4	8	2	2	24	24	28	14	8	8	10	4	8	4	2	4	4	2	2	10	24	18	122	8		6	152	52	36	224	194	4	8	10	
Unit Weight		0.41T	0.51T	0.51T	0.51T	0.51T	0.64T	0.84T	0.70T	1.01T	0.68T	0.83T	0.63T	0.85T	0.67T	0.80T	0.67T	0.80T	0.99T	0.86T	0.88T	0.88T	0.89T	0.86T	0.80T	0.85T	2.37T	2.31T	0.29T	0.62T		3.79T	0.35T	0.33T	2.6T	0.12T	0.1T	1.79T	3.51T		.
Total Weight		11.34T	12.24T	18.31T	4.08T	7.14T	2.16T	5.12T	1.4T	2.02T	16.32T	19.92T	17.64T	11.90T	5.36T	6.40T	6.70T	3.20T	7.92T	3.44T	1.76T	3.52T	3.56T	1.72T	1.60T	8.50T	16.58T	45.18T	35.38T	4.96T		22.74T	53.04T	17.16T	93.6T	26.88T	19.10T	7.16T	28.08T		
Item & Sub-Item		23-01																									15-03					15-01	15-03						15-01	15-03	

F-33

3) Grouping of Breakdown Structure: Fig. 3-22

During the breakdown of the hull structure into parts and components in Engineering through the information of Production Planning, there are grouping by the following two major factors:

1) Shapes of material : For Products Planning

a) Flat or Curved

b) Main Structure or Internal Structure

c) Plate Fabricated or Shape Fabricated

d) Big Size or Small Size

2) Types of Facilities and Equipment : For Process Planning

a) Cutting Machine

N/C Burning Machine

Flame Planner

Electric - Eye Tracing Machine

Semi-Auto Burning Machine

Manual

b) Bending Machine

Vertical Press

Bending Roller

Horizontal Press

Flame Bending

c) Welding Machine

One-Side Welding

Submerged Both-Side Welding

C02 Semi-Auto Welding

Line Welding

Gravity Welding

Vertical Welding

Other Manual

d) Transportation Measures

Crane (Overhead, Gantry, Movable, Floating)

Conveyor Line

Fork Lift

Trailer

e) Slab Foundation

Conveyor

Steel Grid

Concrete

FIG. 3-22

WORK PACKAGE FOR HULL CONSTRUCTION

PRODUCTS		KIND OF PRODUCTS	PROCESS AND STAGE		PROCESS GATE NO.
SHIP		FORE HULL / CARGO HOLD / ENGINE ROOM / AFT HULL / SUPER STRUCTURE	TESTING		
			ERECTION		30
GRAND UNIT		FLAT PANEL / CURVED PANEL / SUPER STRUCTURE	UNIT TO UNIT	NIL.	27, 28
UNIT (3 DIMENSION)	NIL		JOINTING	NIL.	29, 25, 26, 28
COMPONENT & UNIT (2 DIMENSION)	NIL	FLAT PANEL / SEMI-FLAT PANEL / CURVED PANEL / SPECIAL CURVED PANEL / SUPER STRUCTURE	TURN-OVER	NIL.	22, 23, 24
			ASSEMBLY		22, 23, 24
			EGG-BOX FRAMING	NIL	21, 23, 24
			PLATE JOINTING	NIL	21, 23, 24
COMPONENT (PANEL)	NIL	SIMILAR SIZE IN A LARGE QUANTITY / SIMILAR SIZE IN A SMALL QUANTITY	TURN-OVER	NIL	20
			ASSEMBLY		20
			PLATE JOINTING	NIL	20
INTERNAL STRUCTURE COMPONENT (SUB-ASSEMBLY)	NIL	SIMILAR SIZE IN A LARGE QUANTITY / SIMILAR SIZE IN A SMALL QUANTITY	TURN-OVER	NIL	16, 17
			ASSEMBLY (SUB-ASSEMBLY)		16, 17
(PRE-SUB)	PARTS	PRE-SUB-ASSEMBLY / BUILT-UP PART (T-TYPE BAR OR L-TYPE BAR)	BENDING (FORMING)	NIL	15
			ASSEMBLY (SUB-ASSEMBLY)		15
			PLATE JOINTING		15
PART FABRICATION		PLATE FOR PANNEL / PLATE FOR INTERNAL STRUCTURES / ANGLE FOR INTERNAL STRUCTURES / OTHERS (PIPE FLAT BAR ETC)	BENDING (FORMING)	NIL.	13, 14
			MARKING AND CUTTING		11, 10, 12
			PLATE JOINTING	NIL	11, 10, 12

3-2. Process Planning : Material Information List

During the development of hull construction drawing in Engineering, the unit parts list are to be provided with component number, piece number, its size, if necessary description, quantity, and net weight, and item and sub-item, as aforementioned, such as products planning, on the other hand, for material purchasing, the steel bill of material as rough cutting plan are also to be provided from the above unit parts list in accordance with the Assembly Master Schedule, if available.

In Production Planning, according to the above unit parts list, the each piece and component are to be assigned into the process gate which is predetermined by the optimum process follow, in accordance with the unit information list or basic production flow list. From this assignment of process gate into each piece and component the material flow of all pieces of unit is determined respectively, as shown in Fig. 3-3 thru Fig. 3-9, from process gate of Fabrication Stage to Erection Stage. The applicable material information lists in this shipyard at this moment are shown in Fig.3-23 [redacted] In this planning, the most important subjects are as follows:

How to cut steel material (plates and shapes) to fabricate parts and pieces of all unit of hull structure.

- What steel material to be allocated for those parts and pieces.

In other words, before the commencing of fabrication job, the material allocating planning is a key of forwarding to following process in smoothly in accordance with each process gate assigned by the material information list. This planning are to be provided by Engineer, Mold Loft and Production Planning with according to the Assembly Master Schedule as follows:

- Rough Cutting Plan and Steel Material Requisition Order Sheet
- Detail Cutting Plan and List
- Steel Material Allocating List
- Material Storage and Issuing Plan

Fig. 3-23

HULL 751/752/753
UNIT: 131

MATERIAL INFORMATION LIST | STEEL B/M P13-4, P23-4, P23-35, -36, P23-37, -38 | WORK INFORMATION

DRW. NO.	COMPT NO / SUB-ASSY NO	PC NO	DESCRIPTION OF PIECE	QTY P	QTY C	QTY S	QTY T	NET WEIGHT UNIT	NET WEIGHT TOTAL	ITEM & SUB ITEM	PAINT	MATERIAL/CUT FORM	MAT'L SPEC	REQ. NO	REQ. LINE	PO NO	TOTAL FT LIN/SQ	WEIGHT UNIT	WEIGHT TOTAL	N/C TAPE NO	PROCESS GATE
T-31-10-H12-4	131-1		(TANK TOP)		1		1			13-01		<P13-4>							29,359		(20)→(22)→(25)
		1	R.7087 x 7'-3" x 36'-10½"		1		1				ZINC	R.7087 x 87 x 37'-0	ABS GRA	10367	1	. .	267	28.84	7,727		11
		2	R.6102 x 9'-9" x 36'-10½"	1		1	2					2R.6102 x 119 x 37'-0			2		719	24.92	17,917		11
		3	FB ½" x 6" x 36'-10½"	1		1	2					2FB ½ x 6 x 37'0			4		74	10.20	755		12
		XH-8	WT 9 x 20 x 36'-10½"	2		2	4					4WT 9 x 20 x 37'-0			5		148	20	2,960		12
	-2		(BOTTOM SHELL)		1		1			23-01		<P23-4>							32,264		(20)→(25)
		5	R.7087 x 8'-11" x 36'-10½"		1		1				ZINC	3R.7[illegible]x109 x 37'-0	ABS GRA	10368	1		329	28.84	9,521		11
		6	R.7087 x 8'-11" x 36'-10½"	1		1	2					[illegible]o.					658	"	19,043		11
		XH-10	WT.185 x 25 x 36'-10½"	2		2	4					4WT.185 x 25 x 37'-0"		10369	7		148	25	3,700		12
	-3				1		1					<P23-4>							4,885		(21)→(22)
		4	R.5512 x 1'-10⅝" x 36'-10½"		1		1				ZINC	R.5512 x 73 x 37'-0	ABS GRA	10368	5		217	22.51	4,885		11
	-4(S)			1		1	2					<P23-4>							9,278		(16)→(21)
	-5(P)	7	R.15/32 x 5'-10⅝" x 36'-10½"	1		1	2				ZINC	2R.15/32 x 73 x 37'-0	ABS GRA	10368	8		434	19.15	8,311		11
		XPF-45	FB.4688 x 6" x 5'-7⅝"	9		9	18					6FB 15/32 x 6 x 18'-0		10369	2		101	9.57	967		12
	-6(S)			1		1	2					<P23-4>							9,769		(16)→(22)
	-7(P)	8	R.5512 x 5'-10⅝" x 36'-10½"	1		1	2				ZINC	2R.5512 x 73 x 37-0	ABS GRA	10368	5		434	22.51	9,769		11
[illegible]	SA-1(P)			14		14	28					<P23-35><P23-36>							22,879		(16)→(21)
	SA-2(S)	XP101/100	R.5512 x 5'-10⅝" x 5'-2 3/16"	14		14	28				ZINC	4R 5512 x 73 x 37-0	ABS GRA	10368	5		28 x 30	22.51	18,908		10
		XPF-43	FB 4688 x 4" x 3'-2⅛"	28		28	56					12FB 15/32 x 4 x 18'-0		10369	1		28 x 6	6.38	1,072		12
		XPF-44	FB.4688 x 6" x 5'-0 3/16"	28		28	56					14FB 15/32 x 6 x 21'-0"		10369	3		28 x 10	9.57	2,680		12
		XPC-81	FB.5512 x 4" x 0'-3½"	14		14	28					RMT					28 x 1	7.5	210		10
[illegible]	SA-7(P)			5		5	10					<P23-37><P23-38>							10,120		(16)→(22)
	SA-8(S)	XP107/108	R.4688 x 5'-10⅝" x 7'-10"	5		5	10				ZINC	2R 15/32 x 73 x 39'-8"	ABS GRA	10368	10		10 x 46	19.15	8,809		10
		XPF-40	FB 4688 x 6" x 4'-3¼"	10		10	20					10FB 15/32 x 6 x 18'-0"		10369	2		10 x 8	9.57	861		12
		XPC-82	R 5512 x 7 5/16 x 0'-7½"	10		10	20					RMT					10 x 1	22.51	225		10
		XPC-80	R.5512 x 7 5/16 x 0'-8½"	10		10	20					"					10 x 1	22.51	225		10
										13-01 23-01									29,359 89,186		

(10)	(11)	(12)	(16)	(20)	(21)	(22)	(25)
XP100 (14)	1 (1)	3 (2)	SA-1 (14)	-1	(-3)	(-1)	(-2)
XP101 (14)	2 (2)	XH-8 (4)	SA-2 (14)	-2	(-4)	(SA-7) (5)	
XP107 (5)	5 (1)	XH-10 (4)	SA-7 (5)		(-5)	(SA-8) (5)	
XP108 (5)	6 (2)		SA-8 (5)		(SA-1) (14)		
XPC-81 (28)	4 (1)	XPF-45 (18)	-4 (1)		(SA-2) (14)		
XPC-82 (20)	7 (2)	XPF-43 (56)	-5 (1)				
XPC-80 (20)	8 (2)	XPF-44 (56)					
		XPF-40 (20)					
([illegible]T)	(34.05T)	(6.27T)					

3-3 Products Amount List

Through the Products Planning in Engineering and Planning, the following lists, which indicate the amount of products, are essential to perform the detailed process planning adequately and also production control more effectively.

1) Preliminary Products Quantity List/Table

a) Item and Sub-Item/Weight : Fig.

At initial stage for sales budget, the above estimation is initiated by Estimation with reffering to the sister ship and/or a few key plans.

b) Zone/Stage/Weight : Fig.

For Production throughput planning and manpower planning, after contract at early stage, the above rough calculation is initiated by Engineering with refering to the key plan.

2) Detailed Products Quantity List/Table

a) Unit/Weight : Fig. 3-30

After the definition of Unit Division, as soon as possible, the calculation of rough weight for each unit is initiated by Engineering for proceeding the production planning, such as:

- Master Schedule for Erection and Assembly
- Manhour Budgeting for each stage

b) Unit/Component/Part/Item and Sub-Item/Weight : Fig. 3-31

Through the development of detailed engineering, the unit parts list is provided with piece number and calculated in its net weight.

This list only enables us to transpose a part, a component and/or a unit from cost category to products process category and also vis-a-vis.

c) Unit/Process Gate/Weight, Cutting Length, Welding Length, Number of Pieces and/or Number of Sheet of Plate : Fig. 3-32, 3-33,3-

Through the products and process planning based on the unit parts list, the above parameters of products amount or quantity, which are directly related production performance, are necessiatated for scheduling and manning of each process gate.

Any all of them, during the progress of Engineering, time by time, are necessary to correct and issue for improvement of planning.

FIG. 3-30

Fig 14-1 FS M.T. No. 2609 ERECTION BLOCK WEIGHT LIST

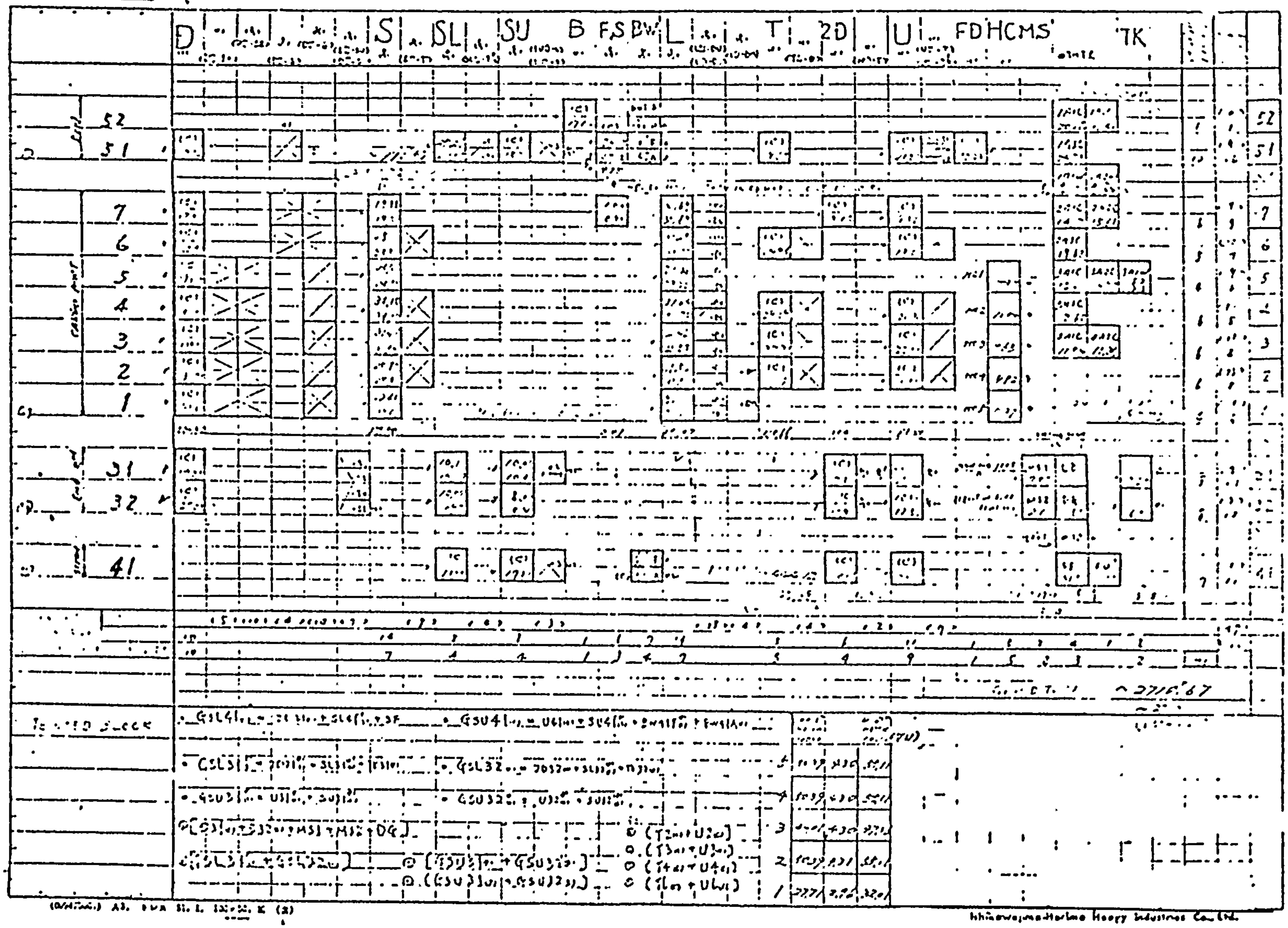


Fig. 3-31 TABLE OF UNIT AND ASSEMBLY COMPONENT WEIGHT

○ : COMPONENT WEIGHT

Zone	Area	Unit	Bottom Center T.Top Pl	Bottom Center T.Top Comp	Bottom Center Bottom Pl	Bottom Center Unit	Bottom Side T.Top Pl	Bottom Side T.Top Comp	Bottom Side Bottom Pl	Bottom Side Unit	Side Shell Low Stiff Bhd	Side Shell Low Bhd Comp	Side Shell Low S.Shell Pl	Side Shell Low S.S Comp	Side Shell Low Bilge Comp	Side Shell Low Unit	Side Shell Low Unit-Unit	Side Shell Upper Stiff Bhd	Side Shell Upper Stiff Comp	Side Shell Upper Deck Pl	Side Shell Upper Deck Comp	Side Shell Upper Side Stringer	Side Shell Upper Unit	Side Shell Upper Unit-Unit	Stool	T. Bhd	Flat	Low Eng Flat	Upper Eng Flat	Upper Dk Pl	Upper Dk Side	
Zone-3	Fore	33x				51.04																	22.5									[illegible]
Zone-3	Fore	32x				57.03										510) 75.83					6.0 / 6.0	16.06 / 16.06				17.61				18.0		[illegible]
Zone-3																																
Zone-3		31x		(31.46)	(15.63)	55.09		(13.15) / (13.15)	(6.86) / (6.86)	10.21 / 10.21				33.95 / 33.95										63.46 / 63.46						21.34		[illegible]
Zone-3		30x		(45.84)	(12.88)	58.72		(41.51) / (41.51)	(10.11) / (10.51)	65.62 / 65.62				35.2 / 35.2									61.12 / 61.12		18.75	40.5				33.03		
			xx 1				xx 2 (STARB) xx 3 (PORT)				xx 4 (STARB) xx 5 (PORT)							xx 6 (STARB) xx 7 (PORT)							x8x	x8x				x9x		1212.77
Zone-1	Cargo Hold	17x				55.75				39.10 / 39.10						43.84 / ? 33.15							55.45 / 55.45									
Zone-1	Cargo Hold	16x				61.26				39.88 / 39.88						44.47 / 44.47							55.45 / 55.45		15.65	47.83				30.06		
Zone-1	Cargo Hold	15x				58.92				37.45 / 37.45						44.47 / 44.47							55.45 / 55.45									
Zone-1	Cargo Hold	14x				61.35				39.83 / 39.84						50.73 / 50.73							55.45 / 55.45		34.43	32.77				30.06		
Zone-1	Cargo Hold	13x	(14.68)	(43.19)	(16.13)	55.29	(11.85) / 11.85	(24.14) / (24.14)	(13.50) / (13.50)	38.08 / 38.08	(5.39) / (5.39)	(15.46) / (15.46)	(18.33) / (18.33)	(45.17) / (45.17)	(14.80) / (14.80)	30.56 / 30.56	15.57	(13.71) / (13.71)	(22.10) / (22.10)	(21.19) / (21.19)	(43.19) / (43.19)	(11.19) / (11.19)	55.45 / 55.45	? 1448 / 1448								
Zone-1	Cargo Hold	12x				61.22				40.69 / 40.64						50.98 / 50.58							55.45 / 55.45		34.43	32.77				30.06		
Zone-1	Cargo Hold	11x				58.51				37.45 / 37.45						42.10 / ? 48.60							55.45 / 55.45									
Zone-1	Cargo Hold	10x				63.01				40.51 / 40.51						53.93 / 53.93							55.45 / 55.45		15.59	42.68				30.06		
			x x 1				xx 2 (STARB) xx 3 (PORT)				x x 4 (STARB) x x 5 (PORT)							xx 6 (STARB) x x 7 (PORT)							x8x	x8x				x9x		3159.8 / 1515.36
Zone-2		20x				55.14				51.28 / 51.28				48.04 / 48.04									52.07 / 52.07									
Zone-2		21x				68.91				112) 73.62				29.53 / 28.53									40.2 / 40.2		28.27	20.37	213) 5.75	343) 3.93	1.79	9.54		
Zone-2	Eng Room	22x				93.78										66.67 / 66.67							71.04 / 71.04							19.18		[illegible]
Zone-2	Eng Room	23x				30.95										27.23 / 27.23							23.18 / 23.18							3.19		[illegible]
Zone-2	[illegible]	24x				74.27										55.48							19.03 / 19.03			2.32				6.09		[illegible]

Fig. 3-32

RAW MATERIAL SUMMARY & PROCESSED MATERIAL SUMMARY. (Ref to Report No 78-009 BY I.E.)

GATE / ZONE	SQUARE CUT PLATE (FLAME PLANER)	CONTOUR CUT PLATE (N/C MACHINE)	FORMED PLATE (N/C MACHINE)	SUB-TOTAL (PLATE)	STRUCTURALS (FORMED)	TOTAL (AFT CUT)	SMALL SUB-ASSEMBLY	FLOOR & INTERNAL SUB-ASSEMBLY	PANELS FLAT	PANELS CURVED	TOTAL (PROCESSED)	ERECTION
	(11)	(10)	(10)→(13)	FABRICATION MARKING & CUTTING	(12) / (14)	FABRICATION	(15)	(16) or (17)	(20)(21)(24)	(23)		(30)
1	1878T/576P	652T/200P	242T/74P	2772T/850P	487T/1432P	3259T/2282P						3259T/68P
	(158T/78P)	(23T/96P)	(143T/48P)		(61T/4868P)		(108T/500P)	(790T/848P)	(2007T/152P)		(3259T/1550P)	
2	574T/191P	518T/176P	273T/93P	1365T/464P	152T/1156P	1517T/1620P						1517T/48P
			(105T/22P)		(87T/7375P)		(69T/315P)	(373T/408P)	(529T/41P)	(345T/25P)	(1517T/8188P)	
3	340T/150P	501T/182P	261T/100P	1102T/442P	122T/1103P	1224T/1545P						1224T/31P
			(84T/18P)		(70T/5934P)		(55T/251P)	(308T/328P)	(427T/33P)	(278T/20P)	(1224T/6584P)	
4	158T/72P	172T/87P	17T/7P	347T/166P	113T/686P	460T/852P						460T/3P
			(17T/49P)						(443T/70P)		(460T/119P)	
5	336T/114P	10T/3P	12T/4P	358T/121P	52T/395P	410T/516P						410T/–
	(31T/24P)		(12T/4P)		(19T/1615P)		(3T/15P)	(3T/3P)	(322T/37P)		(410T/1588P)	
TOTAL	3286T/1107P	1853T/658P	805T/278P	5944T/2043P	926T/4772P	6870T/6815P						6870T/150P
	(178T/120P)	(23T/96P)	(361T/141P)		(237T/19792P)		(235T/1081P)	(1484T/1587P)	(3728T/333P)	(623T/45P)	(6870T/23177P)	

NOTE :
1 UPPER COLUM : RAW MATERIAL SUMMARY.
LOWER COLUM ( ) : PROCESSED MATERIAL SUMMARY

FIG. 3-33

PL. NO. Frg 14-3 F/B MII N.vo 2609 DM LIST (< > = mounted) ASS USE

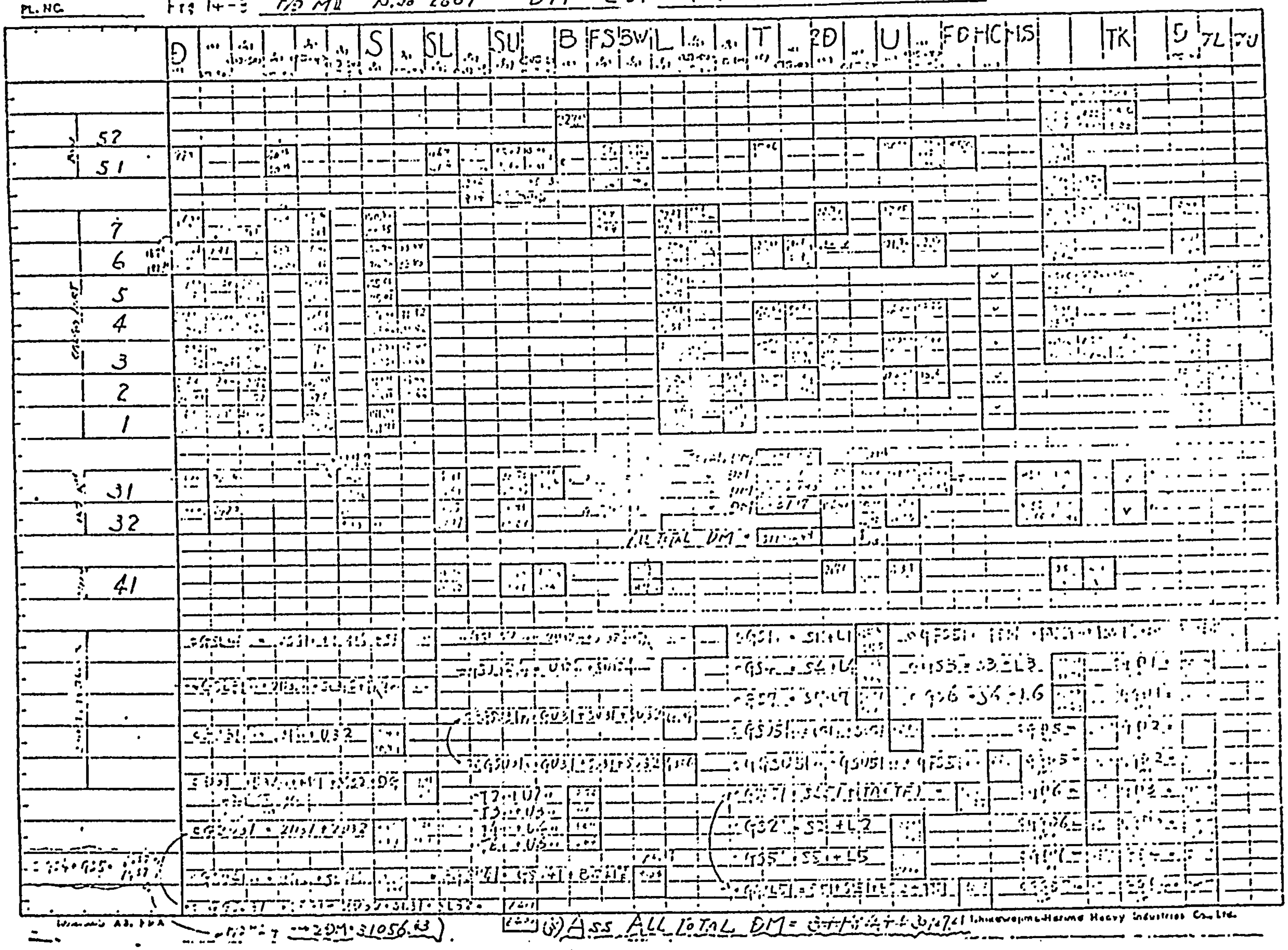


FIG. 3-34

SH. 2641

BLOCK LIST 2K P 2

UNIT	W.T	R.UNIT		W.L OF R	WELDING LENGTH						TOTAL	SIZE
LT10 p	11.7	6.9		11				208			208	11.3×53
s	11.7	6.9		11				208			208	″
SL×LT	293.3			312							5325	
SL3 p	13.7 (130.2)	12.9	(G) 3.3	27				349			349	13.7×9
s	13.7 (130.2)	12.9	3.3	27				349			349	″
4 p	13.7 (30.9)	12.9	(G) 3.2	27				375			375	13.7×9
s	13.7 (30.9)	12.9	3.2	27				375			375	″
5 p	13.7 (32.4)	12.9	4.0	27				368			368	″
s	13.7 (32.4)	12.9	4.0	27				368			368	″
6 p	13.7 (32.6)	″	3.7	27				364			364	″
s	13.7 (32.6)	″	3.7	27				364			364	″
7 p	13.7 (30.3)	″	(G) 3.3	27				369			369	13.7×9
s	13.7 (30.3)	″	″	27				369			369	″
	137.0		(G) 35.0	270							3650	
SU2 p	14.8	11.6		15				166			166	15.3×57
s	14.8	11.6		15				166			166	″
3 p	12.4	10.0		14				134			134	13.7×57
s	12.4	10.0		14				134			134	″
4 p	12.5	9.8		14				146			146	″
s	12.5	9.8		14				146			146	″
5 p	12.4	10.0		14				127			127	″
s	12.4	10.0		14				127			127	″
6 p	12.7	10.0		14				147			147	″
s	12.7	10.0		14				147			147	″
7 p	12.4	10.0		14				123			123	15.7×57
s	12.4	10.0		14				123			123	″
8 p	11.7	9.1		13				137			137	13.7×57
s	11.7	9.1		13				137			137	″
	177.6			169							1960	

4. Facility Allocation

4. Facility Allocation

Now-a-days in shipbuilding, the hull unit construction method is a benefical way to maintain the optimum production flow.

As described before, the work breakdown structure of hull unit are consisted of huge number and many kind of interim products in shape, size, material, hull structure, quantity, weight, process and etc.

The most optimum production flow are to be taken into the following considerations:

- Minimum transportation and movement of material
- Continuous and uniform flow of work : ie conveyor line
- Optimum size and portion of job arrangement: ie uniform work quantity
- Simultaneous operation: ie tact flow system
  Series operation with same group of workers
- Fixed routing
  - Minimum time or material in process
  - Inter changeability, ie similarity of parts and components

In addition, the following points also are necessary to pay attention to:

- Quantity
  Balance of each flow level
- Continuity

From the above point of view, the products planning is a key of the establishment of optimum production flow. Furthermore, the production ratio or working term and total quantity of products are necessary to obtain or develope. The material summary is shown in Fig. 3-32 for Bulkers.

4-1 Basic Production Flow

From the work breakdown structure of hull unit, the interim products and product of hull structure are composed of as follows :

Parts/Pieces
- Pre-Sub Parts
  - Sub-assenbly Components
- Panel Components
- Main Structure Components
- Unit
- unit to Unit (Grand Unit)
- ship (Erection)

Each of product and interim products are distinguished from the shape of material and the usage of facilities and equipment in process.

In accordance with the above considerations, the facilities and equipment are assigned respectively into the above interim products in order to get optimum operation of job and minimum transporation of material flow, namely the basic production flow in this shipyard, as shown in Fig. 4-1 and 4-2.

From the optimum organization between facilities and interim products, the production flow are able to lead the more workable and effective system in production, such as Gate System, with fixed manpower and schedule of each facilities.

This is able to introduce the following merits and demerits into Production for comparing from the previous production flow, as shown in Fig. 4-3.

Fig. 4-1: BASIC PRODUCTION FLOW IN HULL CONSTRUCTION

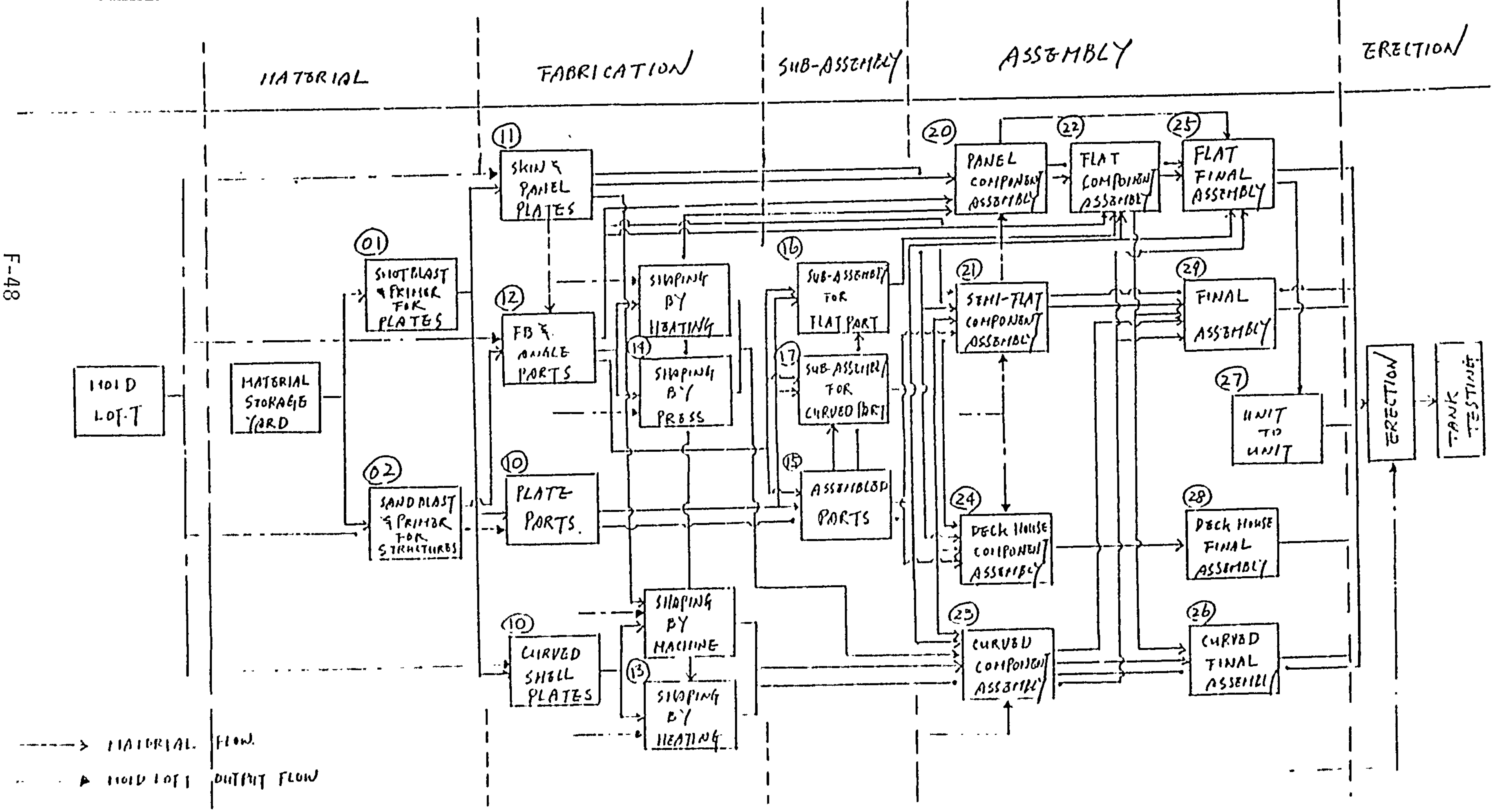
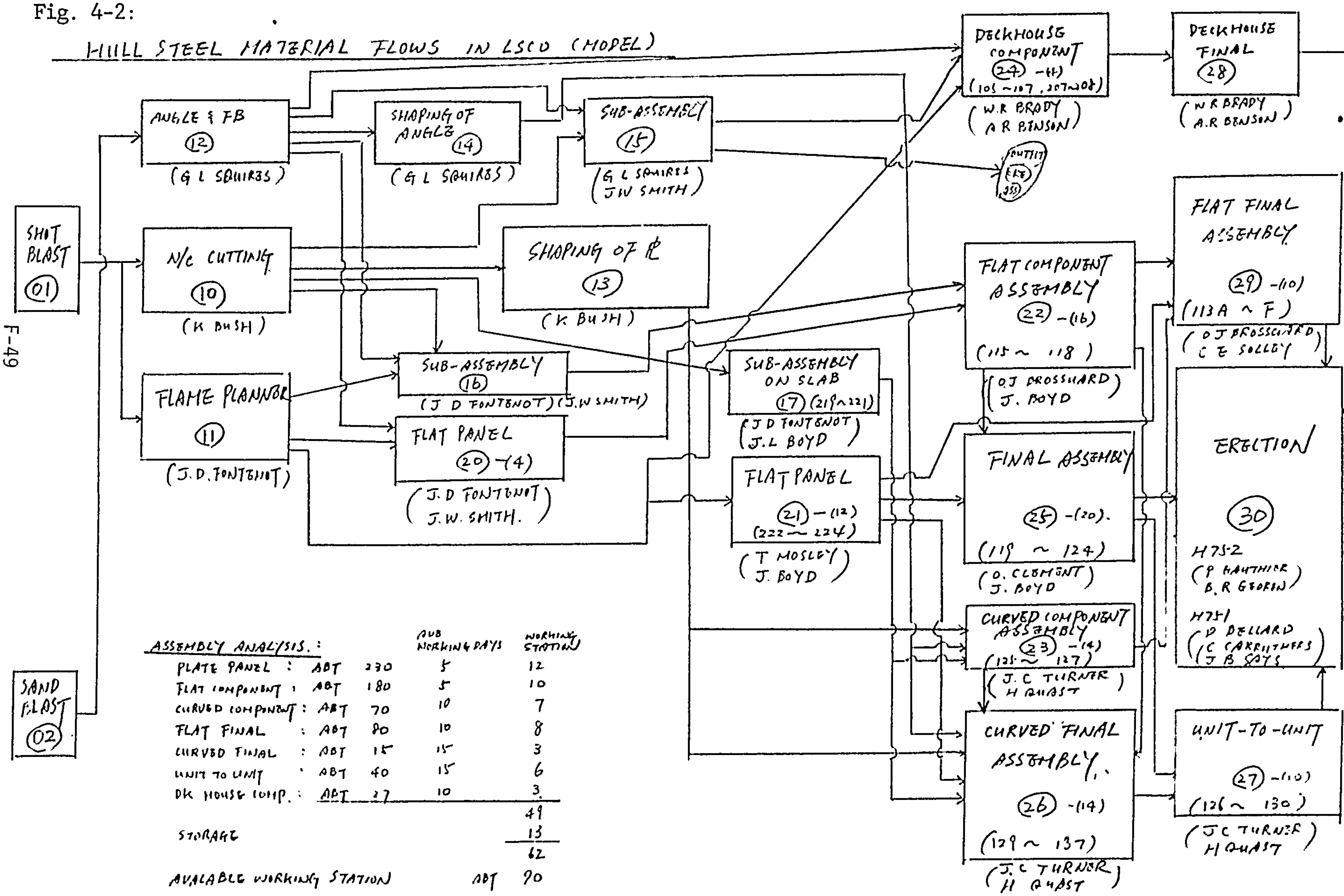


Fig. 4-2:

HULL STEEL MATERIAL FLOWS IN LSCO (MODEL)



ASSEMBLY ANALYSIS.:

			SUB WORKING DAYS	WORKING STATION
PLATE PANEL :	ABT	230	5	12
FLAT COMPONENT :	ABT	180	5	10
CURVED COMPONENT :	ABT	70	10	7
FLAT FINAL :	ABT	80	10	8
CURVED FINAL :	ABT	15	15	3
UNIT TO UNIT :	ABT	40	15	6
DK HOUSE COMP. :	ABT	27	10	3.
				49
STORAGE				13
				62
AVALABLE WORKING STATION			ABT	90

Fig. 4-3: COMPARING TABLE OF PRODUCTION FLOW

	Previous System (Fixed type of Production flow)	Gate System (Process type of Production flow)
Work Site	Determined by main structure (Unit)	Predetermined by each interim products (Work Order)
Work Package	Unit basis	Interim products basis
Working Volume	Large size	Small Size
Working Term	Long term	Short term
Skill Requirements	Many kind of skill and high level	Single or simple kind of skill
Tool and Machines	Movable tool and machines if requested	Pre-fixed tool and machines on work site respectively
Worker	Movable and high skill	Fixed and low skill
Heavy Crane Requirements	Not many	Many
Number of Materials	Many number	Small number
Follow-up Progress	Difficult	Easy
Productivity Analysis	Difficult	Easy
Design Change	Applicable	Not-applicable
Production Method Change	Applicable	Pre-determined

4-2. Allocation of Facility

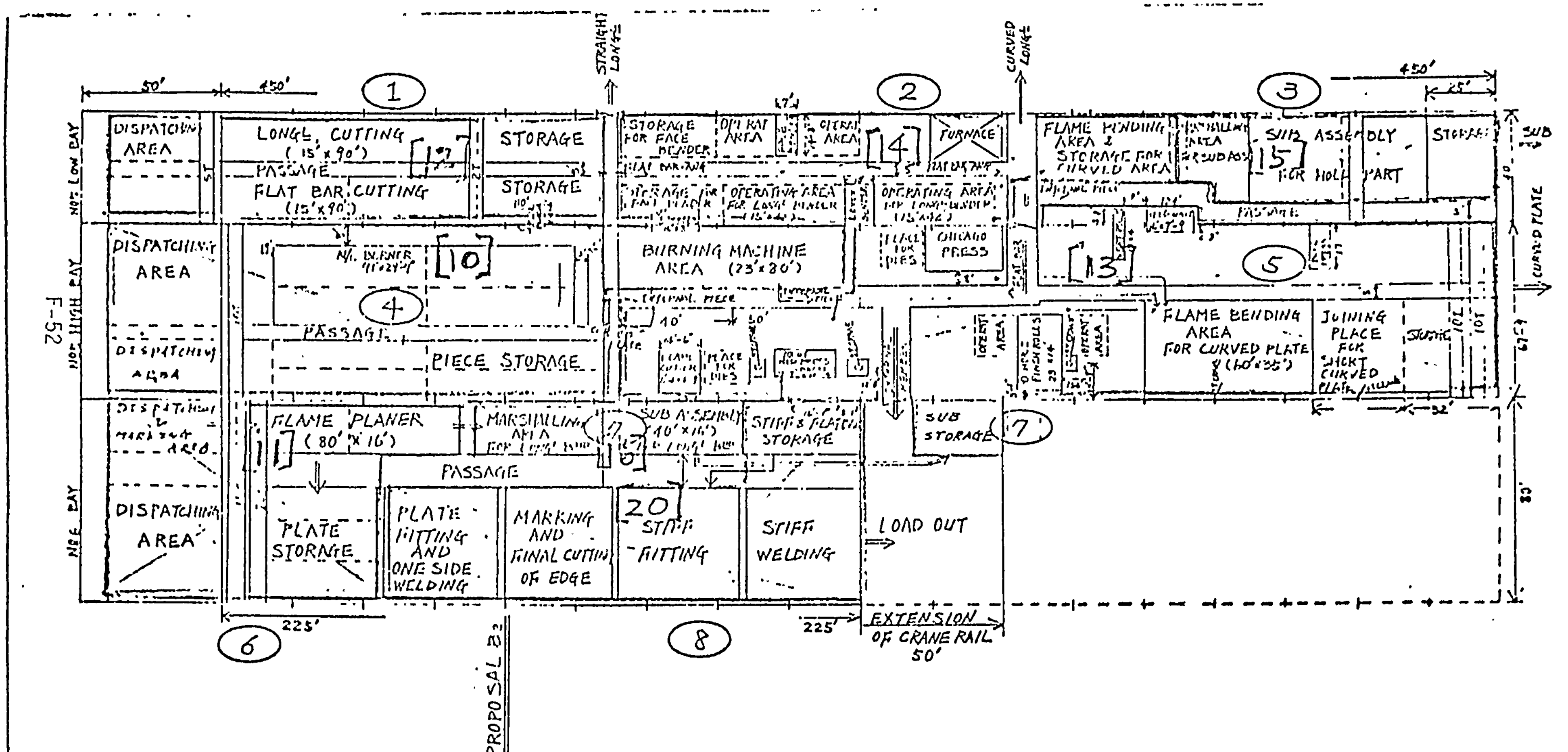
As stated in the management Task Force Report, the primary purpose for the scheduling of facilities is to insure a proper flow of material through the production process at the optimum usage of labor and time. In order to met this purpose, a proper flow of material are established the most adequate combination between the interim products and the facilities/equipment, namely process gate, as shown in Fig. 4-3, 4-4 and 4-5, and Fig. 4-6, 4-7.

Once the facilities are assigned into the process gate, through the work breakdown of hull unit-such as, products planning and process planning-the interim products to be produced in accordance with the sequence of work are to be scheduled the details based on the process network within the time frame.

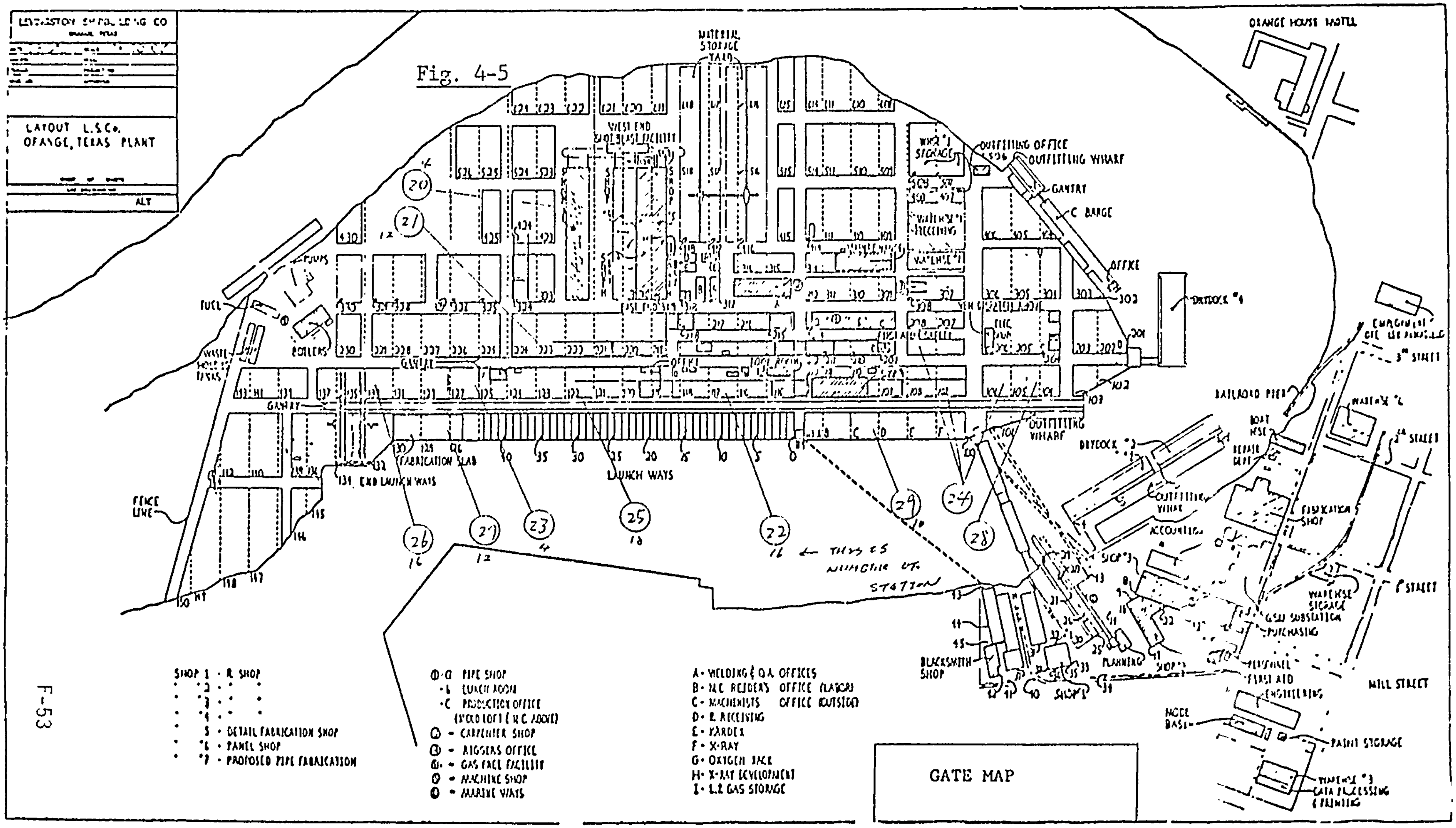
The availability of facilities requirements within time frame are necessary to comfirmed for each process gate as follows:

- All interim products are allocated into most optimum process gate.
- The capacity (such as working station and/or products rate) of each process gate are checked within given time frame to all assigned products, and if necessary, to be adjusted. This means that the assigned process gate, in order to utilize constantly, are to be allocated to the assigned products within allowable time frame.

FIG. 4-4



ALTERATION	TITLE	LEVINGSTON SHIPBUILDING Co PLANNING DEPT.
	No5, No6 SHOP SITE MAP	DRAWN	DATE	CHKD



LAYOUT L.S.Co.
ORANGE, TEXAS PLANT
ORANGE HOUSE HOTEL
MATERIAL STORAGE YARD
WEST END SHOT BLAST FACILITY
OUTFITTING OFFICE
OUTFITTING WHARF
GANTRY
C BARGE
OFFICE
DRYDOCK #4
EMERGENCY
3rd STREET
RAILROAD PIER
BOAT HSE
DRYDOCK #2
OUTFITTING WHARF
ACCOUNTING
FABRICATION SHOP
WAREHSE STORAGE
GSU SUBSTATION
PURCHASING
PERSONNEL
FIRST AID
ENGINEERING
MILL STREET
PAINT STORAGE
DATA PROCESSING & PRINTING
BLACKSMITH SHOP
PLANNING
PUMPS
FUEL
BOILERS
GANTRY
FABRICATION SLAB
LAUNCH WAYS
END LAUNCH WAYS
FENCE LINE
THESE ES NUMBER OF STATION
SHOP 5 - DETAIL FABRICATION SHOP
6 - PANEL SHOP
7 - PROPOSED PIPE FABRICATION
PIPE SHOP
LUNCH ROOM
PRODUCTION OFFICE
CARPENTER SHOP
RIGGERS OFFICE
GAS FACE FACILITY
MACHINE SHOP
MARINE WAYS
A - WELDING & Q.A. OFFICES
B - MC REIDER'S OFFICE
C - MACHINISTS OFFICE (OUTSIDE)
D - R RECEIVING
E - KARDEX
F - X-RAY
G - OXYGEN RACK
H - X-RAY DEVELOPMENT
I - L.P. GAS STORAGE
GATE MAP

Fig. 4-5

Fig. 4-6: FACILITY ALLOCATION OF FABRICATION & SUB-ASSEMBLY PROCESS GATE (BASED ON 600T/WEEK IN BULKER & WORKING DAYS)

STAGE	PROCESS GATE	DESCRIPTION OF JOB TYPE	STATION NO OR SHOP NO	CONDITION OF FACILITIES	AVAILABLE AREA	MAX THROUGH-PUT REQ.	MAJOR ALLOCATED PART & SUBASSEMBLY	MAJOR SKILL REQUIREMENTS & EQUIPMENT OR TOOL	ASSIGNED FOREMAN	NO OF WORKER MAX. REQUIREMENTS
BLASTING & PAINTING	01	SHOT BLAST & PRIMER		VERTICAL BLASTING						
	02	SAND BLAST & PRIMER		SAND BLASTING PIT						
FABRICATION (MTL PREP.)	10	N/C CUTTING & MARKING	SHOP 5 HIGH BAY (WEST END)	N/C BURNING TABLE 30' x 110' 1-10T OH	200' x 65'	44T/DAY 16P/DAY		- N/C BURNING MACHINE & TAPE. - CUTTING PLAN - MATERIAL INFORMATION LIST (UNIT PARTS LIST)	K. BUSH	
	11	FLAME PLANER	SHOP 6 (WEST END)	FLAME PLANER TABLE 30' x 110' 1-20T OH	25' x 75' 21' x 75'	55T/DAY 19P/DAY		- SIZE LIST - MATERIAL INFORMATION LIST (UNIT PARTS LIST) - FLAME PLANER	J.D TONTON	
	12	SHAPE MARKING & CUTTING	SHOP 5 LOW BAY (WEST END)	BURNING RACK 13.5' x 145' x 2 1-5T OH	150' x 40'	15T/DAY 50P/DAY		- CUTTING SIZE LIST - MATERIAL INFORMATION LIST (UNIT PARTS LIST)	G.L. SQUIRES	
	13	PLATE SHAPING	SHOP 5 HIGH BAY & 219.	1000T PRESS 12'0" HORIZ ROLLER FLAME BENDING TABLE 1-10T OH x 2	50' x 85'	6T/DAY 2P/DAY.		- BENDING INFORMATION LIST. - BENDING TEMPLATE. - ROLLER & PRESS - FLAME BENDING	K. BUSH	
	14	SHAPE SHAPING	SHOP 5 LOW BAY	HORIZONTAL PRESS HORIZONTAL PRESS 1-2T OH. BENDING TABLE x 2	150' x 40'	4T/DAY 330P/DAY		- BENDING INFORMATION LIST - BENDING TEMPLATE. - HORIZONTAL PRESS.	G L SQUIRES	
SUB-ASSEMBLY	15	PRE-SUB	SHOP 5 LOW BAY (EAST END)	WORKING TABLE	150' x 40'	4T/DAY 18P/DAY		- MATERIAL INFORMATION LIST (UNIT PARTS LIST) - CO_2 - SEMI-AUTO	G. L SQUIRES J.W SMITH	
	16	PARALLEL SUBASSEMBLY	SHOP 6	1-20T OVER HEAD	25' x 125'	25T/DAY 26P/DAY	SA-O	- CONVEYOR LINE - GRAVITY WELDING - MATERIAL INFORMATION LIST - FAIRING	J. D FONTENOT J.W SMITH	
	17	CURVED SUB ASSEMBLY	219, 220, 221	1-45T GANTRY 1-10T BRIDGE GRID.	50' x 300'			- MATERIAL INFORMATION LIST - CO_2 SEMI-AUTO.	J D FONTENOT J L BOYD	

Fig. 4-7: FACILITY ALLOCATION OF ASSEMBLY PROCESS GATE

(BASED ON 2,000T/WEEK IN BULKER, 60 WORKING DAYS)

STAGE	PROCESS GATE	DESCRIPTION OF JOB TYPE	STATION NO	CONDITION OF FACILITIES	AVAILABLE NO. OF STATION	MAX THROUGHPUT PRO.	MAJOR ALLOCATED UNIT	MAJOR SKILL REQUIREMENTS & EQUIPMENT OR TOOL	ASSIGNED FOREMAN	NO OF WORKER: MAN	NO OF WORKER: REQUIREMENTS
COMPONENT ASSEMBLY	20	FLAT PANEL LINE	SHOP 6	300' x 50', 2-20T OH ONE-SIDE WELDING CONVEYOR LINE	6 ↓ 12	2.17 UNITS/DAY x 3 DAYS/UNIT ≒ 7 STATIONS	T.T.R 28, D.B.R 20 SLOP.R 16, SLR 12 T.SLOP.R 16, SHR 14 DKR 14 (128)	- ONE-SIDE WELDING - LINE WELDING MACHINE. - MARKING TEMPLATE - CONVEYOR LINE	J.D FONTENOT J.W SMITH	(F) 15 (W) 20	(T/C) 2 TOTAL 37 (17760 H)
	21	SEMI-FLAT COMPONENT	222 223 224	1 45T GANTRY 1-10T BRIDGE CONCRETE W/GRID FOUND (50' x 300')	10	1.35 UNITS/DAY x 5.5 DAYS/UNIT ≒ 8 STATIONS	FBR 15, SLOP.R 20 DKR 10 BHD, FLAT & DK FOR ZONE 2 & ZONE 3 36 (81)	- FLAT FOUNDATION. - GRAVITY WELDING - MARKING TEMPLATE - SUBMERGED WELDING	T. MOSLEY J.L BOYD	(F) 18 (W) 23	(T/C) 3 TOTAL 44 (21120 H)
	22	FLAT COMPONENT	115, 116 117, 118	2-45T GANTRIES 1-10T BRIDGE CONC & GRID FOUND (50' x 332') STORAGE (50' x 78')	8	1.17 UNITS/DAY x 5.5 DAYS/UNIT ≒ 7 STATIONS	TT 28 SLOP BHD 42 (70)	- FLAT FOUNDATION - GRAVITY WELDING - VERTICAL WELDING	O.J BROUSSARD J.L BOYD	(F) 20 (W) 30	(T/C) 4 TOTAL 54 (25920 H)
	23	CURVED COMPONENT	125 127	2-45T GANTRIES GRID FOUND (70' x 160'), STORAGE (45' x 70')	8	0.63 UNITS/DAY x 8 DAYS/UNIT ≒ 6 STATIONS	SIDE SHELL 16 BOTTOM R 4 UPPER DK. 10 BILGE 8 (38)	- CURVED JIG & JIG HEIGHT LIST - CURVED PLATE MARKING TEMPLATE - SUB-MERGED WELDING (ONE-SIDE) - VERTICAL WELDING & GRAVITY WELDING	J.C TURNER H.OUAST	(F) 15 (W) 16	(T/C) 3 TOTAL 34 (16,320 H)
	24	DECK HOUSE COMPONENT	106, 107 207, 208	2 45T GANTRIES (58' x 110) GRID FOUND (50' x 110) 1-10T BRIDGE CONC FOUND (50' x 108')	8	0.45 UNITS/DAY x 10 DAYS/UNIT ≒ 5 STATIONS		- FLAT FOUNDATION - MARKING TEMPLATE - GRAVITY WELDING - SUBMERGED WELDING	W.R BRADY A.R BENSON	(F) 8 (W) 10	(T/C) 3 TOTAL 21 (10080 H)
FINAL ASSEMBLY	25	FLAT FINAL	119, 120, 121 122, 123, 124	2-45T GANTRIES GRID FOUND (50' x 110') (78' x 382') (30' x 30')	16	1.58 UNITS/DAY x 6 DAYS/UNIT ≒ 10 STATIONS	F.B 24, SL 12 HD 26, STOOL 10 TT & DB (ZONE 2 & 3) 23 (95)	- FLAT FOUNDATION - GRAVITY WELDING - VERTICAL WELDING - MARKING TEMPLATE - LIFTING PAD PLAN - SCAFFOLDING PLAN.	O CLEMENT J.L BOYD	(F) 20 (W) 35	(T/C) 4 TOTAL 59 (28,320 H)
	26	CURVED FINAL	129, 131, 133 135, 137 ✓	2-45T GANTRIES GRID FOUND (76' x 443')	12	0.58 UNITS/DAY x 8.5 DAYS/UNIT ≒ 5 STATIONS	1 W.T. 18 U W.T 12 Q B 4 1 (35)	- CURVED JIG & JIG HEIGHT LIST - SUB-MERGED. WELDING & CO2 SEMI AUTO - GRAVITY & VERTICAL WELDING - CURVED PLATE MARKING TEMPLATE	J.C TURNER H.OUAST	(F) 20 (W) 25	(T/C) 4 TOTAL 49 (23520 H)
	28	DECK HOUSE FINAL	104 105 103, 109	1 45T GANTRY CONC FOUND (88' x 110') (90' x 110')	2			- SPECIAL JIG	N R BRADY A R.BENSON	(F) 5 (W) 8	TOTAL 13 (6240 H)
	29	FINAL	113A, -B -C, -D, E -F	1-150T HAMMERHEAD 2 45T GANTRIES CONC FOUND (80' x 570')	15	0.78 UNITS/DAY x 8.5 DAYS/UNIT ≒ 7 STATIONS	LWT 8 TRHB 10 UWT 14 ENG SHELL 8 STERN FRAME 7 (47)	- FLAT JIG. - VERTICAL WELDING - CO2 SEMI-AUTO WELDING - LIFTING & SCAFFOLDING PLAN.	O.J BROUSSARD C.G SOILEY	(F) 30 (W) 30	(T/C) 5 TOTAL 65 (31200 H)
	27	UNIT TO UNIT	126, 128 130, 132 ✓	1 150T HAMMERHEAD 2-45T GANTRIES CONC FOUND (70' x 116') (40' x 110') ST. (110' x ...)	4	0.35 UNITS/DAY x 8 DAYS/UNITS ≒ 3 STATIONS	DK & LWT 8 UWT 12 END 1 (21)	- FLAT JIG - LIFTING PLAN.	J.C. TURNER H. OUAST	(F) 25 (W) 30	(T/C) 4 TOTAL 59 (28,320 H)

1) Preliminary Allocation Planning for Fabrication and Sub-Assembly Process Gate

In the hull construction, the huge number of parts are cut from the raw materials with usage of several type of machines and equipment in the Fabrication Stage.

Therefore the type and capacity of equipment and machines, and its layout are directly affected to the material flow and the throughput capacity.

From this point, the following considerations are essential to allocate the facilities into process gate in Fabrication.

To grasp all of parts; in shape, size, quantity and etc.

To grasp the capability of machines and equipment and its mechanical limitations.

The details are reported as follows:

Proposal of layout for shop 5 and shop 6; dated on March 16, 1979

Study on Bending Slab Layout; Ref. No. HP-68 Arpil 3, 1979.

Study on Cutting System; Ref. No. HP-70 April 10, 1979.

2) PRELIMINARY ALLOCATION PLANNING FOR ASSEMBLY PROCESS GATE

PURPOSE:

In initial stage of Production Planning, after making the decision for Unit Division of Hull, in order to grasp the production flow, especially assembly flow, and the requirements of production capacity on assembly, the preliminary production flow list of all of the hull units are necessary to prepare as shown in Fig. 4-8

This production flow list is provided in the same manner presented by Mr. O. Togo's report but more roughly in order to adjust the allocation of process gate from their area capacity.

PREPARATION STEPS:

a) Whole units of each zone are listed in accordance with the grouping of its breakdown structure.

b) These grouped units are assigned into process gate following its category of main structure components.

c) The process term of each component allocated into the process gate is expressed in working days and listed in the table.

d) After filling each unit into process gate, the total number of working days are summarized by zone and by process gate as shown in Fig. 4-9.

e) From the production master schedule, the production steel through put amount is expected to be 600 tons per week as the maximum. In order to meet the above requirements, the working days per bulker is calculated as 60 working days as follows:

e) continued

Total hull steel = 7200 tons

Production steel through put requirement = 600 tons/week

7200 ÷ 600 x 5 = 60 days

f) From the above 60 working days per bulker, the number of working stations and producing number of component and unit are expected as shown in Fig. 3-11.

g) The requirements of work station on each process gate are presented through the above preparation steps, and then will confirm the availability of each gate work station.

In this time, if necessary, the assigning of a component of a unit into the process gate will be rearranged by its nature of component shape.

h) From the above plannings, once the allocation of each unit into process gate as shown in Fig.4- this production flow list will be a key of the development of Engineering and Planning as a guidance of production flow.

FIG. 4-8

60 working days (600T/week)

PRELIMINARY PRODUCTION FLOW LIST FOR GATE ALLOCATION PLAN

1/4

Units \ Process: Gate	20 Panel Shop	21 Semi-Flat	22 Flat Comp	23 Curved Comp	25 Flat Final	26 Curved Final	29 Final	27 Unit to Unit	24 Dk House	28	30 Erection
Double Bottom ℄ (101~171) 63T01	Tank Top ℄ 8×4 Bottom ℄ 8×4		Tank Top 8×5		Final 8×5						101~171 8
Double Bottom Side (102~172 / 103~173) 40T14	Tank Top ℄ 16×4 Bottom ℄ 16×4		Tank Top 16×5		Final 16×5			{117/7 (x×2)×(x×4)} {117/2 (x×3)×(x×5)} Double Bottom Side (River) 8×9			Inland Side … 102~172 or 103~173 8
Low Wing Tank (104~174 / 105~175) 10T98	Slop Bhd ℄ 16×3 Side Shell ℄ 12×3		Slop Bhd 16×6	Bildge 8×7.	Side Shell with Bhd 12×5	104/5, 174/175 4×8 114/5, 164/165 4×8	Final 8×5				Fine Side 8 Inland Side 8
Upper Wing Tank (106~176 / 107~177) 10T98	Slop Bhd ℄ 16×3 Deck ℄ 16×3 Side Shell ℄ 14×3		Slop Bhd 16×5		Deck with Slop 16×5	Final (176/7) 2×8	Final 14×5	116×126 136×146 156×166, 117×127 137×147, 157×167 6×5			6 2
Upper Deck Center 291 391 (191,192,193,194)				Upper Dk 6×9							111~154 4
Stool Bhd P/S 381 (181,183,185,187)					10×(4+5)						10
Corrugated Bhd P/S 388 (182,184,186,188)							10×10				10
Zone-1 Sub / Total	122 | 2.03 350 | 5.83		56 | 0.93 296 | 4.93	14 | 0.23 110 | 1.83	62 | 1.03 350 | 5.83	10 | 0.17 80 | 1.33	32 | 0.53 210 | 3.5	14 | 0.23 102 | 1.7			66 | 1.1
Double Bottom ℄ 201, 211T1 55T1	Tank Top ℄ 2×4 Bottom ℄ 2×4		Tank Top 2×8		Final 2×5						2
Double Bottom Side 202, 203 S/T 212, 213		Tank Top ℄ 4×4 Bottom ℄ (202/3) 2×4		Bottom ℄ (202/203) 2×6	Tank Top 4×6 Final (202/203) 2×6	Final 2×8					4
Double Bottom ℄ 221, 231		Tank Top ℄ 2×11			Tank Top 2×6 Final						2

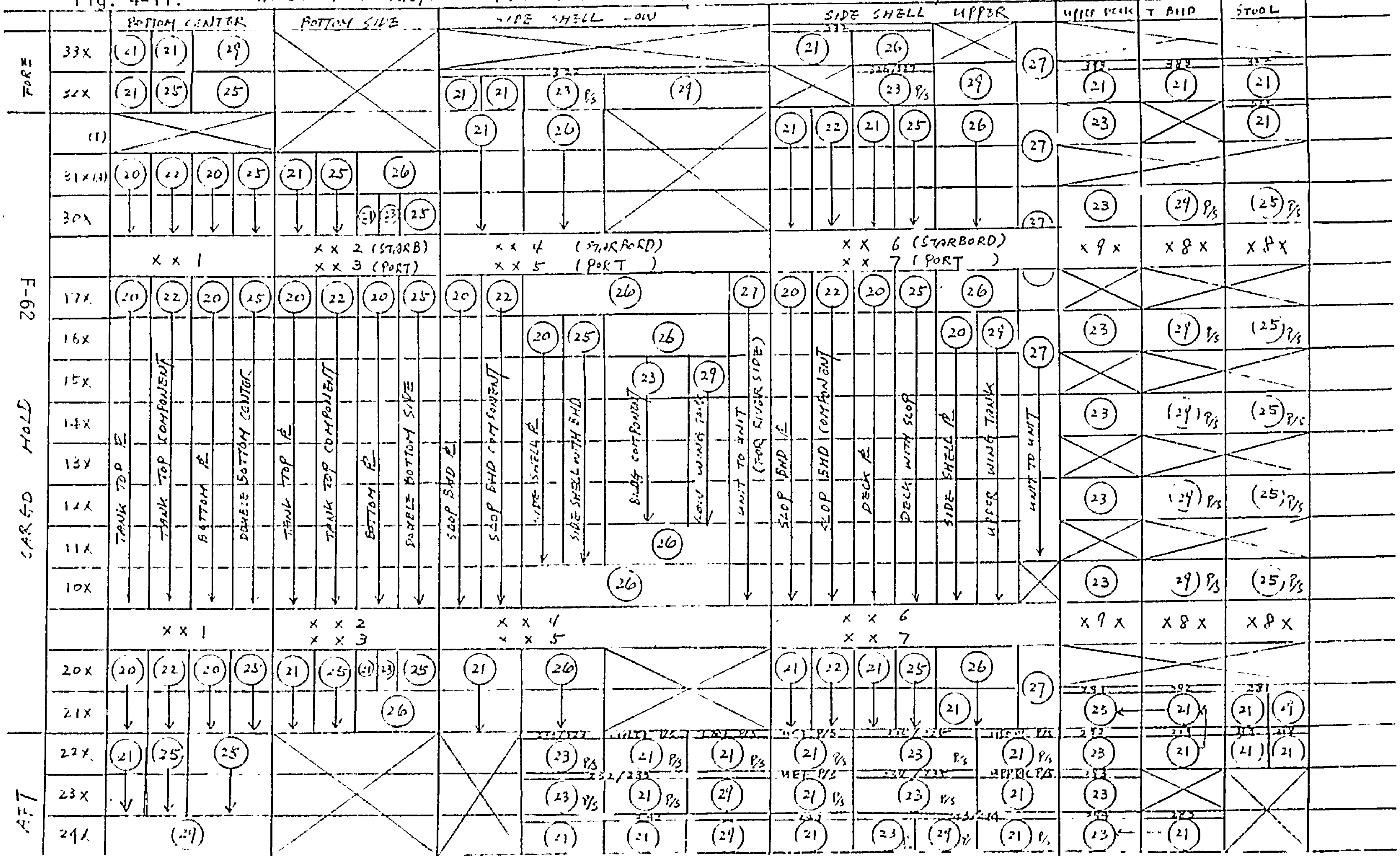
ZONE / PROCESS GATE	1			2			3			TOTAL		
	NO. OF UNITS	TOTAL WORKING DAYS	AVERAGE WORKING DAYS/UNITS	NO. OF UNITS	TOTAL WORKING DAYS	AVERAGE WORKING DAYS/UNITS	NO. OF UNITS	TOTAL WORKING DAYS	AVERAGE WORKING DAYS/UNITS	NO. OF UNITS	TOTAL WORKING DAYS	AVERAGE WORKING DAYS/UN
20	122	350	2.87	4	16	4	4	16	4	130	382	2.94
21	---	---	----	47	264	5.62	34	180	5.29	81	444	5.48
22	56	296	5.29	6	40	6.67	8	52	6.5	70	388	5.54
23	14	110	7.86	18	146	8.11	6	44	7.33	38	300	7.89
25	62	350	5.65	16	102	6.38	17	112	6.59	95	504	5.94
26	10	80	8	10	80	8	15	124	8.27	35	284	8.11
29	32	210	6.56	6	79	1.32	3	40	13.33	41	329	8.02
27	14	102	7.29	2	18	9	5	44	8.8	21	164	7.81
30	66	---	----	43	---	----	20	---	----	129	---	----

FIG. 4-9 WORKING DAYS REQUIREMENTS

PROGRESS GATE	UNIT/ DAY	WORK STATION	
		REQUIREMENTS	AVAILABLE NUMBER
20	2.17	6.37	6 - 12
21	1.35	7.4	10
22	1.17	6.47	8
23	0.63	5.0	8
28	1.58	9.4	16
26	0.58	4.73	12
29	0.68	5.48	15
27	0.35	2.73 (5.46)	4 (8)
30	2.15	----	------

FIG. 4-10 WORK STATION REQUIREMENTS FOR ASSEMBLY SLAB

Fig. 4-11: TABLE OF PRODUCTION SEQUENCE AS GATE ASSIGNED FOR ASSEMBLY



5. Manpower Allocation

5-1 Manpower Requirements

1) Manhour Budgeting

2) Manpower Requirements Plan

5-2 Manpower Allocation

1) Production Stage Organization

2) Supervisor's (Foreman) Function

5. Manpower Allocation

Products, which are broken-down from the hull structure during the development of Engineering and Planning, are to be produced by optimum manpowers on their most suitable process gate in accordance with gate schedule such as well balanced requirements of their products throughput. In other words, the progress of production on each process gate are affected by allocated manpowers with their performance.

Therefore each area and facilities allocated into production process is necessary to be assigned by a few specific foreman and his optimum group of workers, for maintaining the schedule with improvement of quality and productivity instead of rotation or moving of their working area.

5-1. <u>Manpower Requirements</u>

In production planning, the manhour planning such as labor budget (cost) and the manpower planning, which is affected by the production throughput plannning vis-a-vis, both are closely linked into the costing system.

Once the job is commenced by Production, the producing of products, which are identifiable for cost categroy by the unit parts list, will be performed by the manpower belonged to process gate (area) under the allocated manhour budget, which is formulated as follows.

Manhour = e x Products Amount

e = Production Efficiency

The production performance, such as productivity or efficiency are subject to change by actual total operation performance; such as:

Planning of Products and Process

Production Method

Facilities and Equipment

Control of Producing

Skill

Therefore these performance on each process gate are necessary to grasp, analyze and feed back for future improvements.

1) Manhour Budgeting

As stated before, the production manhour are expected from the products amount and the production performance coefficient.

The products amount are facilitated from the product to amount list. The production performance coefficient are expected from the analyzed historical data.

The following three steps are necessiatated for the manhour budgeting.

a) Sales Labor Budget

For company profit and loss planning by cost category, Item and Sub-Item and Department (Trade)

b) Production Operation Budget

For manpower planning by Zone, Stage and Trade

c) Implementation Budget: Fig. 5-3

For production schedule with manning by Process Gate and Trade

And the relation of the three budgets are intended as follows:

Sales Budget> Production Operation Budget> Implementation Budget.

The above three kind of budgets are necessary to follow-up the actual expended manhour on the control charts by weekly or monthly.

Fig. 5-3

HULL STEEL		FITTER	PLATER	WELDER	T/C	SUB TOTAL	OTHER	
FABRICATION	MARKING & CUTTING		7319		736	8055	MOLD LOFT (05) 11358	
WT (INVOICE 5673 T, NET 5118 T)	BENDING		3520		588	4108	PLANNING (02) 3595	
CUTTING LENGTH 103,403 M	SUB-ASSEMBLY		6003	6082	741	12826	MATERIAL STORAGE 1509 (06)	
SUB ASS WT (1347 T, 271 T (SUBCON))	SUB CONTRACT SUBASSEMBLY		3614	2725		6339	SHOT BLAST 834 (21)	
WELDING LENGTH (32,755 M, 10,454 M)			20446	8807	2065	31328	STORAGE CRANE 437 (06) (773)	48501
ASSEMBLY	PANEL BLOCK	9490		12480	CRANE 1235	(21970)	SCAFFOLDING (07) 1450	
	CURVED BLOCK	5245		6000	RIGGER 2020	(11245)	CLEAN UP (03) 134	
WELDING LENGTH (91,233 M, 10,787 M, 21,219 M) 123,239 M	SEMI PANEL BLOCK	2610		3450	TRANSPORT 1103	(6060)	TRANSP (20) 571	
	COMBINED BLOCK	470	(29) (−139)	720		(1190)	STERN FROM (29) 139	
	DK HOUSE	1960		2700		(4660)		
	SUB CONTRACT	7125		5150		12275		
		26900	(29) (−139)	30550	4358	61,619	(2244)	63863
ERECTION	PRE-ERECTION	767		1985	CRANE 1030	(2752)	SCAFFOLDING (07) 3358	
	SKIN PLATE	1391		5120	RIGGER 2115	(6511)	CRIBBING (03) 793	
WT 5432T	SKELTON MEMBER	3063		8824		(11887)	SURFACE LINE (07) 1742	
WELDING LENGTH (15,081, 2,241) 17,322 M	DECK HOUSE	2042		1499		(3541)	TEMP LIGHT (07) 1550	
	FINISHING	3307				(3307)	WATER TEST (09) 387	
		10570		17428	3145	31143	LAUNCHING (03) 353; CLEAN UP (08) 236 (8433)	39576
TOTAL (HULL) IN IHI		37470 (−139)	20446	56735	9568	124090	28220	152310

						MODIFIED F-32 WT	MODIFIED F-32 M/T	MODIFIED F-32 H	WT	ESTIMATE M/T	ESTIMATE H	BUDGET T/-	BUDGET H
13						509	17.16	8736	546	5853	30740	[illegible]	27112
15						2541	17.9	45,481	2575	100.	257,500	9.0	236131
17						1110	21.57	23,882	1137.2	556	63224	873	57,685
21						789	17.76	14,010	807	390	31,473	3077	[illegible]
23						1492	15.83	23,616	1521	4600	70,285	[illegible]	63,962
27						24	23.92	574	23	2387	5413	10504	[illegible]
37						485	26.1	12,640	3523	111.47	44440	21.8	34,579
						6950	18.6	128,919	7023.1	71.9	505,734	6372	447,733
								36.1%			43.4%		

2) Manpower Requirements Plan

In order to meet the production throughput requirements, the manpower requirements plan are requested and to be prepared as follows:

Production Throughput Requirements by Weight/Week or Month.

Manhour Budget for Total Hull, and Each Stage; such as Fabrication, Sub-Assembly, Assembly and Erection.

Distribution of manhour budget into each week or month according to requirements weight.

Putting the above manhour on a graph on each week or month with several ship's one concurrently.

Calculating the manpower requirements from the following formula based on the above summation of manhour on each week or month

$$p = \frac{A - 173 \times a \times PO}{173 \times a}$$

or

$$o = A - (173 \times a + h) \times PO$$

A: Manhour requirements per month

PO: Number of payroll employees at the present

a = Attendance ratio . 85 - 90%

p = Number of recuritment requirements

h = Average overtime of each employee

Working hour calculation:

365 days/year

52 week/year

4.34 week/month = 21.73 days/month

= 173 H/month

In this manpower planning relation, the following personnel statistic reports are preferable to make attentions.

Production Department manpower statistic by week end

Attendance ratio :

Attendance ratio is one of the factors for calculation of manpower planning. It will occur in the cause of the following;

such as lost manhour for production.

Vacation

Sick leave

Reported off-work

Unreported off-work

Rain and other weather condition

Power shut down or Equipment fail

Accident

Education/Training

Others

From the above cause, the unreported off-work, rain and accident are necessary to make attention by management.

- Department Manpower Status by end of month
- Supervisor/Worker ratio
- Department Skill Status
- Hire, termination and transfer statistic by end of week or month

Hire and Termination by skill

5-2 Manpower Allocation

In the implementation of the Gate System, the most important elements are as follows:

To allocate the facilities into the breakdown interim products of hull structure in order to obtain the optimum material flow.

To assign the foreman and the group of workers into the allocated facilities in order to produce the allocated interim products on the gate schedule.

Therefore the performance of each process gate, especailly in time, are closely related to each process gate from Fabrication stage to Erection stage.

From this point of view, as described before, the following considerations are essential to maintain the Gate System in the hull production as well as shipbuilding.

The allocation of well balanced products and its amount to meet the capacity of facilities and equipment.

The accomplishment of planned products through the allocated facilities and equipment by the assigned group of workers.

The later is a major objects of the implementation for the Gate System.

Therefore to grasp the productivity by the products amount on each process gate is able to take into the following recycle actions:

- Analizing the difference between the scheduled and the actual one.

  If necessary, issuing the recovering schedule, as temporary.

- Analizing the skills of workers, job methods and its facilities.

  Instructing and leading daily the implementation of improvement.

For this prupose, the foreman is a first level of key personnel in the Gate System and requested to assign into the designated process gate with the group of workers.

1) Production Stage Organization

As shown in Fig. 4-1; Basic Production Flow in Hull Construction, the Gate System are able to lead the every interim products of hull units to the optimum production flow related to facilities and equipment and to be assigned the group of workers and the foremen respectively.

Once the facilities and equipment are assigned into the process gate and allocated by the group of workers, through the products and process planning the interim products are scheduled by the predetermined process gate.

In order to meet the schedule requirements in time and cost, the foreman and group of workers assigned into the process gate are requested to perform by their best efforts with the full utilization of facilities, equipment and tools.

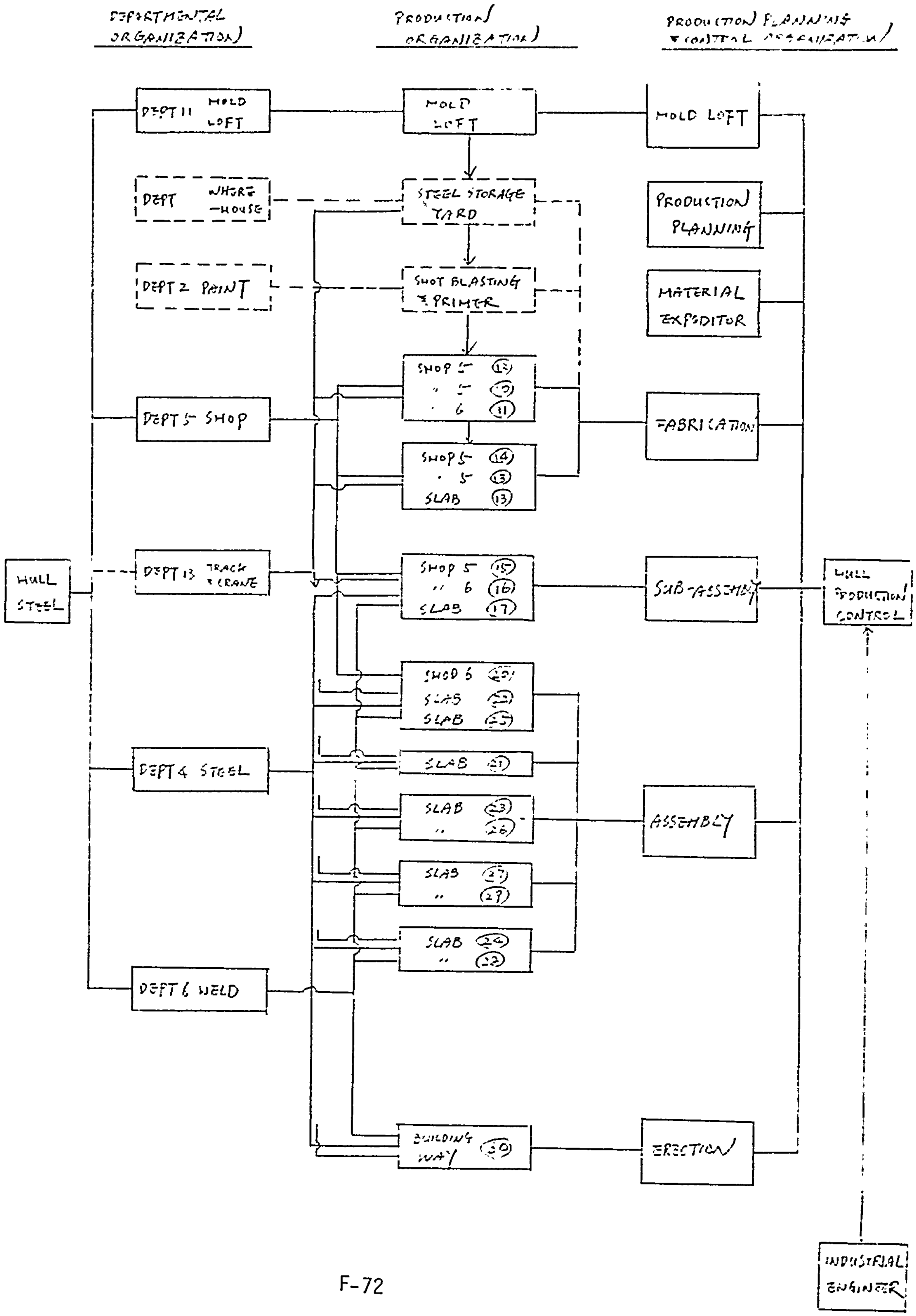
For this purpose, the continuance of job assignment on the same process gate are able to maintain the good performance.

Therefore once the foreman and workers are designated for each gate from the Department, the necessary information for proceeding of the daily job are issued by the gate schedule, the material information lists and the working instruction plans from Production Planning and then the progress reports are fed back to Production Control to grasp the difference between the scheduled and actual one in time and cost.

In other words, the foreman and the workers are belonged to Department, but for proceeding of job are closely related to Production Planning and Control, as shown in Fig. 5-13, namely Production-Oriented Organization.

Fig. 5-13

ORGANIZATION RELATIONSHIP AMONGST DEPARTMENT, PRODUCTION & PRODUCTION [illegible]



2) Supervisor's (Foreman) Function

In the implementation of Gate System, each foreman assigned into the process gate are requested to lead the group of workers in accordance with the gate schedule.

As aforementioned, since each process gate are allocated by the respective level of interim products, it is easy to set up the standard job flow and procedure, and furthermore to identify the requested skills and its level.

From these circumstances of working area, once the foreman as well as the workers are assigned into a process gate, it is able to lead the following benefits:

Increasing efficiency

Group Development

Identifiable responsibility and recognition

Improvement of skills and methods

In this relation, the foreman in their group are necessary and able to lead the group of workers on their working area in order to accomplish the task on schedule with them.

Therefore the functions and roles of foreman as the first level of supervisor is a key of success for the implementation of the gate system.

SUPERVISOR'S (FOREMAN) ROLE

a) To understand the production method of each assigned work package provided the information from Engineering, Production Planning, IE and Mold Loft.

For Fabrication:

Cutting Plan and Part Size List

Bending Information Plan and Templates

Material Information List (Parts List)

For Sub-Assembly:

Material Information List (Sub-Assembly List)

Sub Assembly Plan

For Assembly:

Guide to Construction of Units

Assembly Plan

Material Information List

Size List of Assembly Jig

Finish Marking Tapes
Lifting Pad Arrangement Plan
Scaffolding Arrangement Plan

For Erection:

Hull Unit Arrangement Plan
Shipwright Dimensions Plan
Cribbing Arrangement Plan

b) To Instruct the job method to his members of working group prior to start the job.

c) To maintain his assigned gate schedule.

d) To maintain the adequate quality of producing product to next gate.

e) To grasp the availability of parts and/or components to meet the schedule in advance with coordinating material expeditor. In this purpose, to make a requisition of usage of transportation equipments (ie; crane, trailer, etc), at least one day in advance.

f) To report the following items daily:

Job Progress Report;
to color in the material information list and/or the schedule to Production Control; Daily Production Report, as shown in Fig. 6-5
Man Hour Report;
With process number
Member's Attendance to Production, as shown in Fig. 5-14

g) To lead the member's daily job on the job site at all times if possible.

The main items are as follows:

-Improvement of each member's skill
-Feed back of job problem
-Housekeeping of working site
-Maintenance of equipments and tools
-Improvement of job method
-Maintenance of job standard
-Keeping of quality standard

Fig. 5-14

DATE :

WORKER ATTENDANCE REPORT

PRODUCTION OFFICE → PRODUCTION CONT OFFICE → MANAGEMENT OFFICE → INDUSTRIAL RELATION OFFICE

SHOP / DEPARTMENT	STEEL YARD	SHIP QUAY	SAND PIT	SHOP 5 LOW			SHOP 5 HIGH		SHOP 6			SLAB (A)		SLAB (B)		SLAB (C)						WAY				TODAY'S TOTAL	ABSENCE	PAYROLL TOTAL.
				12	14	15	10	13	11	16	20	17	21	22	25	23	26	27	29	24	28	HTS1	HTS2					
1 LABOR																												
2 PAINT																												
3 SHIP REPAIR																												
4 STEEL ERECT																												
5 PLATE SHOP																												
6 WELDERS																												
7 I/S MACH																												
8 O/S MACH																												
9 PIPE FITTERS																												
10 CARPENTERS																												
11 MOLD LOFT																												
12 ELECTRICAL																												
13 TRUCKS/CRANES																												
TOTAL																												

6. Work Order System on the Implementation of Gate System

6-1 Role of Work Order

1) Definition of Interim Product

2) Indication of Horizontal Relationship

3) Item and Sub-Item

6-2 Role of Schedule

Fig. 6-1 Work Order Number Assignment

Fig. 6-2 Detail of Work Order Number

Fig. 6-3 Process/Gate Codes

Fig. 6-4 Work Order Data Sheet

Fig. 6-5 Daily Production Report

Fig. 6-6 Weekly Hull Steel Progress Report

Fig. 6-7 Preliminary Planning for Key Erection and Assembly Schedule fo F-32 in LSCO

6. Work Order System on the Implementation of Gate System

The work order system applied by this shipyard is designed to allow planned and controlled expenditures for labor and material plus organized use of facilities and equipment.

In order to implement the system, the computer is organized by the following input data and output reports.

Labor Sales Estimate Data (Fig. IV - D-2)
Work Order Data (Fig. IV - D-3)
Proposed Work Order Format (Fig. III - B-2)
Actual Labor Data (Fig. IV - D-4)
Labor Charge Information Card (Fig. IV - C-1)
Daily Labor Card (Fig. IV - C-2)
Report Hierarchy (Fig IV - D-1)

Once the gate system is implemented in this shipyard, the most necessary elements for production in the work order system are covered by the gate schedule, material information list, guidance of unit construction and other working instruction planning. On the other hand, the accounting and the costing in this work order system is necessary for following considerations:

Unit parts list and/or material information list is indicated by cost item and sub-item for each interim products.
Each interim products are grouping into the work package and assigning in the work order No.; as referred to in our PF-44 and PF-49 and shown in Fig. 6-1 and 6-2, and the process code No.; as shown in Fig 6-3.
Once the work order is assigned, this is recognized the item and sub-item by weight from the above unit parts list and/or material information list.
The manhour budget of each craft is requested *for* each item and sub-item of work order package.
Therefore, these budgets of manhour are listed for each work order data sheet, as shown in Fig. 6-4, and then put into the computer.
In Production, the actual production is able to be performed by the following information:

- Commencement of job by the gate schedule with manning.

Material routing and quantity of interim products by the material information list.

Construction drawing and guidance of unit construction or other working instruction plan.

The progress reports are to be provided by assigned foremen as shown in Fig. 6-5.

ŽDaily Production Report

From the above daily reports, the Production Control is to be calculated the expended manhour into the corresponding work group, work order, and item and sub-item in accordance with the weight proportion of completed products, and then put into the computer.

Furthermore, from the daily production report, the weekly hull steel progress report, as shown in Fig. 6-6, is calculated in order to grasp the production status. From this report, the control charts are plotted the difference between the plan and the actual, and if necessary, the Production Control is taking into a necessary action on time.

IHI MARINE TECHNOLOGY, INC.

FIG. 6-1 Work Group [| |] Work Order [| |]

WORK ORDER NUMBER ASSIGNMENT

ZONE NO.	WORK GROUP \ WORK ORDER	000	100		500	600	700 999	DES-CRIPTION
	000	Work of Entire Shipyard/Non-Zone						
	⌇	↓						Non-Zone
	012							
1	100	Work of Non-Unit						
2	200	↓						
~~3~~	~~300~~							Non-Unit
4	400							
5	500							
	600 030 630	No assignment to date						
	700 730	↓						
	800 830							
	900 930							
1	101～199	000～009 Paint	010～099 Steel	100～499 Piping	500～599 Electric	600～699 Machinery	700～999 Joiner	
2	201～299	"	"	"	"	"	"	
3	301～399	"	"	"	"	"	"	On-Unit
4	401～499	"	"	"	"	"	"	
5	501～599	"	"	"	"	"	"	
1	601～629	000～009 Paint	010～099 Steel	100～499 Piping	500～599 Electric	600～699 Machinery	700～999 Joiner	
2	701～729	"	"	"	"	"	"	
3	801～829	"	"	"	"	"	"	On-Module
4	901～929	"	"	"	"	"	"	
5	013～029	"	"	"	"	"	"	
1	631～699	000～009 Paint	010～099 Steel	100～499 Piping	500～599 Electric	600～699 Machinery	700～999 Joiner	
2	731～799	"	"	"	"	"	"	
3	831～899	"	"	"	"	"	"	On-Board
4	931～999	"	"	"	"	"	"	
5	031～099	"	"	"	"	"	"	

FIG. 6-2

DETAIL OF WORK ORDER NUMBER

ASSIGNMENT FOR ENTIRE SHIPYARD, ENTIRE SHIP, NON-ZONE/UNIT

DESCRIPTION		Non-Zone/Unit	WORK GROUP	WORK ORDER
Contractual Cost			000	000～129
Common Piece Fabrication	Bottom Pltg.	Non-Zone	000	130～149
And/Or Assembly	Bulkhead	"	"	150～169
(Stiffeners, Girders,	Sidepltg.	"	"	170～189
Brackets, Etc.)	Hull Deck	"	"	210～229
	Double Bottom	"	"	230～249
	Foundations	"	"	250～269
	⁝	⁝	⁝	⁝
	Piping	"	"	830～869
Classification Fees			001	000～999
Building Ways, Launching			003	000～999
Mold Loft			005	000～999
Receiving/Storing Materials			006	000～999
Construction Services			007	000～999
Clean-Up			008	000～999
Testing & Inspection			009	000～999
Administrative Expense			010	000～999
Insurance, Photo Christening			011	000～999
Common Piece Fabrication	Bottom Pltg.	Non-Unit	100	130～149
And/Or Sub-Assembly	Bulkhead	"	200 300	150～169
(Stiffeners, Girders,	Sidepltg.	"	400	170～189
Brackets, Etc.)	Hull Deck	"	500	210～229
	Double Bottom	"		230～249
	Foundations	"		250～269
	⁝	⁝		⁝
	Piping	"		830～869

FIG. 6-3

PROCESS/GATE CODES

PAINTING:

01 Automatic Blasting and Prepriming
02 Manual Blasting and Priming
03 On-Unit Painting
04 On-Board Painting

HULL STEEL:

Material Preparation/Fabrication:

10 N/C cutting/marking (Area #4)
11 Flame planer cutting (marking) (Area #6)
12 Angle and FB marking and cutting (Area #1)
13 Shaping of plate (Area #5)
14 Shaping of angle and of plate (Area #2)

Sub-Assembly (Internal Structures):

15 On shop 5 (Area #3)
16 On shop 6 (Area #7)
17 On slab

Component Assembly:

20 Flat panel on shop 6 (plates with stiffeners)
21 Flat panel on slab (plates with stiffeners)
22 Flat component on slab
23 Curved component on pin-jig slab
24 Deckhouse

Final Assembly:

25 On slab
26 On pin-jig slab
27 On flat-jig slab
28 Deckhouse

Unit-to-Unit:

29 Unit-to-Unit

Erection:

30 Erection

OUTFITTING:

Material Preparation/Fabrication/Sub-Assembly:

40 Pipe Shop
41 Electrical Shop
42 Carpenter Shop
43 Machine Shop

Unit Assembly:

50 Piping
51 Electrical
52 Carpenter
53 Machinery related

Module Assembly:
- 55 Piping
- 56 Electrical
- 57 Carpenter
- 58 Machinery related

On-Board Installation:
- 60 Piping
- 61 Electrical
- 62 Carpenter
- 63 Machinery related

SERVICE SUPPORT:
- 70 Warehousing
- 71 Maintenance
- 72 Mold Loft/NC
- 73 Testing Related

Note: Summary Level Reports can be generated by keying on first digit of code number.

FIG 6-4 WORK ORDER DATA SHEET.

WORK ORDER DATA SHEET	. W. G	W. O	PROCESS DATE

ITEM & SUB-ITEM	WEIGHT OR PARAMETER	CRAFT BUDGET					
							TOTAL.
BUDGETED PRODUCTIVITY H/T							
TOTAL							
FOLLOW-UP	MH						
	PRODUCTIVITY						

Fig. 6-5 Daily Production Report

PROCESS GATE :

DAILY PRODUCTION REPORT

DATE :

FORMAN :

PRODUCTION CONTROL USE

MANHOUR EXPENDITURES RECORD : DEPT									PRODUCTS COMPLETION RECORD						MANHOUR CHARGING CALCULATION								
	NAME OF WORKER & WORKER NO.	DAY SHIFT			NIGHT SHIFT			TOTAL	JOB	PRODUCTS (W.O)					WEIGHT		ITEM & SUB-ITEM	JOB NO.	W.G	W.O.	MH DISTRIBUTION		
		H	OT H	SUB TOTAL	H	OT H	SUB TOTAL	H	NO.	UNIT NO (W.G)	COMPONENT NO	QTY	PART NO.	QTY	UNIT	TOTAL					ITEM SUB-ITEM	WEIGHT	MH
1																							
2																							
3																							
4																							
5																							
6																							
7																							
8																							
9																							
10																							
11																							
12																							
13																							
14																							
15																							
MEMO :								G. TOTAL								TOTAL							

FIG. 6-6

WEEKLY HULL STEEL PROGRESS REPORT

HULL ______

W/E ______

MAJOR PROCESS	WORK ORDER		THIS WEEK					TOTAL TO DATE				
			WEIGHT	DEP 4 or 5	DEP 6	DEP 13	TOTAL	WEIGHT	DEP 4 or 5	DEP 6	DEP 13	TOTAL
MATERIAL PREPARATION	10	N/C CUTTING / MARKING										
	11	FLAME PLANER CUTTING										
	12	ANGLE CUTTING										
	13	SHAPING OF PLATE										
	14	SHAPING OF ANGLE										
		TOTAL										
SUB-ASSEMBLY	15	ON SHOP 5										
	16	ON SHOP 6										
	17	ON SLAB										
		TOTAL										
COMPONENT ASSEMBLY	20	FLAT PANEL ON SHOP 6										
	21	FLAT PANEL ON SLAB.										
	22	FLAT COMPONENT ON SLAB										
	23	CURVED COMPONENT ON PIN-JIG SLAB										
	24	DK HOUSE										
		TOTAL										
FINAL ASSEMBLY	25	ON SLAB.										
	26	ON PIN-JIG SLAB										
	27	ON FLAT-JIG SLAB										
	28	DK HOUSE										
		TOTAL										
UNIT TO UNIT	29	UNIT TO UNIT										
ASSEMBLY TOTAL 20~29												
ERECTION	30	ERECTION										
GRAND TOTAL HULL STEEL												

6-1 Role of Work Order

Regardless of the well organized system, Work Order System does not fulfill functions as its original purpose. There are many reasons for the difficulty, such as:

Indistinct segment for work order of work group : Definition of Interim Products.

Indication of vertical relationship by work order under its work group.

Indication of horizontal relationship for work orders assigned at the same facility or working area, such as process gate.

- Plural cost centers : Singular cost center.

1) Definition of Interim Product

According to the Work Order System in this shipyard, "Unit" which is an end product of hull structure for "Zone" and "Ship", is appointed as "Work Group", which is a key of control in this system.

Since a unit is an end product, it is to be produced through the several production processes, in other workds, to be divided into several interim products, which is assigned as "Work Order" in this system.

As described before, during the development of Engineering drawing for each unit, these interim products is classified by piece number and component number.

Each part and/or component named by piece number and/or component number is to be grouped by its natures; such as shape, material, quantity, size etc, and then assigned into a work order.

For this purpose, the unit parts list and the material information list are able to perform most effectively.

2) Indication of Horizontal Relationship

Once a unit such as a work group is broken down into several interim products,these interim products are to be reorganized by optimum size of work package as work order.

Each work order of work group is to be assigned into an adequate production process in order to obtain the highest production performance.

Once a work order is assigned into a production process; such as process gate, these work orders are to be leveled under the facility's capacity; such as production ratio of machine, number of work station, etc; and manpower availability on the date basis.

The leveling of work order on each process gate with production resources is really indicating the applicability of production to Production Department.

Only in this realistic manner, the Work Order System will be functioning properly.

From the above point of view, the scheduling system presented by our Mr. O. Togo's final report is essential to obtain the proper operation of the Work Order System in this shipyard.

In this relation, at the present the tremendous number of sheet of each work order are issued separately to related Departments from Production Control.

It is a most dangerous cause of human error, and very costly.

From the above consideration, the gate schedule, especially the implement gate schedule by two (or 4) week basis, are workable as a part of work order sheet.

3) Item and Sub-item

During the products planning and the process planning, each interim products are assigned into a work order and process, such as process gate.

In this process, the all interim products of unit (such as work group) are to be indicated by item and sub-item for the identification of cost category - such as unit parts list. Once the interim products are assigned into process gate, the process gate is a cost center for materials and labors.

In this connection, the production report is only requested the expended manhour by craft and the completed interim product’s piece No.

6-2. Role of Schedules

As aforementioned, the gate schedules with manning are enabled to act as a main part of work order system in this shipyard in order to obtain the production operation more practically, in other words, the product-oriented manner. The details of scheduling are presented by our Mr. O. Togo's final report and also the implementation of the gate schedules are starting on the assembly stage at the present.

For maintaining the above assembly gate schedule, it is necessary to take into consideration the following items:

To make sure the each level of interim products in weight.

' Products Amount List

To make sure the process flow for each unit.

' Unit Production Flow List

To make the standard assembly sequence.

' Unit Information List

To plot the process weight curve with assembly and erection on graph corresponding to the building material schedule.

' Throughput Capacity Plan

To arrange the key erection schedule and the latest (without leveling) assembly key plan.

' Master Preliminary Schedule in Initial Stage

From the above basic planning, the basic strategy of hull production is to be provided and discussed within top management including painting and outfitting before the commencement of the details planning. Attached Fig. 6-7 are shown in examples.

F-91

F-32 BLOCK WEIGHT

SNo 2567 — ○ CURVED BLOCK — 9/10/78

	DC -S(c)	DC -L(c)	DC (c)	BS (P/S)	BS-G (P/S)	DS (P/S)	HZ (P/S)	HZ-T (P/S)	LT (P/S)	SL (P/S)	UT (P/S)	US (P/S)	SU (P/S)	T (P/S)	HC (c)	HC (c)
52				(17.2)		1.1	2D				(-L 2.8 / -L 2.7)	(-11 3.9 / -11 3.7)	(3.5 / 3.5)		7.6	
					TA 10.2 / TF 5.5					(47.0)						
51				(24.7)		(53.7)	19.7		-L	(20.5 / 20.5) 3.6 3.0			(10.8 / 10.8) (41.3)	19.8 / -L 4.8 (24.6)	5.3 / 5.9 (33.1)	
10	—	—	P 21.3 C 4.0 S 32.0 (61.3)	(22.1 / 26.5) (48.9)	—	—			11.7 / 11.7	(16.2 / 16.2)	11.7 / 11.7	11.0 / 11.0	(12.9 / 12.9)		11.3	①
9	24.0	—	61.9	12.9 / 12.9	—	9.8 / 9.8			11.7 / 11.7	(15.2 / 15.2)	16.1 / 16.1	16.5 / 16.5	(13.4 / 13.4)			21.3
8	24.2	15.4	58.6	9.8 / 9.8	8.3 / 8.3	16.2 / 16.2	3.3 / 3.4	5.6 / 6.0	13.7 / 13.7	(17.5 / 17.5)	19.4 / 19.4	17.8 / 17.8	(11.8 / 11.8)	24.1 / 12.7	25.2	②
7	24.7	15.2	57.2	13.8 / 13.8	5.8 / 5.8	15.1 / 15.1			13.2 / 13.2	17.0 / 17.0	19.9 / 19.9	21.7 / 21.7	12.3 / 12.3			19.9
6	24.7	15.0	55.6	14.3 / 14.3	6.5 / 6.5	16.8 / 16.8	4.4 / 5.5	8.1 / 8.7	15.0 / 15.0	17.4 / 17.4	21.8 / 21.8	22.0 / 22.0	12.6 / 12.6	30.7 / 12.3	24.4	③
5	24.7	15.2	58.1	13.8 / 13.8	6.5 / 6.5	15.7 / 15.7			14.4 / 14.4	17.7 / 17.7	20.4 / 20.4	21.2 / 21.2	12.3 / 12.3			20.6
4	24.7	15.1	58.6	14.3 / 14.3	6.5 / 6.5	16.2 / 16.2	4.3 / 4.5	8.8 / 9.4	13.9 / 13.9	16.5 / 16.5	21.5 / 21.5	22.1 / 22.1	12.9 / 12.9	33.1 / 18.3	29.0	④
3	24.7	15.2	57.2	13.8 / 13.8	6.4 / 6.4	15.1 / 15.1			13.2 / 13.2	17.0 / 17.0	20.1 / 20.1	21.2 / 21.2	12.3 / 12.3			20.6
2	27.6	17.0	67.0	20.4 / 20.4	—	18.6 / 18.6	3.3 / 3.4	5.6 / 6.0	16.1 / 16.1	(21.0 / 21.0)	23.6 / 23.6	24.6 / 24.6	15.1 / 15.1	23.5 / 12.7	28.9	⑤ 20.2
1	15.2	18.6	25.6	16.2 / 16.2	—	32.1 / 32.1			28.8 / 28.1	(21.0 / 21.0)	21.4 / 21.4	27.7 / 27.7	(14.7 / 14.7)		7.3	
		(844.5)		(377.5)		(311.8)	(89.2)		(291.6)	(353.8)	(391.1)	(412.2)	(257.2)	(174.2)	(126.0)	(102.4)
31	(-S 6.8)	-D 8.0	44.1 (58.9)	(11.3 / 11.3)	(77.2)	16.0 / 25.5	2D(P/S) 18.6 11.3	3D(P/S) 16.3 16.4	4D	(15.5 / 15.5)		15.9 / 14.5	(24.6 / 24.7)	7L(P/S) 17.0 20.2 (37.2)	13.4	
32	(-5A 6.6)	(-5B 12.8)	16.5 (35.8)				7.3 (37.2)	(32.7)	14.5 (14.5)	(10.3 / 10.3) (51.4)	-L4 / -T4	11.8 10.8 5.6/1.7-P 3.6/3.6 (71.6)	(23.9 / 23.9) 3.9 3.8 (104.7)			
41							30.6 -T 7.4 (38.0)	15.0	-3	(25.0 / 1.3) (26.1)		43=C	(8.7 / 8.7) 4.4 (21.8)	(SF 7.6)	33.5	

CL P/S 3.7 / 3.2 — TB 5.2 / 2.6

FPT	226.8
SHIN	128.6
SUB	68.2
BARAITA	6.7
" KATA	21.8

BUP 1.4

HOLD PART TOTAL 3804.8

SKIN	2230.1
SUB	1004.3
BARAITA	1.2
" KATA	71.6
BUP	•

HC 6.6 — 2.1 — TB P/S 11.6 — (18.2) — 8.0

ENG ROOM 566.1

SHIN	163.3
SUB	287.0
BARAITA	15.4
" KATA	48.6
BUP	0.9

60 — S.F 18.4 (37.0) — RUDDER 14.0 (17.4)

AFT	181.0
SHIN	71.6
SUB	49.7

Ishikawajima-Harima Heavy Industries Co.

Ⓟ : PAINTING
Ⓞ : OUTFITTING
〜 : CURVED SHELL.

No. 1/3

工事日程表 WORK SCHEDULE

工事番号 WORK NUMBER: F-32 HOLD PART (株2)

工事名称 TYPE OF WORK: BLOCK STANDARD SCHEDULE

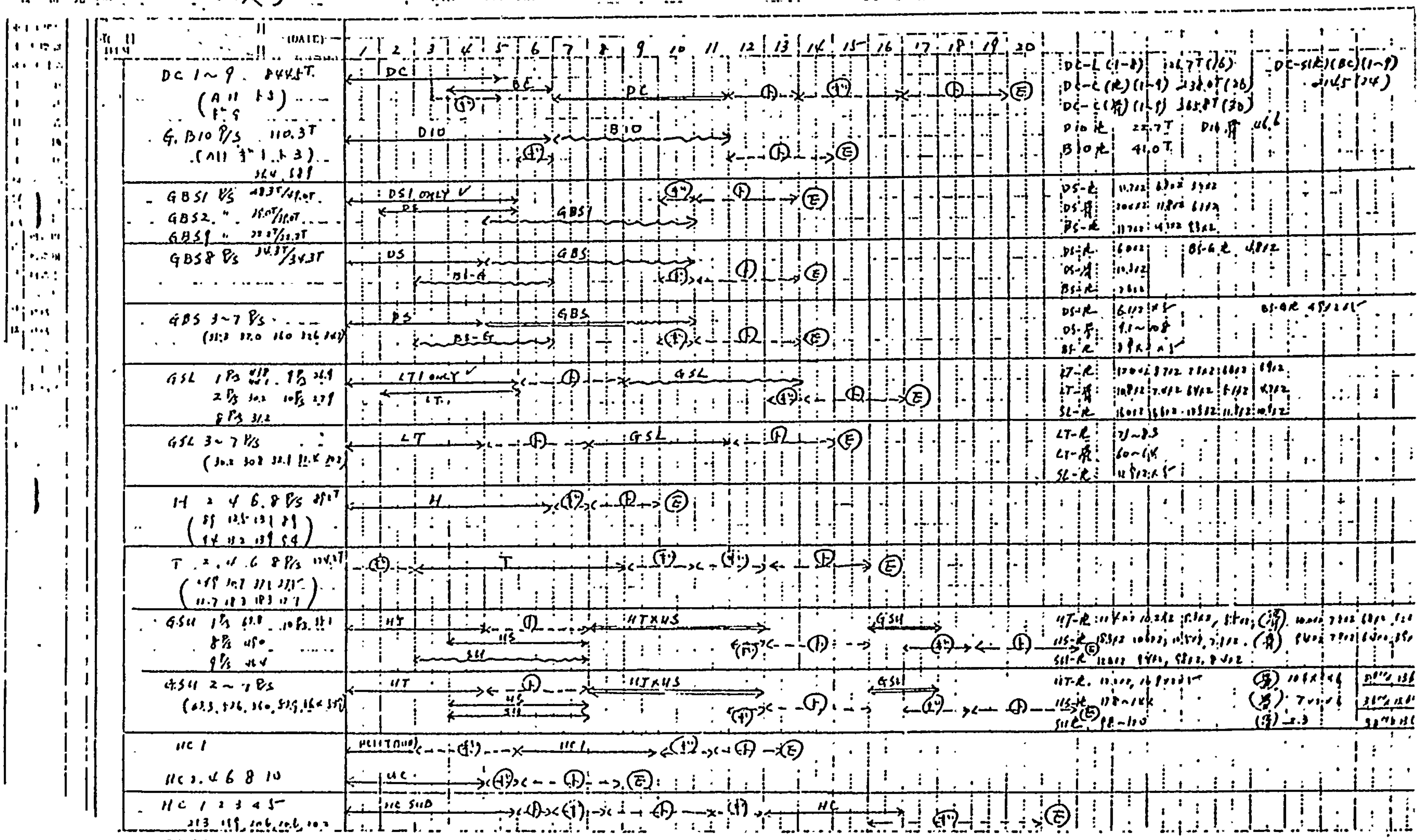
納期 DATE OF DELIVERY

数量 QUANTITY

PREPARED AS OF 年 月 日

石川島播磨重工業株式会社 ISHIKAWAJIMA-HARIMA HEAVY INDUSTRIES CO., LTD.

Lpp 178.000
B. 32.260
D 16.300



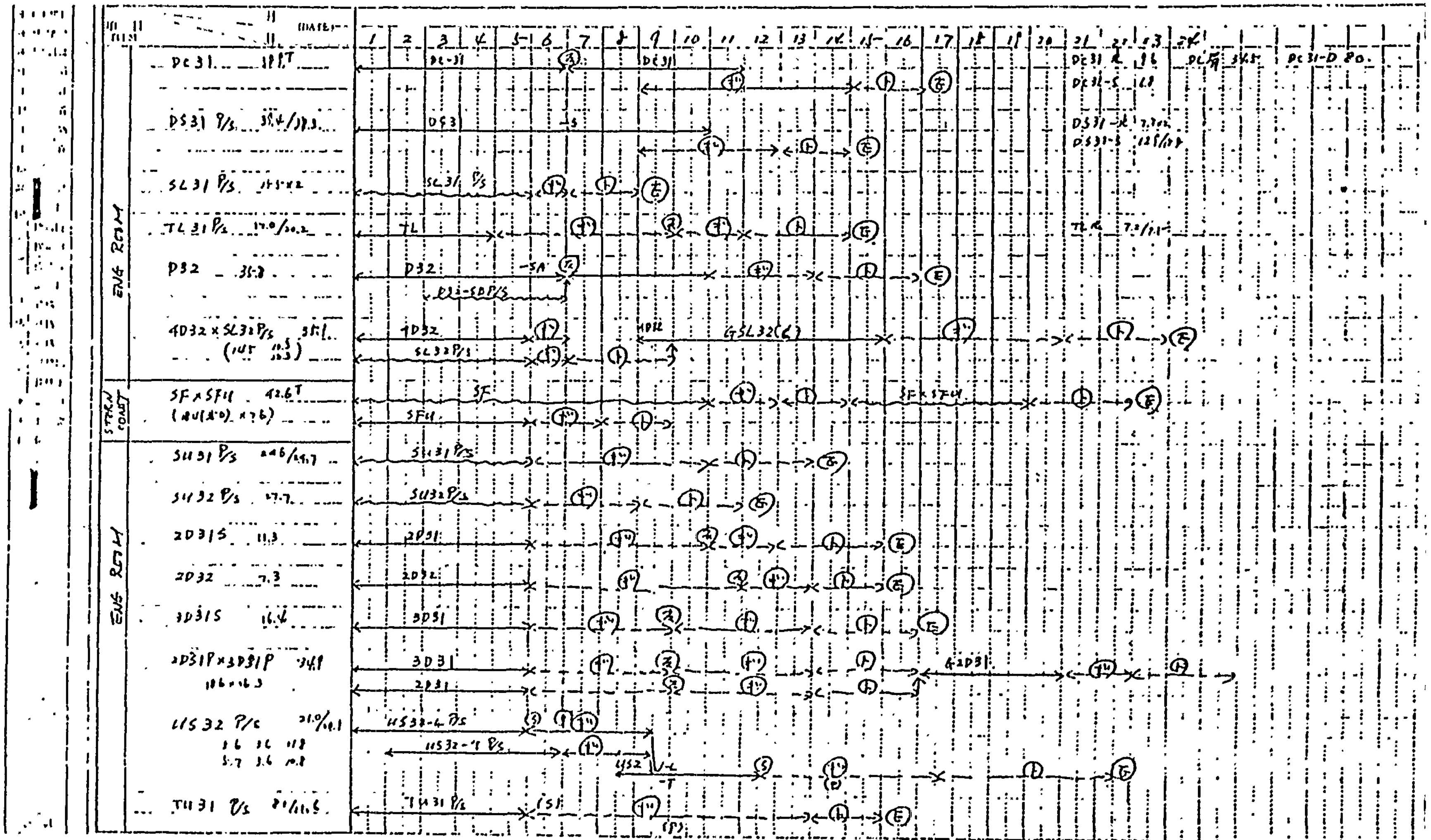
F-92

No. 2/3

工 事 日 程 表 (中日用)
WORK SCHEDULE

工事番号 WORK NUMBER: F-32 ENG ROOM PORT — 工事名称 TITLE OF WORK: ASSEMBLY STANDARD SCHEDULE — PREPARED AS OF 年 月 日付

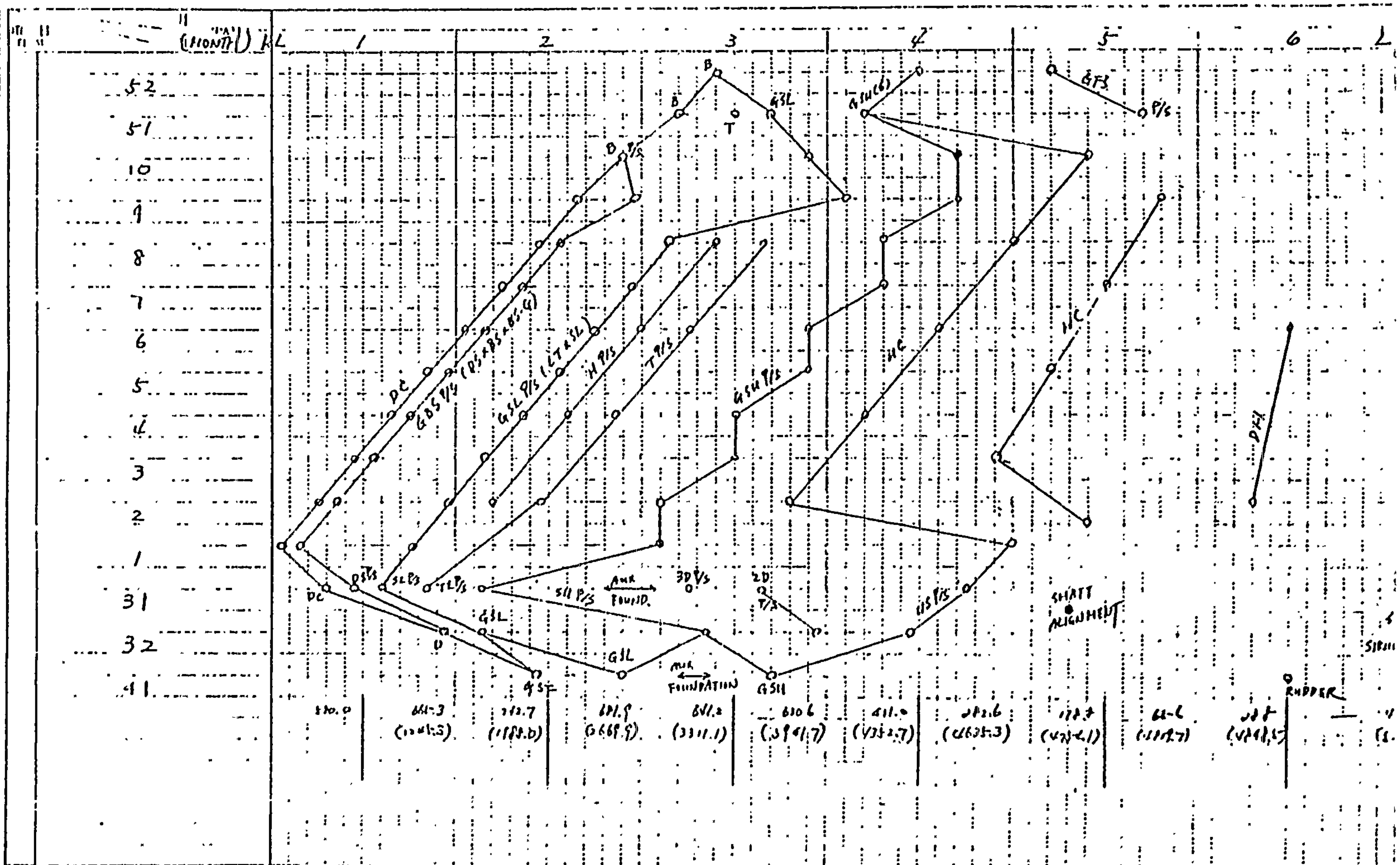
DATE OF DELIVERY — REMARKS — ISHIKAWAJIMA-HARIMA HEAVY INDUSTRIES CO., LTD.



WORK SCHEDULE

TYPE OF WORK: ERECTION SCHEDULE (1)

9/26/78



7. Follow-up of Production

7-1 Production Progress Planning and Follow-Up

1) Production Throughput Planning

2) Production Progress Control Charts

3) Reporting of Progress

7-2 Evaluation of Productivity

Fig. 7-1 Hull Steel Throughput Progress Chart

Fig. 7-2 Weekly Steel Throughput Summary

Fig. 7-3 Hull Steel Throughput Plan (Level O)

Fig. 7-4 Hull Steel Throughput Plan (Preliminary)

Fig. 7-5 Hull Steel Throughput

Fig. 7-6 Production Control Charts in IHI's Hull Steel (Fig. 14-1 thru 14-21)

Fig. 7-7 Welding Progress Check Plan

Fig. 7-8 Model of Production Control Chart

7. Follow-up of Production

The follow-up of production is to grasp the differences of the hull construction work between the schedule and the completion with the various type of control charts or graphs on which are numerically or visually illustrated.

On the production, the scheduled products are produced by scheduled manpower.

Therefore, its actual results, such as the amount of products completed and expended manhours, *are* necessitated to report and grasp for the follow-up of production.

Completed Product Amount = V x Expended Manhours

v = Productivity

(manhours = e x Products Amount

e = Production Efficiency)

From the above formula, the work performance, such as productivity, is able to grasp and analyze with two reports, such as the completed products amount and the expended manhours.

7-1 Production Progress Planning and Follow-Up

1) Production Throughput Planning

In initial stage of production planning, in order to grasp the requirements and capability for production, the throughput requirements are planned for total production and if requested, for each stage and/or each process gate through the following major considerations.

Estimating or Calculating the products amount by weight or welding length: Products Amount List/Table.

Setting the starting date and the completion date on the building master events.

Distributing the products amount into the period of production by weekly or monthly basis.

Leveling the distributed products amount of all concurrent projects.

Displaying the product amount progress curve and the leveling amount by week or ninth, into a sheet of graph for forecasting the production with throughput requirements, by weekly or by monthly.

Attached are some examples:

Fig. 7-1, 7-2, 7-3, 7-4, 7-5

Fig. 7-1:

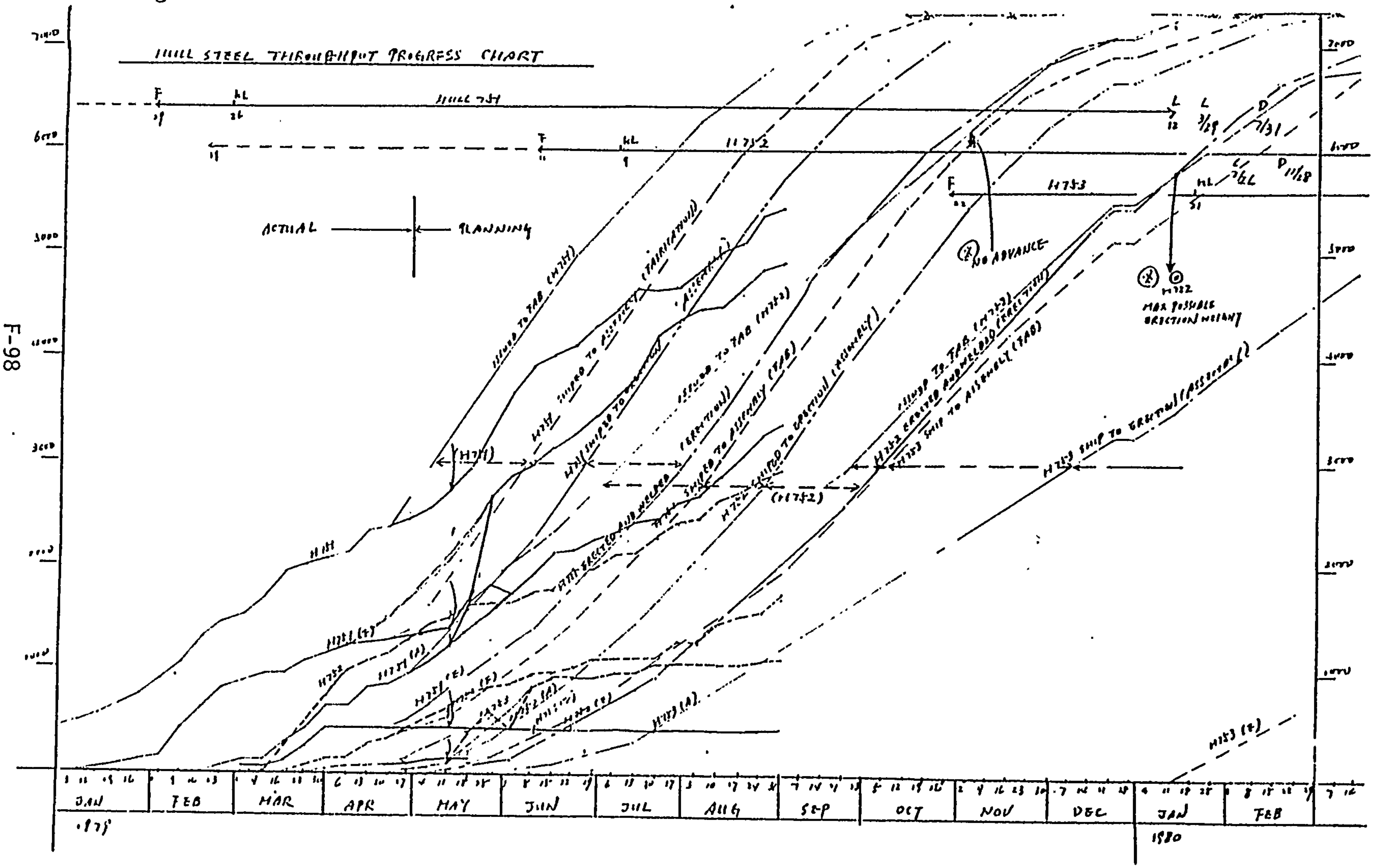

HULL STEEL THROUGHPUT PROGRESS CHART
ACTUAL
PLANNING
NO ADVANCE
MAX POSSIBLE ERECTION WEIGHT
JAN
FEB
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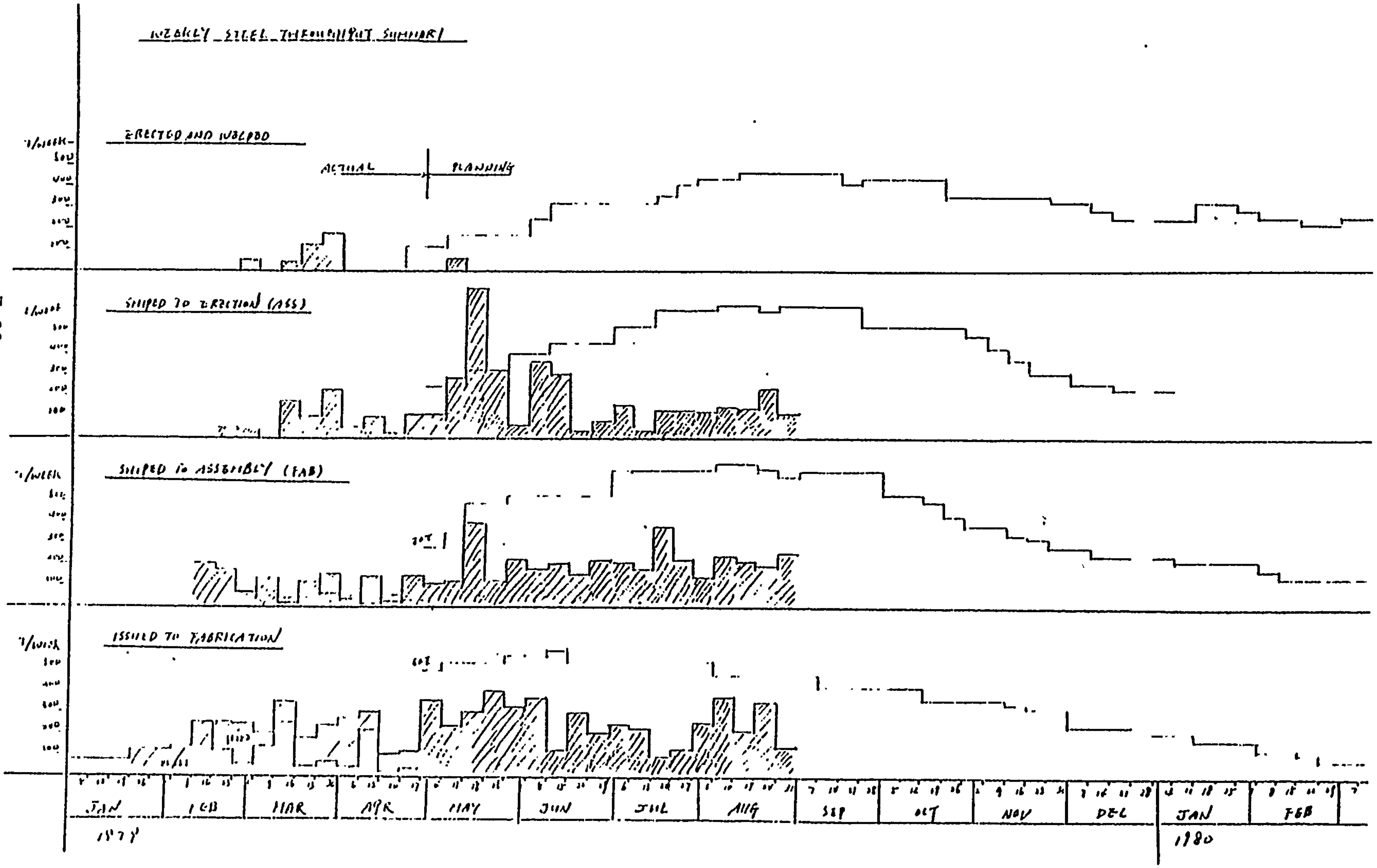
Fig. 7-2:


WEEKLY STEEL THROUGHPUT SUMMARY
ERECTED AND WELDED
ACTUAL
PLANNING
SHIPED TO ERECTION (ASS)
SHIPED TO ASSEMBLY (FAB)
ISSUED TO FABRICATION
JAN
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1980

Fig. 7-3:

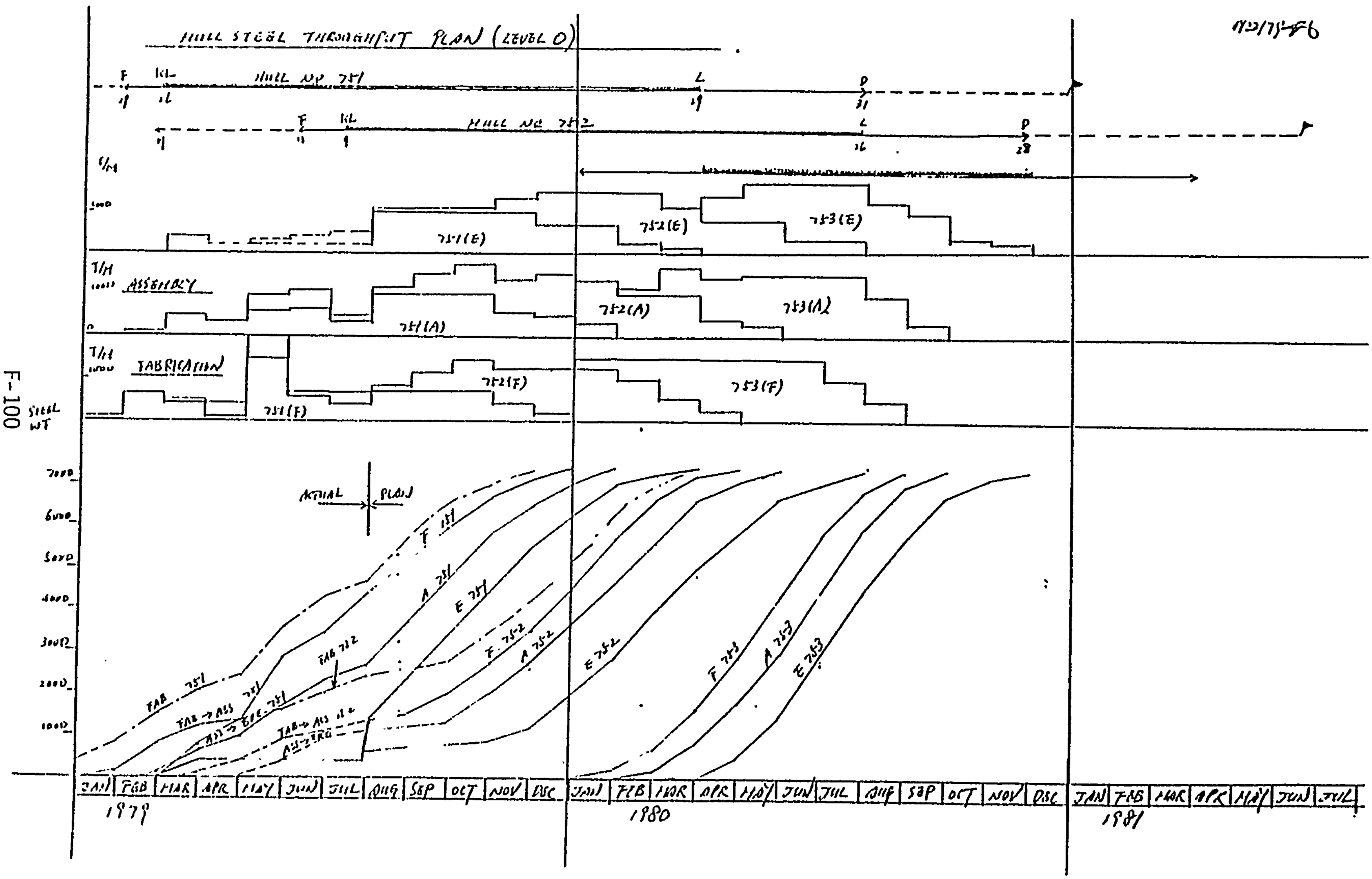
HULL STEEL THROUGHPUT PLAN (LEVEL 0)
HULL NO 751
HULL NO 752
ASSEMBLY
FABRICATION
751(E)
752(E)
753(E)
751(A)
752(A)
753(A)
751(F)
752(F)
753(F)
STEEL WT
7000
6000
5000
4000
3000
2000
1000
ACTUAL
PLAN
FAB 751
FAB 752
F 751
A 751
E 751
F 752
A 752
E 752
F 753
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Fig. 7-4:

HULL STEEL THROUGHPUT PLAN (PRELIMINARY)

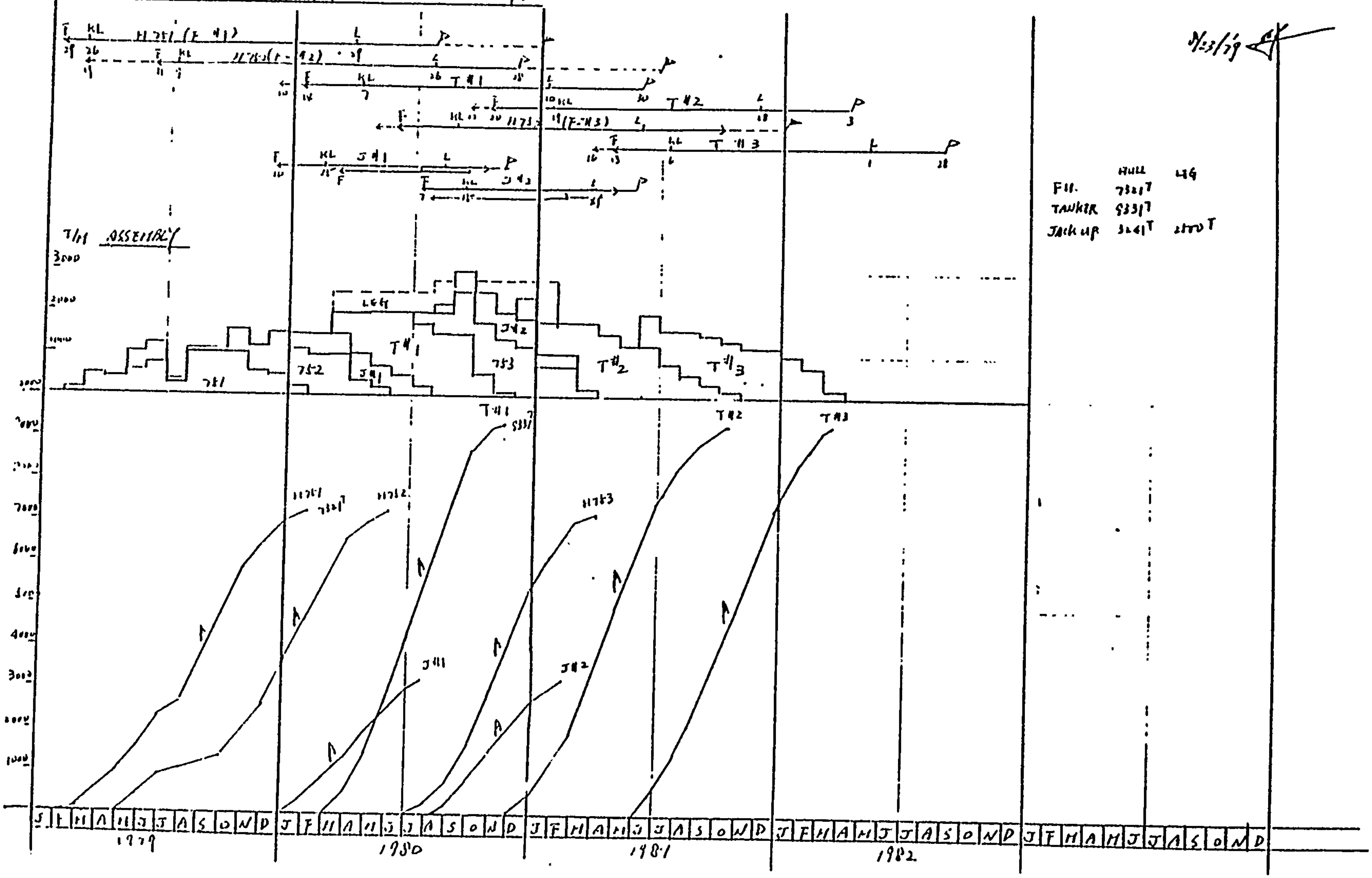
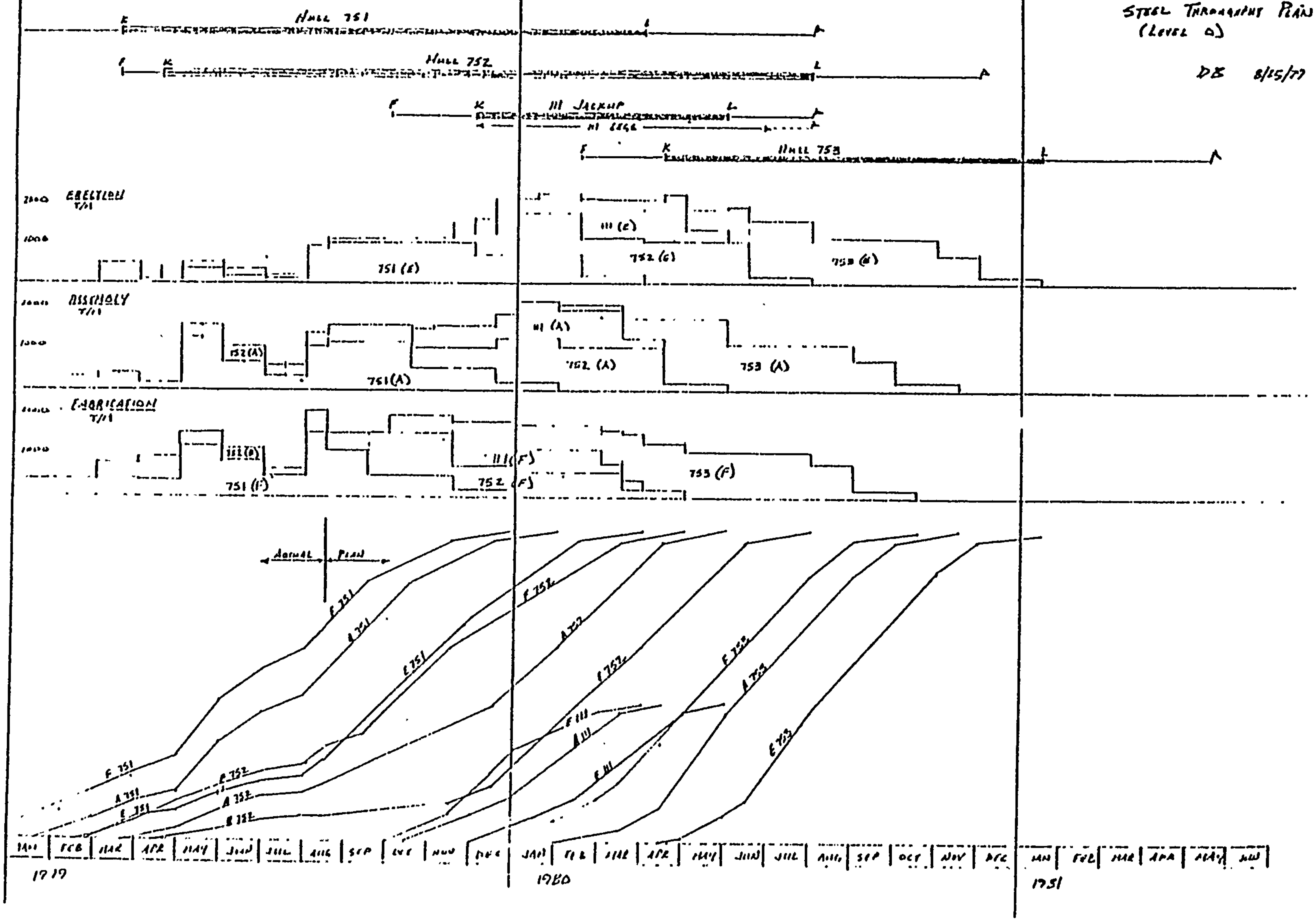


FIG. 7-5



Steel Throughput Plan (Level 0)
DB 8/15/77
Hull 751
Hull 752
111 Jackup
111 Legs
Hull 753
Erection T/M
Assembly T/M
Fabrication T/M
751 (E)
752 (E)
753 (E)
751 (A)
752 (A)
753 (A)
751 (F)
752 (F)
753 (F)
Actual
Plan
1979
1980
1981

2) Production Progress Control Charts

From the above planning, several basic control charts will be provided in order to show the forecasted and the actual progressed which are overlapped under quite the same conditions as good guidances. Any deviation should be checked to rearrange it as requested.

Regarding the control of work progress and productivity, every charts are provided by Production Control about the work forecast at the time of each planning and about the actual work progress by weekly or monthly.

Attached herein after are the typical examples of IHI: Fig. 7-6 (Fig. 14-1 thru 14-21)

PRODUCTION CONTROL CHARTS IN IHI'S HULL STEEL

FIG. 7-6

STAGE / CONTROL CHART	HULL PRODUCTION	MOLD LOFT	FABRICATION STAGE	SUB-ASSEMBLY STAGE	ASSEMBLY STAGE	ERECTION STAGE	NOTE
Process Progress Control Chart	Day Base - Fab. Wt. Ass. Wt. Ere. Wt. (Advance curve)	Day Base - Design Dwg. Mold Dwg.	Day Base - Fab Wt.	Day Base - Sub. Wt. Sub. Dm	Day Base - Ass. Wt. Ass. DM	Day Base - Ere. Wt. Fit. Bnl Weld Bnl	· Leveling by throughput capacity · Follow-up process progress
	Fig. 14-1	Fig. 14-4	Fig. 14-6		Fig. 14-10 Fig. 14-11	Fig. 14-17 Fig. 14-16	
Productivity Control Chart	Ere. Wt. - MH Ere. DM - MH		Fab. Wt. - MH	Sub. Wt. - MH Sub. DM - MH	Ass. Wt. - MH Ass. DM - MH - Fitter MH - Welder MH	Erec. Wt. - MH Erec. Bnl - MH - Fitter MH - Welder MH	· Estimating production amount · Estimating productivity · Budgeting required manhours · Checking productivity
	Fig. 14-2 Fig. 14-3		Fig. 14-7	Fig. 14-8 Fig. 14-9	Fig. 14-12 Fig. 14-13 Fig. 14-14 Fig. 14-15	Fig. 14-18 Fig. 14-19 Fig. 14-20 Fig. 14-21	
MAN-POWER CONTROL CHART	Day Base - Total MH	Day Base - MH	Day Base - MH	Day Base - MH	Day Base - MH	Day Base - MH	· Budgeting required manhours · Leveling required manhours · Comparing available manhours
SCHEDULE	Erection, Ass Master Schedule	Mold Loft Schedule	Fabrication Schedule	Sub-Assembly Schedule	Assembly Schedule	Erection Schedule	

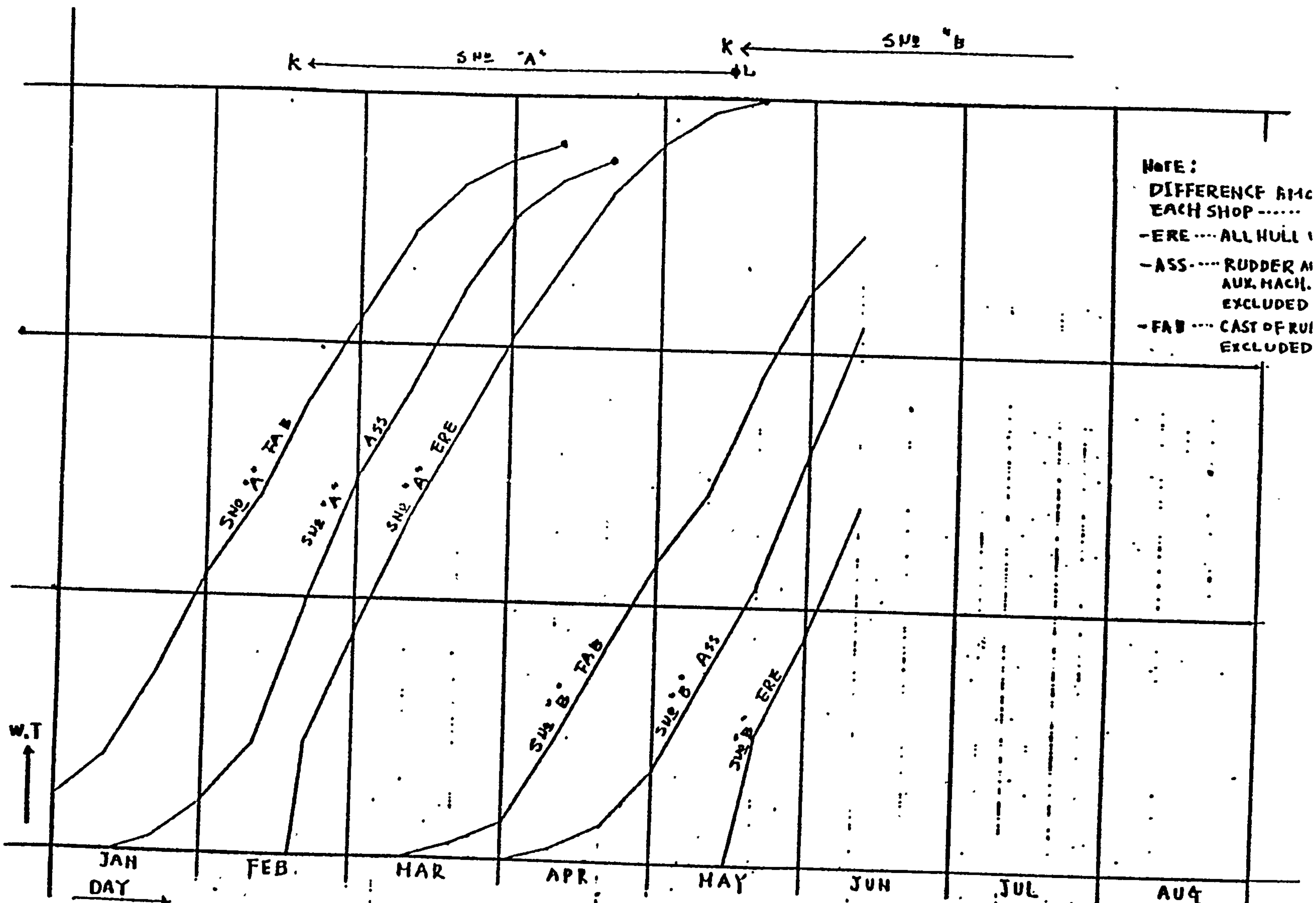


Fig. 14-1 (FAB, Ass. ERE) W.T. ADVANSE CURVE (PAY BASE)

F-106

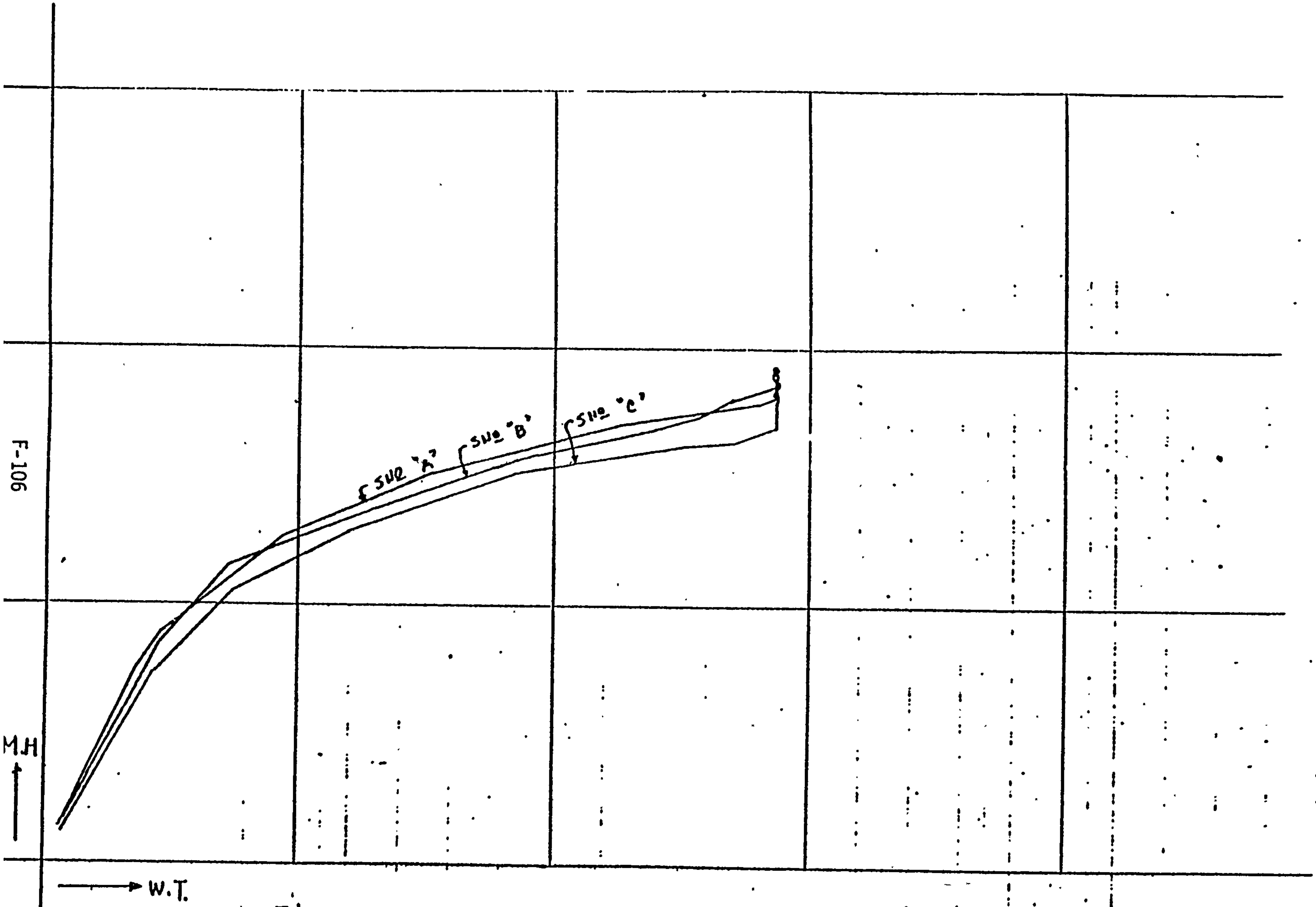


Fig. 14-2 HULL TOTAL M.H. (ERE W.T BASE)

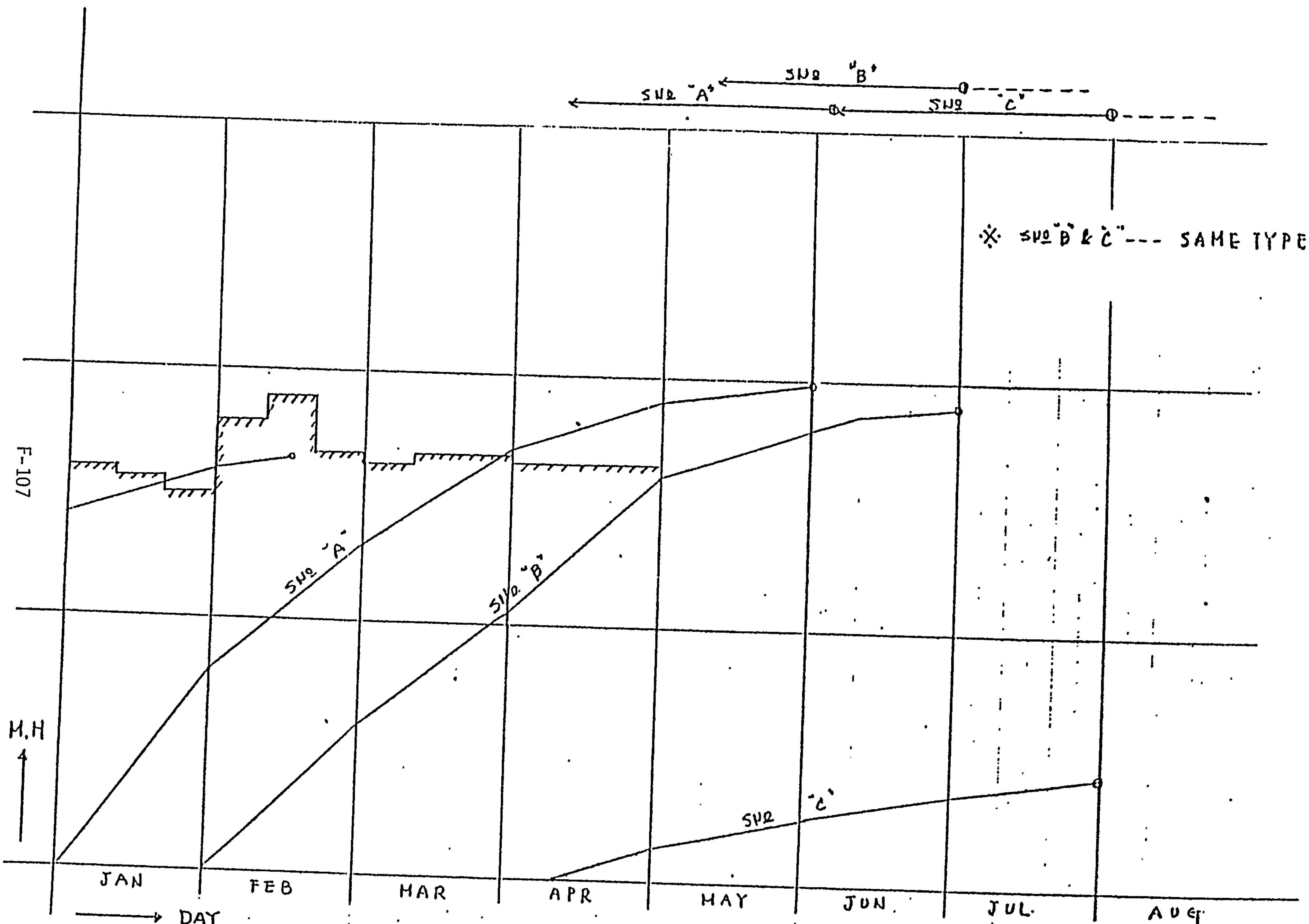


Fig. 14-5 LOFT M.H CURVE (DAY. BASE)

F-108

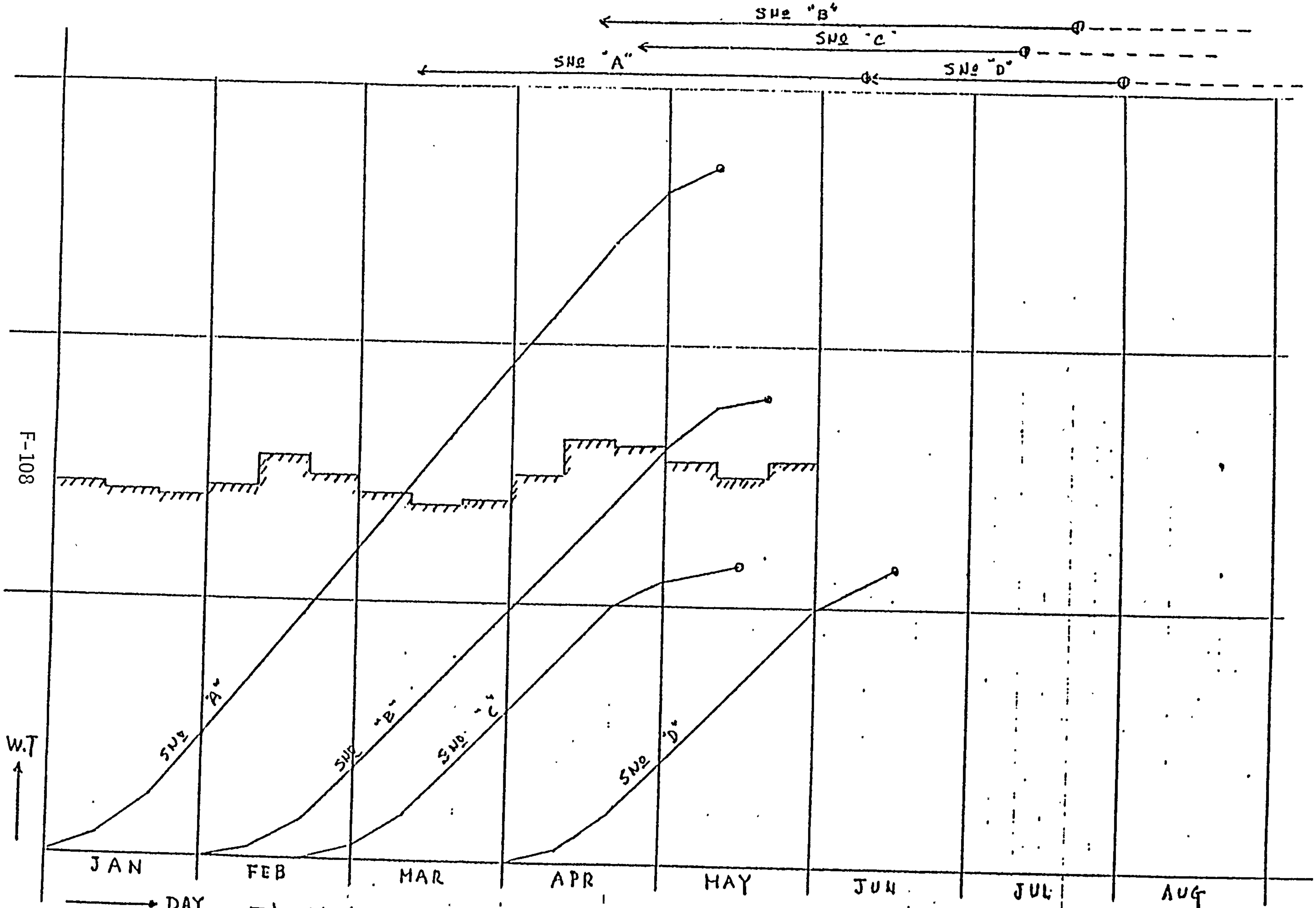


Fig. 14-6 FAB. W.T CURVE (DAY BASE)

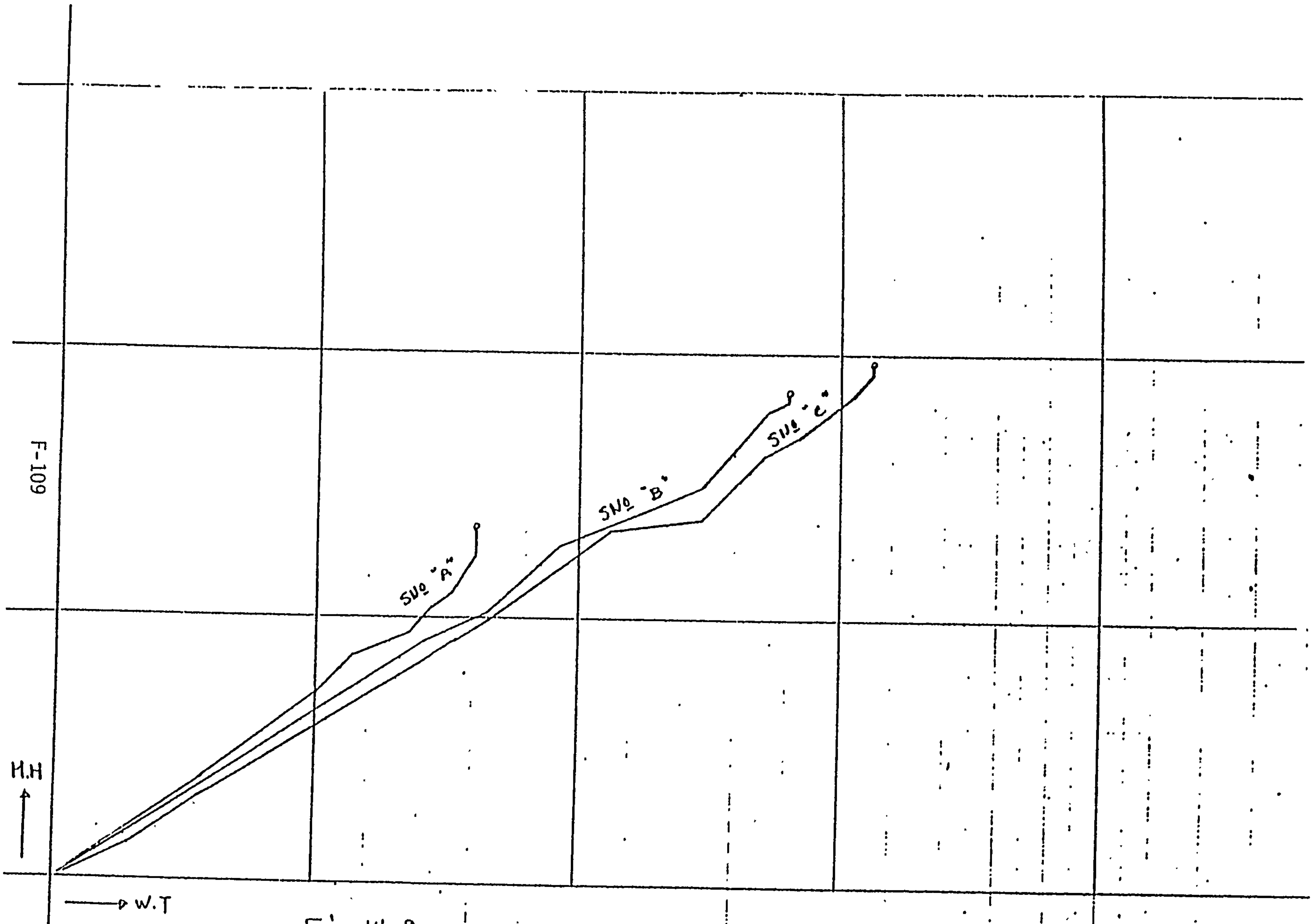


Fig. 14-8 SUB-Ass. M.H. CURVE (W.T BASE)

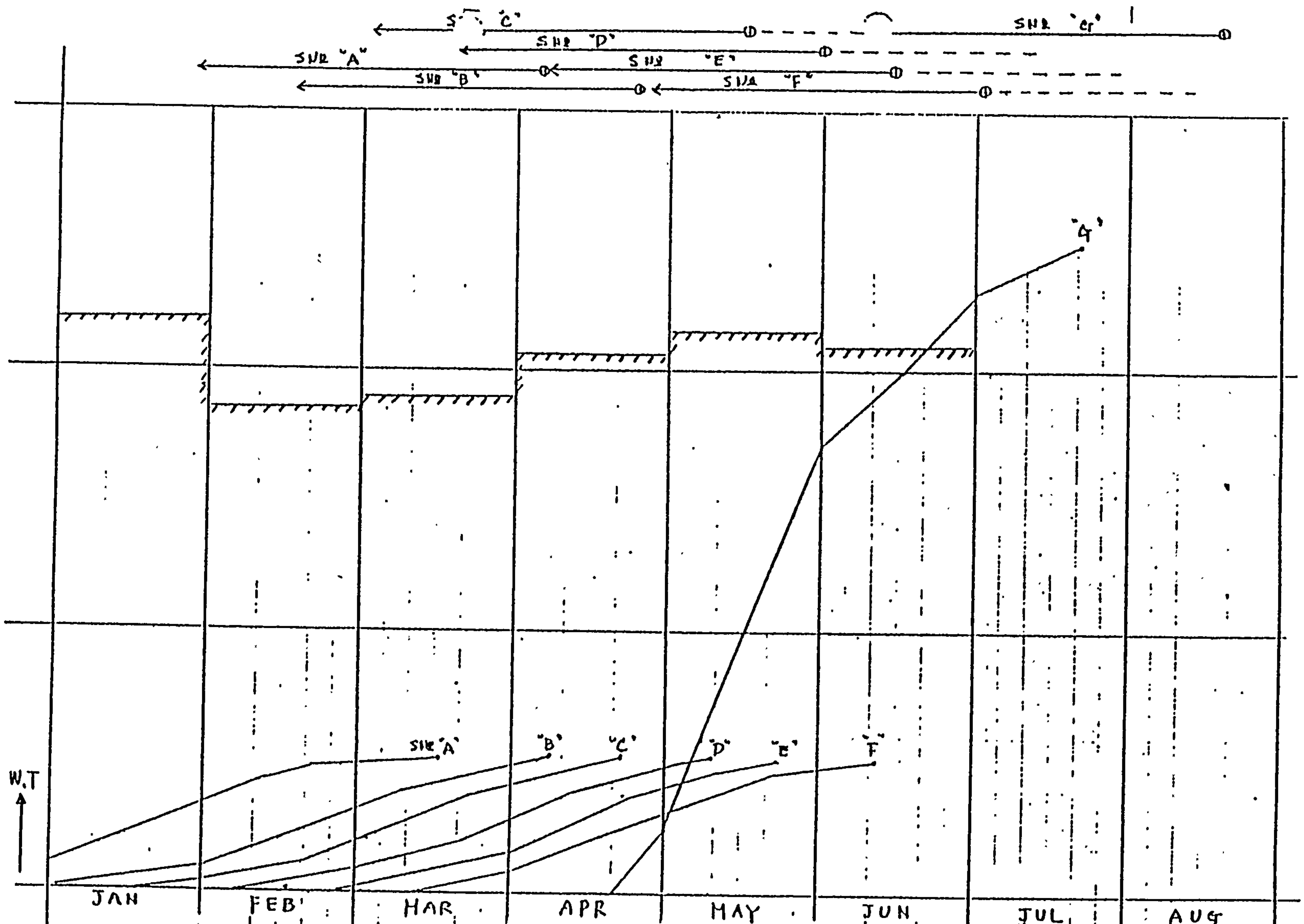


Fig. 14-10 Ass W.T CURVE (DAY BASE)

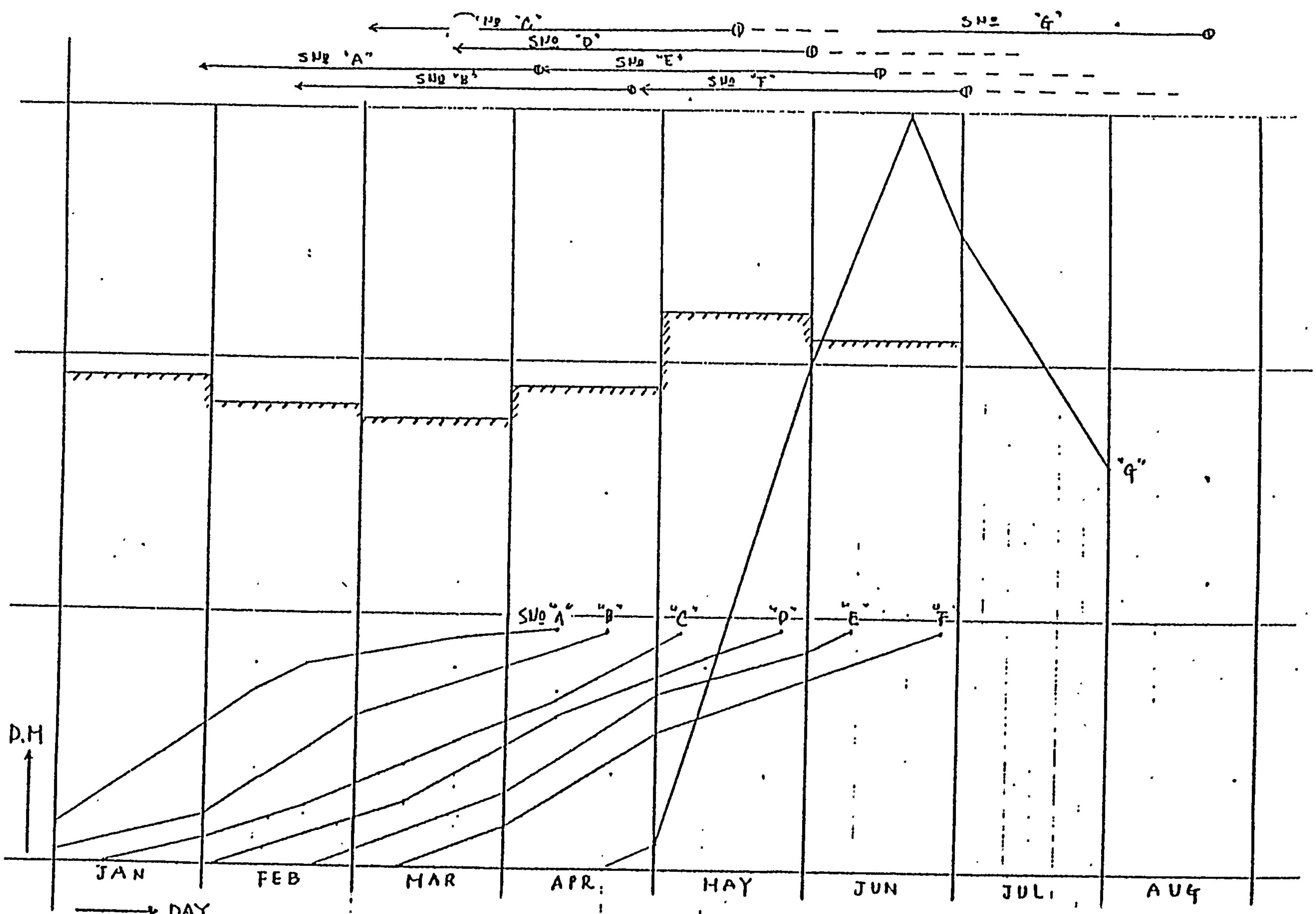


Fig. 14-11' A's D.M CURVE (DAY BASE)

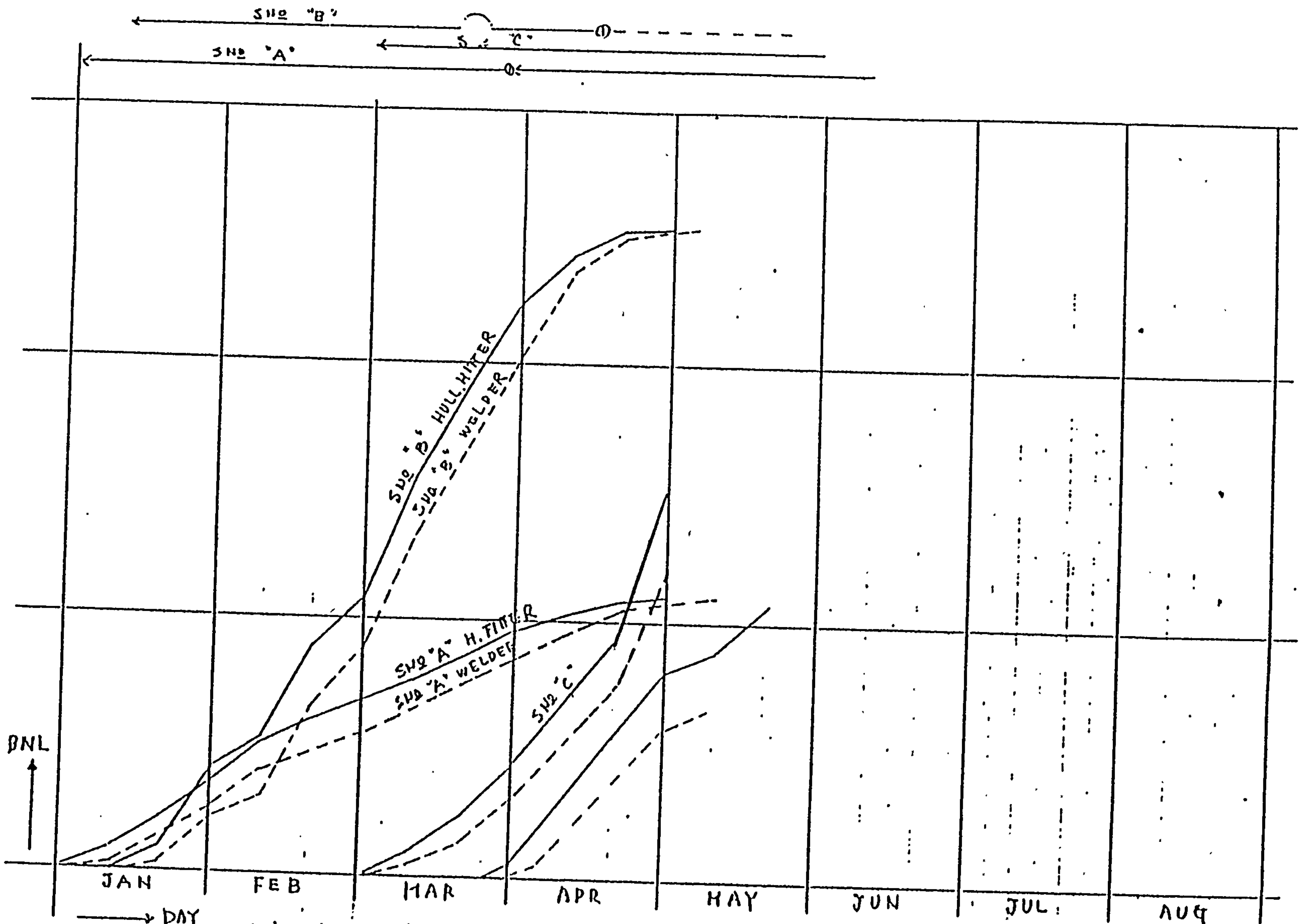


Fig. 14-16 [HULL FITTERS AND WELDERS OF ERE] B.N.L ADVANCE CURVE (DAY BASE)

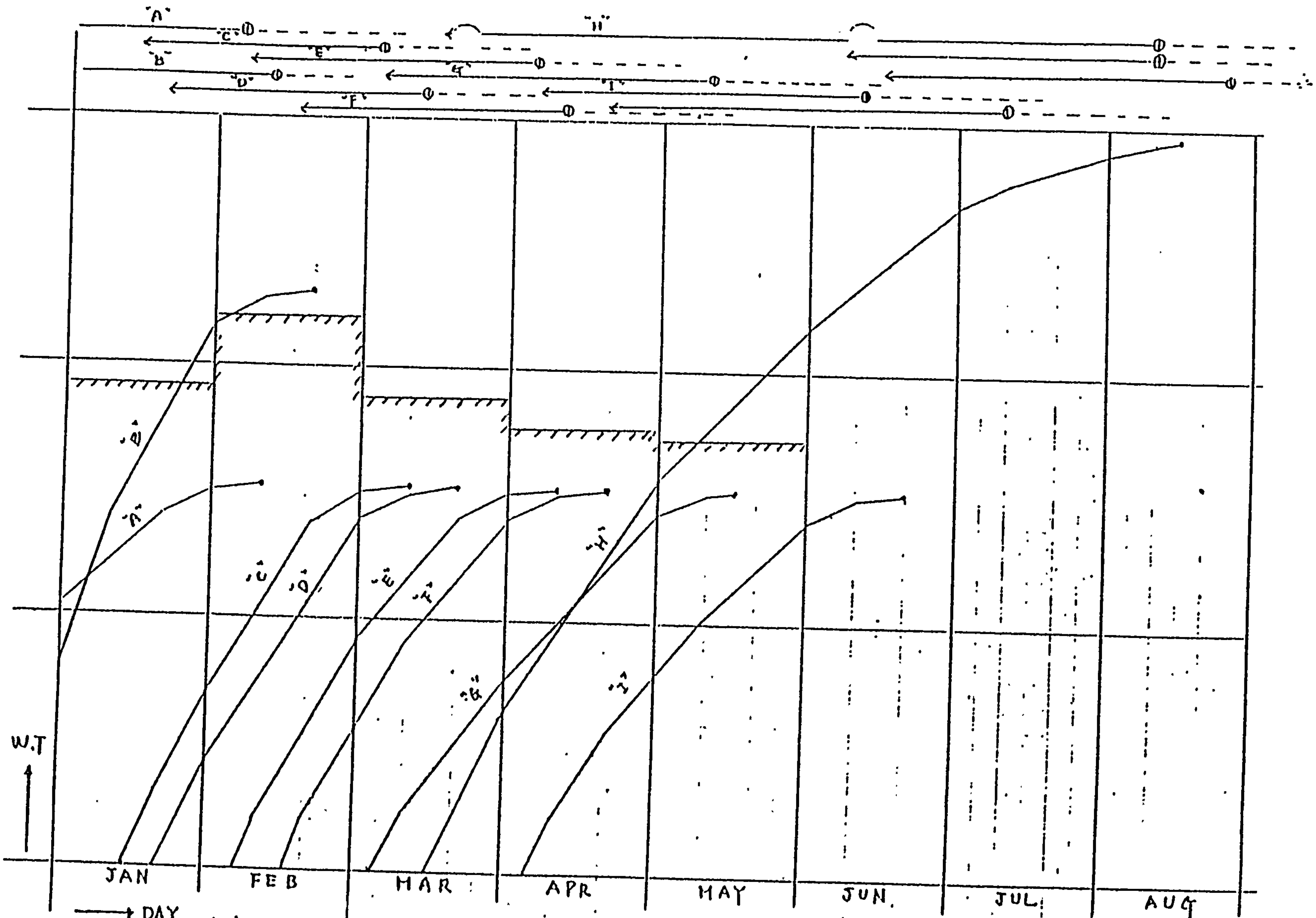


Fig. 14-17 ERE. W.T CURVE (DAY BASE)

F-114

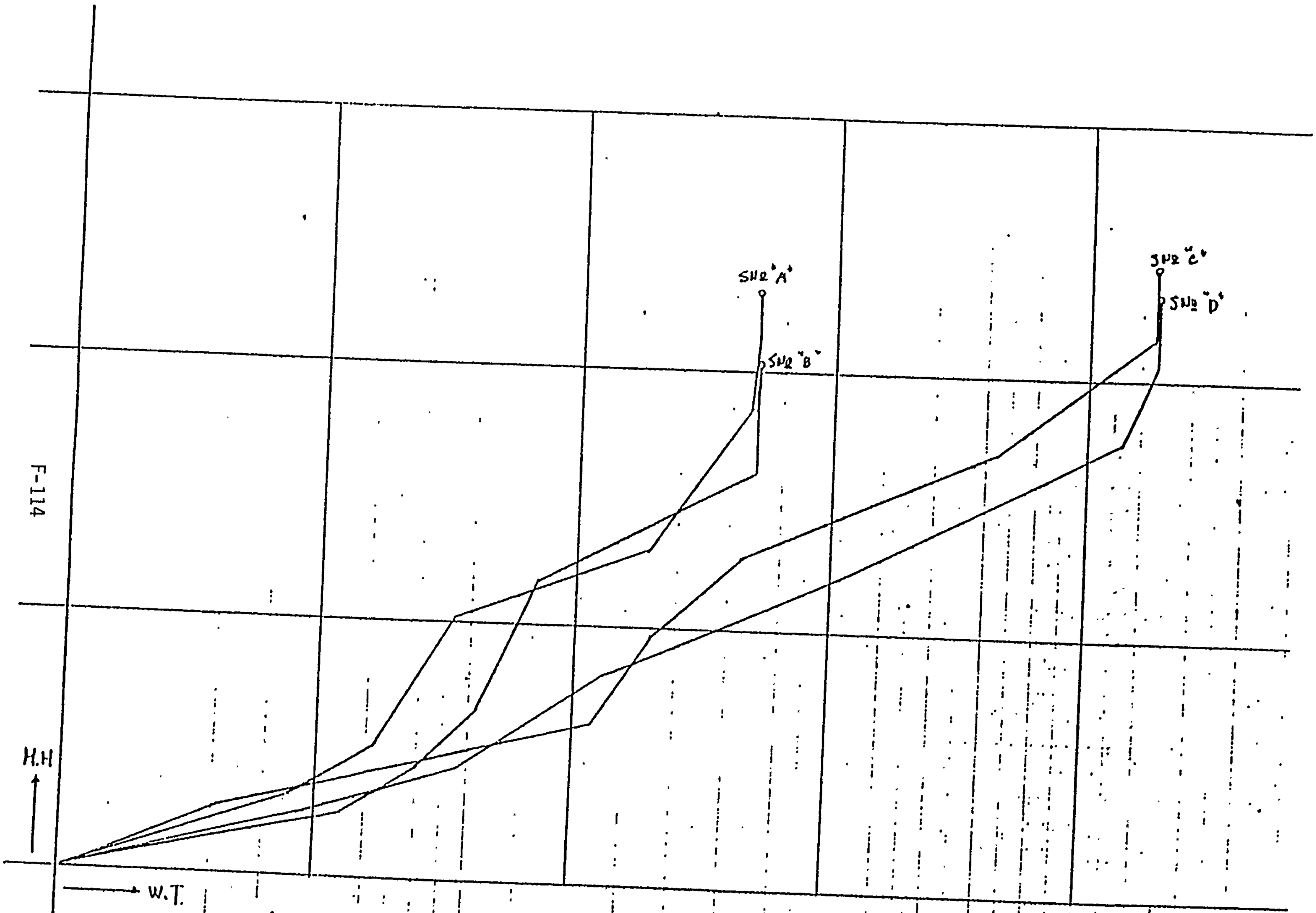


Fig. 14-18 ERE. TOTAL M.H CURVE (W.T BASE)

3) Reporting of Progress

In order to grasp the progress of actual production work, the most important and difficult matter is how to grasp its progress.

As afore mentioned, in the products planning, the unit parts list are provided for the process planning, and lead to prepare the material information list.

From the above list, the planned work package of each gate schedule, such as work order, are clearly distinguished by piece number or component number. Therefore, the progress of work on process gate are easily grasped by the completion of products.

In other words, the process planning and its size of products such as work order assigment is a key of the follow-up of production, namely control as well as schedule.

In this connection, the following special consideration for Assembly and Erection are necessary to take into.

Assigning the optimume size of work quantity to work order, such as work package; especially for Assembly.

Providing the eyesometric sketch with welding length of each joint; especially for Erection, as shown in Fig. 7-7

Once the material information lists and the welding length sketch and list are established, the progress of actual production work are easily grasped by the number or name of completed products refering to the above lists.

These completed products are easily reported by foreman assigned process gate daily and confirmed by Production Control weekly. The summary report by weight and/or welding length are to be provided by Production Control weekly to plot the control charts.

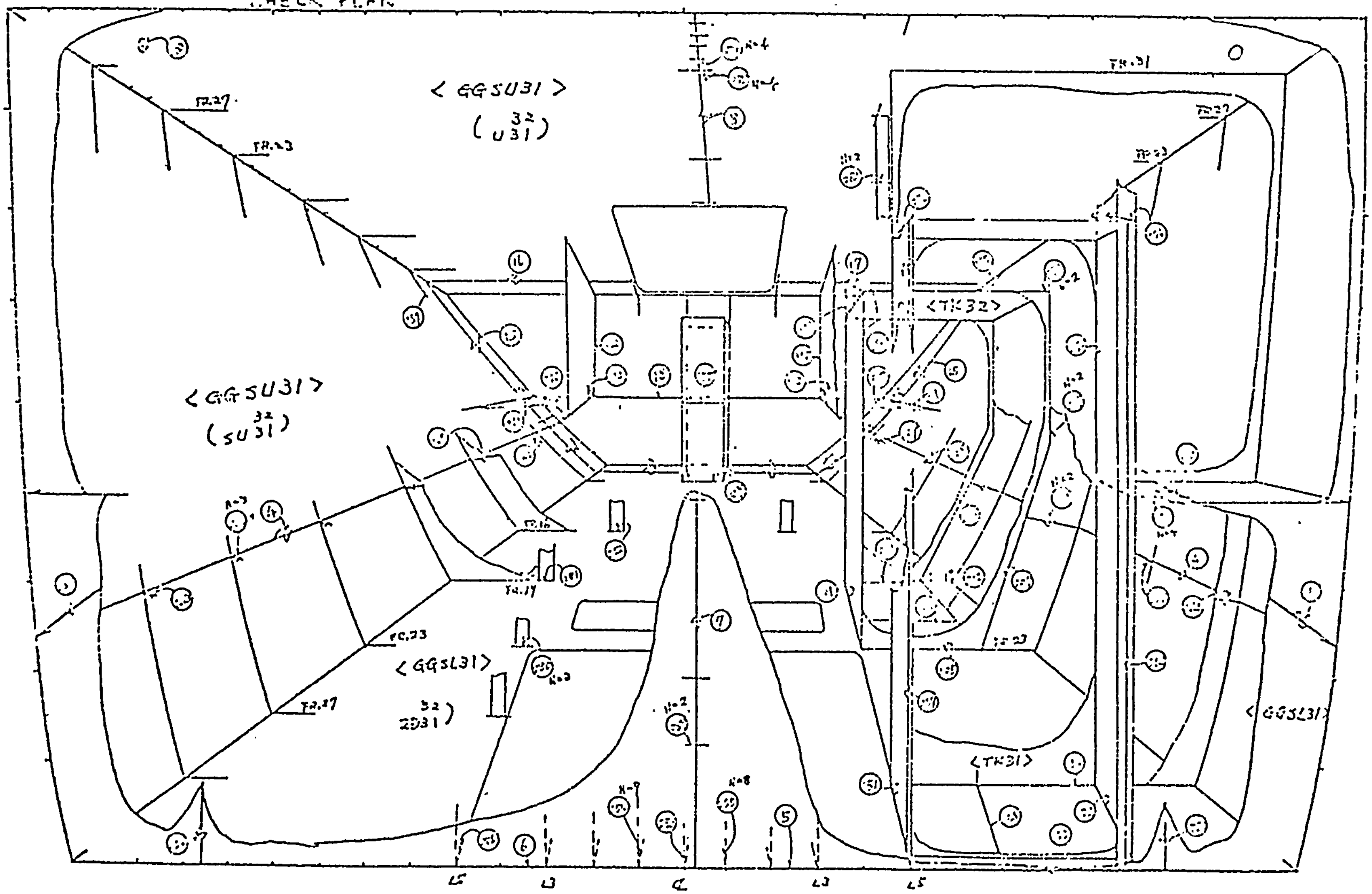
These daily and weekly production progress reports are to be referred to Fig. 6-5 and Fig. 6-6.

FIG. 7-7

SNO. 2609 ERECTION (M-II)

ENGIN ROOM (FR.12~FR.36) P/S

Fig.14-4 WELDING PROGRESS CHECK PLAN



7-2 Evaluation of Productivity

The production performance is indicated by the completed products amount and expended manhours. Therefore, for the above purpose, the control chart, which is displayed by products amount (weight, welding length or others directly related to production) in horizontal axes and manhour in vertical axis, is provided as shown in Fig. 7-8.

In this model the functions of control chart is described as follows:

TC : Estimated total products amount

HCO : Budgeted manhours

Productivity (Estimated) : HCO/$_{TC}$

Then production is progressed at TA, if expended manhour is

HAO : forecasting manhour HCO

HA1 : forecasting manhour HC1

HA2 : forecasting manhour HC2

HC2 HCO HC1

Therefore case 1 is higher productivity and case 2 is lower productivity.

On the other hand, during the development of detailed planning, the total amount is able to change from TC to TB or TD therefore the forecasting manhour is respectively

HBO or HDO : on the same estimated productivity

HB1 or HD1 : on the case 1

HB2 or HD2 : on the case 2

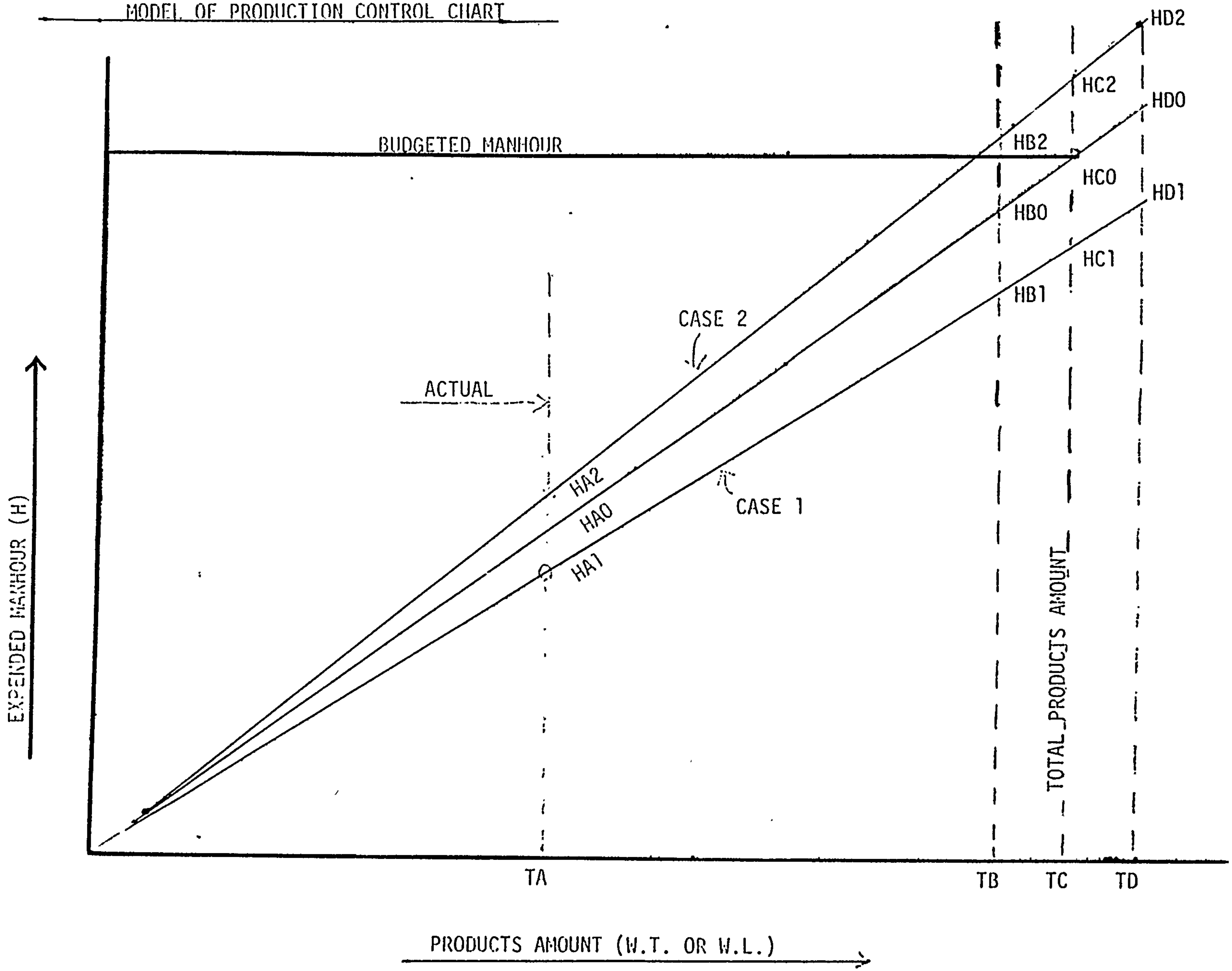
From the above relations, the following major considerations are to be taken:

To estimate and grasp precisely for total products amount

To keep the expended manhour below the estimated line on each process gate respectively.

Fig. 7-8:

MODEL OF PRODUCTION CONTROL CHART



8. Process Stage Control of Hull Production

8-1 Steel Material Control : Receiving, Storing, and Issuing

8-2 Mold Loft Stage

8-3 Fabrication Stage

1) Grouping of Fabrication
2) Scheduling
3) Material Handling and Control
4) Follow-up of Progress and Productivity
5) Accuracy Control

8-4 Sub-Assembly Stage

1) Grouping of Sub-Assembly
2) Scheduling
3) Material Control
4) Follow-up of Progress and Productivity

8-5 Assembly Stage

1) Grouping of Assembly
2) Scheduling
3) Material Control and Handling
4) Storage of Assemblecl Unit
5) On-Unit Outfitting and Painting
6) Follow-up Process Progress and Productivity
7) Accuracy Control

8-6 Erection Stage

1) sequence of Erection
2) Schedule
3) Follow-up of process progress and Productivity
4) Accuracy Control

Fig. 8-1 IHI's Standard Size of Steel Material

Fig. 8-2 Fabrication Material Priority Schedule

8. Process Stage Control of Hull Production

Hull Unit construction method, as you already recognized, are leading to a Product-Oriented System.

As already before mentioned, after break-down planning, a huge number of parts, components and units, as interim products, are fabricated from raw materials and assembled through the several process gates, as shown in Fig. 4-1.

These process gates are grouped as follows; namely Stage.

Fabrication
Sub-Assembly
Assembly
Erection

During hull steel construction through each stage from raw material to a ship, the major objectives to be taken into consideration are as follows:

Material Handling : in volume, in weight
Welding : in volume, in position

From the above point of view, every efforts; Engineering, Planning, Control, Facilities and Organization should be concentrating on the above two major objectives.

8-1. Steel Material Control: Receiving, Storing and Issuing

Steel material control in steel storage yard is the most closely related function to hull production.

The folloiwng steps are to be considered:

a) The rough cutting plans such as the steel bill of material are to be provided for the material requisition at the earlier stage in accordance with the assembly master schedule if available.

In this step, the following consideration is requested:

Reduction of scrap margins.

Interchangeability for cutting material within the same size.

Easiness and minimization of storage piles for accumulation of material.

In this relation, the establishment of the standard size of material is essential. Attached is a sample of IHI's standard size of steel material: Fig. 8-1

This plan is to be provided to meet the production flow as much as possible, such as:

Skin plates and panel plate: For process gate 11.

Curved shell plate and internal structure made of plate: For process gate 10.

Internal structure made of shape: For process gate 12.

b) Detail Cutting Plan and List.

This plan is to be provided by Mold Loft from the computer output with reference to the steel bill of material and the purchasing order sheet in accordance with the Fabrication Gate Schedule and the material information list.

c) Steel Material Allocating List.

This list is to be provided from the material purchase order with the detail cutting plan and then issued to the steel storage yard as the steel material issue order.

d) Material Storage and Issuing Plan.

After the material received into the steel storage yard, the following considerations are to be requested:

Accumulation at each stock piles to be done by size-by-size.

Issuing and transferring the material by unit-by-unit for each gate in accordance with the issue orders of cutting plans.

Therefore, according to the delivery date of the purchasing order, the storage plan is to be provided by size-by-size. On the other hand, the issuing plan is to be provided by process gate, issue date and unit.

Through the above steps, the most important factor is the identification of material: such as when arrived and-issued, and what products assigned into.

1. Application

This standard regulates the sizes (width and length) for purchase of all steel plates to be employed to hull construction of general merchant ship except superstructure, and is applied to repair ship as much as possible.

2. Size Classification

2.1 Sketch Size

Size required is to be the one purchased, rounding size in consideration of size for extra cost only, provided that the size is generally within the range of Table 1.

2.2 Standard Size per ship

Size required is to be deemed to the standard size stipulated in 2.3 because of considerable numbers used for each ship owing to addition of:

- More than 10 pieces per size of the sketch-sized plates used around flat mid part, and
- A few pieces per size of the various-sized plates used for any parts to be made the same size as the above size, provided that the size is generally within the range of Table 1.

Weight (ton)	Width (meter)	Length (meter)
less than 15	1,400 to 1,500	6,000 to 16,000

Table 1 Size Table of Sketch Size and Standard Size per Ship

Approval
Check

Alteration	0	1	2	3	4	5
Date						
Bibliography						

2.3 General Standard Size

Standard sizes are regulated as shown in Table 2 in order to standardize a few pieces of purchase plates per size and to obtain the merits through the standardization, provided that the following may be excepted:

- Mild steel plates, thicker than 19.5mm or thinner than 5.5
- High grade mild steel plates, higher than B grade and inclusive
- Special steel plates such as high tensile steel plate, etc.

T (mm)	W (mm)	L (mm)
6 to 19	2,200	12,000
	2,800	

Table 2 General Standard Size of Steel Plate for Hull Structure

Approval	Check

Alteration	0	1	2	3	4	5
Date						
Bibliography						

3. Applicable Range of Size Classification

Table 3 shows the applicable range of steel plates for each Size Classification.

O ..... Applicable , X ..... Unapplicable

Range \ Size Classification	Sketch	Standard per ship	General Standard
- Skin, deck and double bottom - More than 19.5mm in thickness - Higher than B grade inclusive - Special steel such as high tensile	O*	O	O
- More than 10 pcs. used for main and internal structure	X	O*	O
- Main and internal structure except the above	X**	O	O*

Table 3 Applicable Range of Size Classification of Steel Plates

Note: * this is a main of standard of the applicable range.

** The sketch size may be applied only for the special case after agreement made between Hull Construction Work Shop and Design Department

Approval
Check

Alteration	0	1	2	3	4	5
Date						
Bibliography						

8-2 Mold Loft Stage

In this shipyard, the SPADE System covers mold loft.

From the mold loft, the most important working instruction information to Fabrication and also Assembly and Erection are requested to produce before the commencement of the job in each process gate in advance.

The following information are the major requirements

Gutting information for marking and allocating of materials.

: N/C Tape; Cutting Plans and Size Lists,
Steel Material Allocating List
Marking Templates.

Bending informations (Refer to our Mr. K. Honda's final report)

: Bending Template, Curved Jig Height Lists
Marking Template for Curved Shell.

Accuracy information.
(Refer to our Mr. K. Honda's final report).

8-3. Fabrication Stage

In this stage, the all kind of parts/pieces of hull structure are produced from the steel raw material by marking, cutting and shaping.

Therefore, the most important consideration for this stage is the establishment of optimum flow between the various type and huge numbers of materials and many kinds of tools, machines and facilities.

1) Grouping of Fabrication

The major fabrication job is cutting process from the steel raw materials into several shape of parts/pieces.

Contour cut plates - mainly internal structure

: N/C burning machine or eye-tracing burning machine

: Process gate 10

Square cut plates - mainly main panel plate

Flame planer - Process gate 11

Shaping plates after contour cut plates

Mainly side shell

Process gate 10 to process gate 13

Cutting and shaping, if necessary, shapes

Mainly angles

Process gate 12 and process gate 14

These grouping of parts/pieces are indicated by the material information lists.

2) Scheduling

The Fabrication Master Schedule for each process gate is provided in accordance with the Assembly Master Schedule. In this case, the commencement dates are firstly to be considered for each above process flow, especially the raw materials for shaping are to be cut earlier than those for the internal structure and the shapes in order to meet the assembly schedule.

Therefore, the shaping material for fore and aft parts of hull are necessitated to study about the fabrication period to lengthen its advance of time.

In addition to the commencement date, the N/C burning machine and the flame Planer are requested to operate constantly. From the above point, the following considerations are important:

Long lead time of shaping material.

Balancing or separation of small pieces and beveled pieces.

Standard parts mass production in eye-tracing machine.

The Fabrication Gate Schedule is effected from feeding of the material into fabrication through the shot blasting.

Therefore, the implementation schedule is provided for each process gate with referring to the sub-assembly schedule and the assembly gate schedule respectively by the leveling of machine production capacity, as shown in Fig. 8-2.

Fig. 8-2: FABRICATION MATERIAL PRIORITY SCHEDULE

Material Piling (Storage Yard)	-4	T 10/30	W 10/31	T 11/1	F 11/2	M 11/5		T 11/6	W 11/7	T 11/8	F 11/9	M 11/12
Shotblast & Painting	-2	T 11/1	F 11/2	M 11/5	T 11/6	W 11/7		T 11/8	F 11/9	M 11/12	T 11/13	W 11/14
Fabrication Commencement	0	M 11/5	T 11/6	W 11/7	T 11/8	F 11/9		M 11/12	T 11/13	W 11/14	T 11/15	F 11/16
Commencement Sub-Assembly or Assembly	+3	T 11-8	F 11/9	M 11/12	T 11/13	W 11/14		T 11/15	F 11/16	M 11/19	T 11/20	W 11/20
Shop 6 Flame Planer Process Gate 11		(Refer to the Gate 20 and 21 Schedule) Leveling by Flame Planer Capacity : Sheets/Shift										
Shop 5 N/C Burner Process Gate 10		(Refer to the Gate 16 and 22 or 23 Schedule) Leveling by N/C Burner Capacity : Sheets/Shift										
Shaping Plate for Process Gate 13		(Refer to the Gate 13 and 23 or 26 Schedule) Leveling by Flaming & Roller Capacity : Sheet/Shift										

3) Material Handling and Control

In this stage, the huge number of parts are producing daily, therefore the completion of each part are necessary to be marked by coloring on the material information list.

The completed parts are to be collected by following process gate/unit in accordance with the material information list and fed by the respective gate schedule.

In order to collect and feed on time, although the adequate space of marshalling area, especially between the internal parts cutting (Process Gate 10) and the sub-assembly (Process Gate 16), are requested, but the space of Shop 5 and Shop 6 are limited. Therefore the completed parts for sub-assembly; especially process gate 16 and 17, are once to be shifted to the station 323, 423 and 523 (outside of shop 6) or Station 219, 220, 221 (between Gate 17 and Shop 5) for the marshaling of parts by forklift.

These area also enable to be utilized for marshaling of the assembled sub-assembly components, such as marshaling center for hull steel materials.

4) Follow-up of Progress and Productivity

In order to grasp the huge number of parts produced daily in this stage, the coloring of the material information lists is essential to recognize the completed parts by its piece number and quantity, and enable to do by a assigned foreman. These information is able to check again by the material expediter, and fill into the daily production progress report with expended manhours every day.

From the above report. the following control charts are able to plot by weekly.

Curve graph per ship of completed parts in weight
Curve graph per ship of expended manhours/completed parts in weight.

The above graphing is provided for Fabrication Stage and each process gates to follow-up the process and the productivity.

5) Accuracy Control

Fabrication process is the first stage of hull construction, and the accuracy of its products results greatly in easiness of work and economy of manpower and material at the following process gates. In other words, it makes fitting work supporting to welding at assembling reduce not only its manhours but also correcting of welding performance. The assembled components and units will be consequently in good performance. The systematic approaches to the said performance should be established by:

Regulating of accuracy standard and allowable tolerance of products at the processes of marking and cutting.

Organizing of leader of working group for accuracy under the Superintendent, who produce the statistic data for accuracy control of each process gate.

By these data, repeating its education for the workers to routinize the accuracy check as a part of their own daily task.

The above cycle of PLAN-DO-SEE should be necessitated.

The important attention should be paid to not only the accuracy of cutting size but also the smoothness of gas cut surface. The latter can be obtained by good selection of the nozzle tip size of gas burning torch and by the good balance between the cutting speed and the pressure of fuel gas applicable and oxygen gas corresponding to the tip size

8-4 Sub-Assembly Stage

Necessity of diversion of Sub-Assembly from Assembly is to enable small parts and pieces to assemble them to the adequate sized components in volume and weight.

In other words, the huge number and many kind of parts fabricated in shop are assembled in this stage as a first step.

Therefore it will gain the various merits of

less transportation requirements

good performance and high productivity of welding for increasing of gravity welding usage by flat position

stable flow of Assembly with leveling of the assembly work for each unit and

facilitating the collection of the parts

Therefore the Sub-Assembly is to be facilitated near by the Fabrication Shop prior to the Assembiy Slabs.

1) Grouping of Sub-Assembly

Most of the parts and the pieces is to be sorted into some groups in the same or similar patterns.

Considering the hull structure, the internal structure especially transverse frame are easily recognized the following two type of grouping:

a) Middle part of hull in similar or same size and in many number : Process Gate 16

b) Fore and Aft part of hull in different size and in small number : Process Gate 17

From the above two major patterns, the process flow are to be separated respectively for leveling of manpower.

Furthermore, for making smooth flow of the above major groups, the some type of parts are requested to assemble prior to Sub-Assembly as the part of Sub-Assembly, namely pre-sub(: Process Gate 15). It is necessary to separate from the above two group.

2) Scheduling

The sub-assembly schedule are provided on date base for each process gate under the conditions of Assembly Master Schedule.

3) Material Control

Importance of material control at this stage is the collection of numerous pieces of cut parts before commencing Sub-Assembly,

Therefore, fundamentally, their storage area should be located between the both stages enough to lot them for each sub-assembly component in sequence of the sub-assembly schedules for each process gate.

For this collection, the material expediters should be assigned on full time, and proceeding with the following steps:

Coloring the receipt of parts on the material information lists.
Feeding parts into each sub-assembly process gate according to sub-assembly schedule, and then coloring on the above lists.
Coloring the completion of sub-assembly components on the above lists, and then shifting to the storage area as routed by the above lists.

From the above activity of the material expediters, the confirmation of each part and component in progress is easily grasped by the colored material information lists.

4) Follow-up of Process Progress and Productivity

As described before, the daily sub-assembly stages progress are checked with:

Coloring the receiving of the parts on the material information lists for each sub-assembly component for commencing sub-assembly smoothly.

Coloring the completion of sub-assembly components on the above lists and on each sub-assembly schedules for grasping the progress of sub-assembly components.

Main job of this stage is to assemble the parts by welding, that is, one of the welding shop for small parts.

Therefore, the productivity in this shop depends on the welder's productivity, and the workers here other than the welders are assisting to welder workin-g smooth.

From the above points of view, in this stage, the major consideration is "How to fully and constantly use the gravity feed welding machine on flat position."

In this stage, the following control charts are requested.

Manhour (total, welder and others)/ Sub-Assembly components in weight on each process gate and total sub-assembly

Manhour/welding length.

8-5 Assembly Stage

Assembly Stage is a major stage in hull construction. The throughput capacity of this stage will dominate the total production in the ship yard. Therefore, the total performance of the Assembly Stage is a key of shipbuilding.

1) Grouping of Assembly

Major grouping of assembly is considered from the shape of main structure panel and supporting facilities of the assembly area, as follows:

a) Flat Component/Unit
b) Curved Component/Unit

According to the above basis, in this shipyard, assembly is divided into the following process area:

Flat Panel Line : Process Gate 20
Flat Component Assembly : process Gate22
Flat Final Assembly : Process Gate 25
Semi-Flat Component Assembly : process Gate21
Curved Component Assembly : Process Gate 23
Curved Final Assembly : Process Gate 26
Deckhouse Component Assembly : process Gate ___
Deckhouse Final Assembly : Process Gate 28
Grand Assembly : Process Gate 29
Unit to Unit (Pre-Erection) : Process Gate 27

Furthermore Assembly Stage is divided into the following sequence:

Weld Joining of Panel Plates
Assemble of Frames and Longitudinal
Weld of Panel Plates with Frames and Longitudinal
Over Turning, if necessary
On-Unit Outfitting, Lifting Pad and Scaffolding
Painting

The details of the above sequence for each unit is provided as the Unit Information List.

2) Scheduling

Details of implementation schedule for Assembly are presented by Mr. O. Togo's Final Report

3) Material Control and Handling

Most of the materials at this stage are bulky. Therefore the well planned transportation routing of each material is a key of material handling at this stage. In this purpose, the Basic Production Flow List are essential to indicate the material route.

In order to transfer the routed material to and from each assembly area, the cranes and trailers are the most important measures.

From the above mentioned point of view, the daily scheduling and controlling of crane and trailer leads for the assembly production to maintain the schedule. Therefore this function is a key of shipbuilding.

In this connection, the cranes which cover the assembly area and also erection, are assigned into the major responsible area respectively for effective control.

4) Storage of Assembled Unit

Fundamentally, no advance between the completion of assembled units and the commencement of erection is the most preferable production planning from the following reasons:

- Avoiding the large size storage area requirements.
- Avoiding the crane handling requirements.

On the other hand, the optimum storage is necessitated from the following reasons:

- Constant flow requirements for each production flow especially assembly stage.
- Prompt progress requirements for the following ship on erection stage in order to minimize the ideling of manpower after ship launching.

For the above purpose, the storage area allocations are planned beforehand during the planning of Assembly Master Schedule.

5) On-Unit Outfitting and Painting

After completion of components or units, on-unit outfitting and painting are requested before erection.

During the planning of the Basic Production Flow List, it is necessary to discuss with Outfitting Planning Group and Painting Planning Group beforehand.

These implementations of on-unit outfitting and painting are easily affected from not only planning but also control of hull production process.

6) Follow-up Process Progress and Productivity

Assembly stage is also a welding yard as well as Sub-Assembly Stage.

Therefore once the welding length of each unit is obtained by each process, the welders for each process can be allocated more precisely according to the schedule.

Anyway, in assembly stage, the most important event of progress is the completion of welding for a component or a unit on each work station and then ready to shift it for the next stage or process.

Therefore, the main object of follow-up for each assembly process is "how to maintain the welding job constantly".

In order to obtain the above objective, the fitters and truck/crane group should provide assistance to the welders constantly according to the schedule.

For this purpose, the allocation of similar type of unit or component, which is composed of similar welding length, on each process area is a most important factor of maintaining the same pattern of rotation with the same number of work gangs within a work station of process area, namely tact job flow.

At this moment, the process progress in Assembly Stage will be grasped by the weight. As shown in Fig. each unit is consisted of several components and each component is progressed in each assigned process gate respectively. Therefore, each process gate is grasped by component or by unit respectively. But the total Assembly performance will be grasped by unit completion.

The following control charts per ship describe the performance by every week.

Completed components or units for each process gate in weight/week. (Final assembly units for total assembly performance).
Expended manhours (total, welders and fitters) for each process gate and total assembly manhours (total, welders and fitters)/week.
Assembly manhours/component or unit in weight for total assembly and each process gate.
Assembly welder manhours/weight for total assembly and each process gate.
Assembly fitter manhour/weight for total assembly and each process gate.

7) Accuracy Control

The unit accuracy at this stage will be controlled from the following two aspects:

Control for Erection Stage.

The poor accuracy of the assembly unit have to effect directly and badly to the schedule and the productivity of erection stage. Therefore , the defects discovered at this stage should be corrected without fail.

Control for Fabrication and Sub-Assembly Stages.

Each fabricated and/or assembled parts and sub-assembly components are accumulated its accuracy error to this stage. Therefore, the defects caused by the prior stage should be fed back for maintaining t-heir accuracy standard level.

For more details refer to M. K. Honda’s Final Report.

8-6 Erection Stage

Erection Stage is the last step of Hull Construction and also its scheduling is a key of all other scheduling.

The defaults at this stage may affect the ship's delivery and the special attention to safety should be paid because of this critical circumstances.

1) Sequence of Erection

The work sequence of Erection Stage is divided into the following sequences:

a) Unit loading on building way.
b) Ship weighting and setting of unit.
c) Scaffolding.
d) Main structure fitting.
e) Main structure welding.
f) Internal structure fitting.
g) Internal structure welding.
h) Cleaning (outfitting on-board).
i) internal visual inspection.
j) Scaffold removing.
k) Watertight or airtight test.
l) Completion.

From the nature of above sequences, the Erection Stage is divided into two major steps:

Unit by Unit process step
Sequence a) thru e)

Tank or zone and sub-zone process step
Sequence f) thru 1)

The first process step is closely linked to the erection unit network and on the other hand, the second process step is proceeding the completion of each tank or each zone required by the tank inspection schedule.

In order to increase the building speed on the building way, it is necessary to separate clearly into two different process flows for maintaining the manpower level in this shipyard size.

2) <u>Schedule</u>

As a master schedule of shipbuilding, the Erection Master Schedule should be provided and published before commencement of any job.

According to this schedule, the dates of unit erection are determined and the erection pitch of each unit especially for Zone-1, are carefully paid attention to the fitters flow by gangs for keeping the ship forms. Then following the fitters gangs as soon as possible, the welders gang for main structure will be proceeding. Therefore, the synchronization of these pitches; loading, fitting and welding, is the most important factor of scheduling for erection.

Regarding to the internal structure, the tank test schedule is the basis of fitter and welder scheduling by zone by zone. In this process schedule, it is necessary to pay attention of the avoiding of vertical job arrangement at same time not only fitter and welder but also hull and outfitting.

3) Follow-up of process progress and Productivity

In order to grasp the work completion for each zone, especially on the erection,an eyesometric sketch shown in Fig. 7-7 is able to check more easily and pracisely the actual condition by coloring for each joint daily. In this connection, once each of the joint is calculated by length and tabulated, this sketch will be useful to follow-up the progress visually and the productivity.

From the above information, the manning, especially for welders, of this stage will become more easy and precise instead of by weight.

The control charts in this stage are as follows:

- Erected weight, fitted weight and welded weight/week.
- Commenced welding length, fitted welding length and welded welding length/week for main structure and internal structure.
- Expended manhours (total, fitter and welder by main structure and internal structure)/week.
- Weight/manhours by total, fitter and welder and by main and internal structure.

4) Accuracy Control

The accuracy control at this stage is; specially classified into the following two cases:

The finished condition of assembly unit

The deformed condition clue to erection work

The former is a major objective of accuracy control through all hull production processes for avoiding the cutting adjustment of erection joints.