

0153

UMTRI

7770

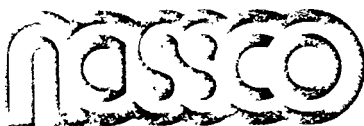
LONG RANGE FACILITIES

PLANNING

IHI SURVEY

VOL. IV OF V

Transportation
Research Institute

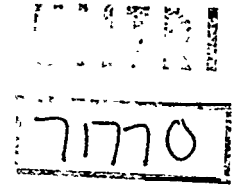


NATIONAL STEEL AND SHIPBUILDING COMPANY
A MORRISON-KNUDSEN COMPANY

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE APR 1982		2. REPORT TYPE N/A		3. DATES COVERED -	
4. TITLE AND SUBTITLE Long Range Facilities Planning IHI Summary Vol, IV of V				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Surface Warfare Center CD Code 2230 - Design Integration Tools Building 192 Room 128 9500 MacArthur Bldg Bethesda, MD 20817-5700				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT SAR	18. NUMBER OF PAGES 527	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

NATIONAL SHIPBUILDING RESEARCH PROGRAM

SP-1 FACILITIES PANEL PROJECT



11-7-82

LONG RANGE FACILITIES

PLANNING

IHI SURVEY

VOL. IV OF V

NATIONAL STEEL AND SHIPBUILDING COMPANY

IN COOPERATION WITH THE

DEPARTMENT OF TRANSPORTATION

MARITIME ADMINISTRATION

APRIL, 1982

IHI SURVEY

Volume IV

TABLE OF CONTENTS

- 1 Volume I - Accuracy Control of Hull Construction
- 1 Volume II - Accuracy Control of Hull Construction Addendum
- 1 Volume III -. Palletization
- 1 Volume IV - Palletization Addendum
- e Volume V - Survey Report on Shipbuilding Procedures at
NASSCO

STUDY REPORT ON SHIPBUILDING
FOR
NATIONAL STEEL AND SHIPBUILDING CO.

Volume I
- Accuracy Control of Hull Construction -

October, 1979

IHI

Ishikawajima-Harima Heavy Industries Co., Ltd.

TOKYO, JAPAN

CONTENTS

	REF. NO.
1. SURVEY REPORT ON THE PRESENT ACCURACY CONTROL SYSTEM AT NASSCO AND RECOMMENDATION FROM IHI _____	KCT033
2. QUALITY CONTROL STANDARD (AN EXTRACT OF THE SPAIS - Shipbuilding Preprocess And Inspection Standard - OF IHI) _____	KCT034
3. MANAGEMENT FOR HULL CONSTRUCTION MATERIALS DEFECT ("F" series Ship) _____	KCT035
4. ~~IHI~~ ACCURACY CONTROL SYSTEM _____	KCT036
5. CHECK POINT , CHECKING DIMENSION , CHECKING METHOD BASED ON FABRICATION SEQUENCE FOR FUTURE-32 BULKERS _____	KCT037
6. ~~ACCURACY~~ CONTROL CHECK SHEET FOR FUTURE-32 BULKERS -	KCT038
7. THE SCHEME OF THE ADDED MATERIALS AND THE PHASE FOR FINISHING UP FOR THE FUTURE-32 BULKERS AT IHI AIOI SHIPYARD _____	KCT039
8. STANDARD AND TOLERANCE FOR KEEPING HIGH ACCURACY AT IHI AIOI SHIPYARD _____	KCT040
9. BASE LINE TO BE EFFECTIVE FOR KEEPING HIGH ACCURACY INCLUDED IN THE OUTPUT THROUGH ENGINEERING AND LOFTING _____	KCT041

SURVEY REPORT

ON THE PRESENT ACCURACY CONTROL SYSTEM

AT NASSCO

AND

RECOMMENDATION FROM IHI



JUNE, 1979

Ishikawajima-Harima

Heavy Industries Co., Ltd.
TOKYO JAPAN

REF. NO. KCT033

Table of ContentsPAGE

1.	Introduction	1 - 1
	List of Reference documents from IHI	1 - 2
	The purpose of the accuracy accuracy control	1 - 3
2.	Review on the present system of	2 - 1
	accuracy control at NASSCO	
	2.1 General view	2 - 1
	2.2 Summaryd of the existing problems.. . . .	2-3
	2.3 Actual problems found an each shop	2 - 6
	and Comment from IHI	
	1) Engineering Department.. . . .	2 - 8
	2) Mold Lofr	2 - 9
	3) Production control	2 - 12
	4) Fabrication.. . . .	2 - 13
	5) Sub-Assembly	2 - 15
	6) Assembly...	2- 17
	7) Erection.....	2 - 19
3.	Recommmdation for the accuracy control from IHI.	3 - 1
	3.1 Establishment of the Quality Control	3 - 2
	Standard off NASSCO	
	3 .2 Establishment of Excess Standard in	3 - 4
	consideration with Shrinkage Allowance	
	3.3 Establishment Of standard for production	3 - 9
	practice and working practice with consideration	
	for the flow of information and data	
4.	Introduction of IHI accuracy control system.....	4 - 1
5.	The expected schedule for the 2nd survey and.....	5 - 1
	implementation at NASSCO	

SURVEY REPORT ON THE PRESENT ACCURACY CONTROL SYSTEM AT NASSCO1. INTRODUCTION

According to the contract concluded between NASSCO (National Steel and Shipbuilding Company) and IMT (IHI Marine Technology Inc.), a survey on the present Accuracy Control system at NASSCO was conducted by two (2) IHI engineers from May 7, 1979 through May 18, 1979. The study was designed to reveal problem that cause interruption in the smooth hull construction process at NASSCO. As the result of this study, and in accordance with the contract, IHI made some effective recommendations.

Due to the coordination and cooperation of NASSCO managers and engineers, the survey was completed successfully.

The following documents are included in this report:

- (1) Review on the present system of the Accuracy Control at NASSCO .
- (2) Recommendation for Accuracy Control from IHI.
- (3) Introduction of IHI Accuracy Control System.
- (4) The expected schedule for the 2nd survey.

List of Reference Documents from IHI

- 1) An extract of the SRAIS (The Shipbuilding Process and Inspection Standard)
Quality Control Standard (Hull Part)
- 2) Management for Hull Construction Defects ("F" series)
- 3) IHI Accuracy Control System (Description) Referred documents:
 - (1) Accuracy Control - Check point, Checking Dimensions, Check Method based on fabrication sequence for Future - 32 bulkers prepared by IHI.
 - (2) Accuracy Control Check Sheet for Future - 32 Bulklers - prepared by IHI.
 - (3) Accuracy Control - The scheme of ~~the Added Materials~~ and Finishing Phase for the Future - 32 Bulklers at IHI.
 - (4) ~~Standard and Tolerance for Keeping High Accuracy at IHI At Shipyard, prepared by IHI.~~
- 4) ~~Hull Block Construction at IHI Kure Shipyard.~~
- 5) ~~Base line to be effective for keeping high accuracy included in the output through engineering and lofting~~

The Purpose of the Accuracy Control

For better understanding, it is necessary to state the purpose and the meaning of Accuracy Control.

IHI considers that Accuracy Control is a system to be supported by all organizations of the shipyard from Engineering, Mold Lofting, Marking, Gas Cutting, Bending, Welding, Sub-assembly, Assembly and Erection. The Accuracy Control system is a series of activities designed to assist the shipyard in constructing high quality ships in a safe manner, at a low cost, with increased productivity. In that sense, the terminology and definition of "Accuracy Control" is distinguished from "Quality Control" or "Quality Assurance" .

Even though there may be many approaches of Accuracy Control, IHI considers that the most important facet in hull construction is to maintain high accuracy in the shape of hull units at the erection stage. In other words, the idea is to minimize work at the erection stage by concerted effort in the preceding phases of assembly, sub-assembly, fabrication and engineering including mold lofting. If the unit is improperly constructed in any one of the previously mentioned phases, considerable rework results at the time of erection. Many of these mistakes will need rework, thereby resulting in hazardous and inconvenient working conditions.

It must be recognized that the accuracy at erection is a result of accuracy in the steps preceding erection, such as marking cutting, bending fitting and welding. Moreover, the Engineering and Production Departments should coordinate their activities to produce more concrete methods and procedures for Accuracy Control.

Most importantly, all the activities for Accuracy Control should be systematically continuous.

CC

2. REVIEW OF THE PRESENT SYSTEM OF THE ACCURACY CONTROL AT NASSCO

2.1 General View

The present system of Accuracy Control at NASSCO was reviewed by two (2) IHI engineers from May 7, 1979 through May 18, 1979. The study covered the Engineering Department, Mold Loft, Production Control and Hull Construction Departments. There were two (2) main points in the survey. One was to obtain facts at the production level which would indicate the results of efforts in preliminary construction phases and the total ability. The other was to understand the "flow of the information and data to indicate how the ships are constructed. "

Many aspects of advanced technology are in Practice, such as the computerized drafting machine; display terminals; NC plasma cutter, welding technology including automatic welding, assembling method on PIN/JIGS and others. Workmanship in the Production Department is considered to be good, if suitable guidance is provided.

However, through the observation of the actual production process during Hull Construction, several problems were found. Some of them are limited to the production practice itself, but ,most of them are related to the present system of communications and information flow from the

Engineering Department, Mold Loft, and Production Control to the Production Department. There are very few written NASSCO ship construction policy standards, and assignment of organizational responsibilities for making, checking and controlling such standards. Written procedures are needed for coordinating the activities between shops concerned with hull construction. ~~Due to the lack of reliable~~
~~data and~~ a formal communication network, the vital data for maintaining high accuracy, such as checking procedures, allowable tolerance, and decisions of excess material, become dependent on personal experience or a method unauthorized by the organization.

With respect to the above, a summary of the general problems and the individual shop problems is presented by the IHI team in the following paragraphs.

2.2 Summary of the Existing Problems

It is believed that almost all of problems found in production are caused **by the following matters:**

1) No written standard data on "excess" *decisions*.

~~No~~ *Written* excess Standard exists

~~to~~ Show *the following* matters:

(1) Why is excess necessary?

(2) Where **is** excess required?

(3) *How* much excess **is** necessary?

(4) **Where is excess** finished up?

For every **ship**, an excess plan for *main strakes* such as **shell** plates is designed by the production planning department, likewise excess is shown for other structure.

However, the excess plan is not governed by any basic written Standard (Philosophy).

Excess **is** now used as a "buffer" to compensate for all errors caused by each phase including *Engineering*. Therefore it is **difficult to find the true cause errors and** a way to improve the methods. "Too much excess" produces "Rough check" **and this** requires "Too much excess".

- (2) No written standard data for shrinkage allowance

The value of shrinkage caused by welding is different due to fabricating method and welding sequence. No clearly recorded for shrinkage or standard of shrinkage considerations exist.

- (3) No clearly written standard for Base lines and Match marks

Though the necessity and importance of Base lines and Match marks is recognized and used, their location and length is required by the Production Department.

- (4) No written checking procedures nor allowable tolerances

It is necessary to establish a checking procedure in order to guarantee precision at each phase. However, no written checking procedures, or allowable tolerances exist. Therefore, there are very few written records of measurement or feed-back.

- (5) No drawn fabrication scheme for assembly

At NASSCO, the fabrication sequence for sub-assembly and assembly is indicated by "Leveling" which is a part of a "piece marking system" and is put into the computer system. This system may be good enough to indicate the simple fabrication sequence for assembly, however, it is not adequate enough to indicate the vital points and vital dimensions for keeping high accuracy in the process of assembly.

(6) Very few written standard practices for work and production

Due to very few standard practices for work and production, the output (result) from each phase cannot be kept in uniform quality. Scarcity in skilled *workers* is a big problem at NASSCO, and limited standard practices accelerates the personnel problem.

(7) Contribution of working drawings to Accuracy Control

Working drawings developed by the Engineering Department show the details of the ship's hull structures and are used by the succeeding phases. The excess is not included in the working drawing. As already described, little guidance is provided to indicate a concrete fabrication method including vital points for measuring high accuracy. Keeping in mind that the working drawing is the only widely distributed official drawing which can display the total requirements of the ship's hull, the working drawing can contribute toward accuracy control by adding necessary information and data.

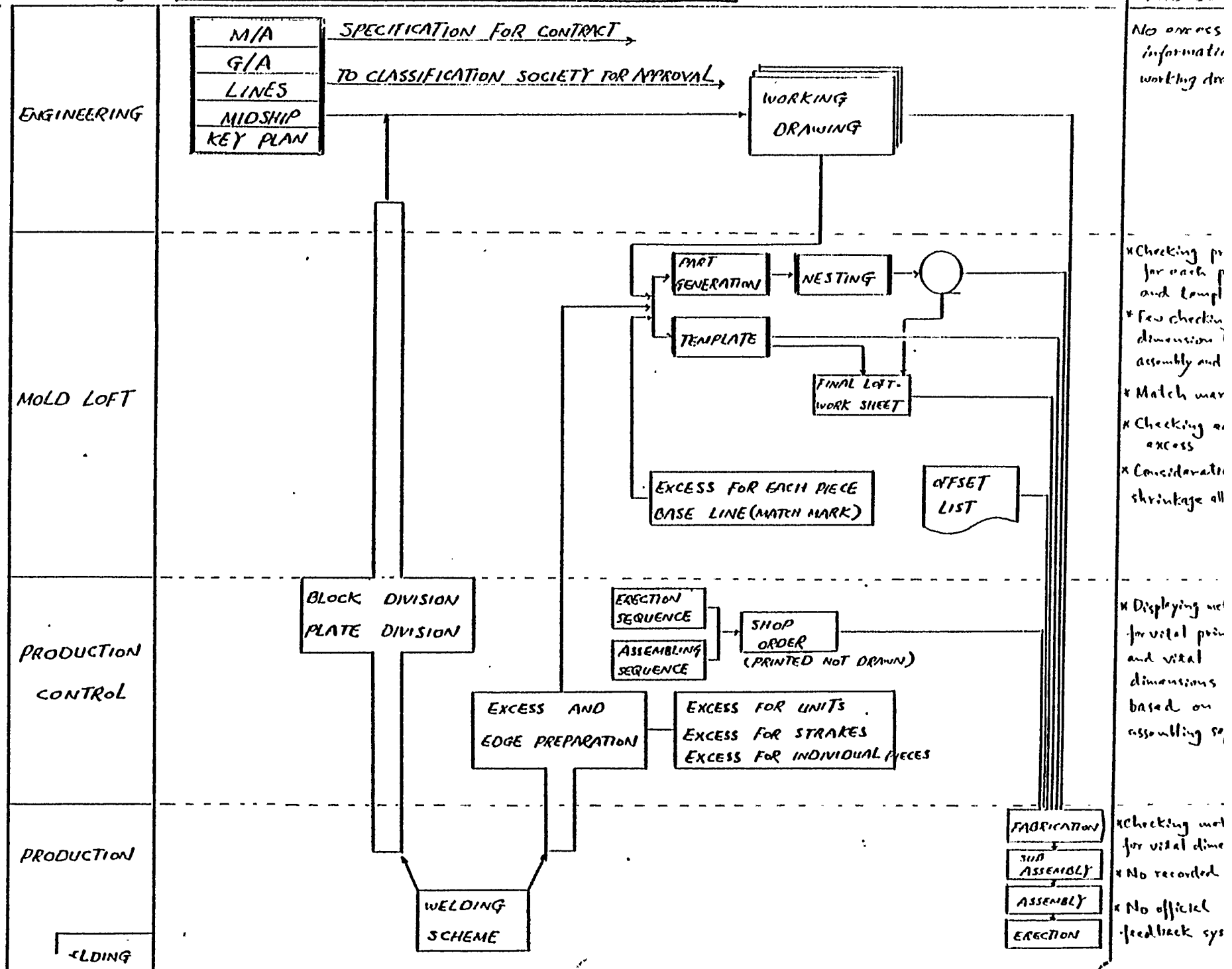
It is not American practice to put manufacturing instructions on a design drawing. Production engineers have this responsibility.

2.3 Actual problems found at each shop and comment from IHI

Through observation and discussions with NSSCO's personnel, the following flow chart of "Eull construction information and data flow" was made by IHI engineers. (See Fig. 1). As shown in Fig. 1, there are some problems at each shop. The common **problem to each shop** is lack of a standard which officially states the exact method for completion of the activities in relation to the other shops. For welding, there are adequate manuals such as "Standard Welding Details" and "process Control procedure for Welding and Repair Welding". Welding is one of the most **vital** aspects for "Quality Assurance".

The Following is a listing of the actual problems found at each shop and comments from IHI.

Fig 1. HULL INFORMATION AND DATA FLOW AT NASSCO



1) Engineering Department

As far as the design function of the Engineering Department in defining the detailed hull structure, there is no problem in particular. However from the viewpoint that the working drawing should define how to construct a unit and how to build a ship, some information is necessary for production such as excess is required in the working drawing. The working drawing is the only **official drawing issued to every shop at present.** Therefore it is recommended that production engineering drawing should be issued showing parts and assembly. **If this information is shown in the working drawing, the checking procedure at each shop should be easily performed using the same media without any contradiction caused by misreading or use of another reference manual or personal judgement.**

2) Mold Loft

By virtue of **its** purposes, the Mold Loft should be the nucleus for Accuracy Control activities. As shown in Fig. 1, most of **tlm** output **used in** actual **production is generated** by the Mold Loft. **Since the shape of** a hull piece is cut out **of material from NC data** and template, the **information** contained therein should guarantee the required accuracy **of a** piece and should include effective data for Accuracy Control .such as shrinkage allowance, base lines (match marks) and allowance for deformation. In other words, such information for production should be provided in advance.

The following problems have been found in the Mold Loft.

Ambiguous checking procedure

-NO specialized checker.

- what **is** the base **for** check?

working drawing is inadequate **for checking necessary data for** accuracy control.

In the case of steel templates for plates assembled at assembly, it should be checked in advance in order to compare the inter-relationships between templates.

- (1) Shrinkage allowance is not considered. Shrinkage at the time of welding cannot be neglected. Even when excess is taken at the plate edge, fitting a web plate to a longitudinal frame, is difficult if shrinkage allowance is not considered at the welding seam between a longitudinal and a plate. In fact, some of cut outs at longitudinals were found to be cut at assembly. This is only one example.

Concerning shrinkage, a recommendation from IHI is made
Lat=-

- (2) Some match marks are unsuitable. Many match marks are involved in the NC tapes and templates. However, those used at assembly were often unsuitable, because match marks punched by NC burning machine are too short for adjustment pieces being used by assembly personnel. It is easy to snap a piece at sub-assembly while connecting marked points, however, it is difficult for workers to know which one should be snapped. In this case, it is recommended that longer marking be accomplished by input to the computer system.

- (3) On the templates, the plate edge is indicated by the designed position, and the excess is gives by numeric *number*.

(Ex 1" → |) Therefore, marking the line **to** be cut to meet **the** excess requirment should be accomplished at the *marking* shop.

It seems *more convenient to* indicate directly the position *of the excess on the templates as well as the* designed position on the plate in order to prevent errors.

- (4) No information such as bridgingg is indicated in the NC data, **and templates, nor is information available for deformation prevention during the cutting procedures.**
- (5) **Very few services are** offered for dimensional checking at asssembly and erection. A full espy of the offset, such as frame *offset*, longitudinal offset and seam offset are issued to the production people; the necessary dimension need to be picked up by the Mold Loft **so that the workers don't have to** pick them up from the offset table themselves. Informed in this area should be provided by the Mold Loft.

3) Production Control

The assembly sequence is decided by production control and transmitted in the form of a "Pieces level" as a part of the piece mark system. This method may be sufficient for the assembling process itself from fabrication through sub-assembly and assembly; however, it is very difficult to indicate the vital dimensions points in order to maintain a high degree of accuracy.

If the fabrication sequence is indicated by a drawing, it would become ~~easier to recall the vital points at the time of survey~~ during ~~the assembly process~~ if the instruction for these vital points can be included in the drawing. This drawing should be **provided as the common base used by each shop to indicate how to proceed** with dimensional checking based on the assembly process. Also the necessary input for NC data and templates can be performed by the Mold Loft referring to this drawing.

4) Fabrication (Gas Cutting, Bending)

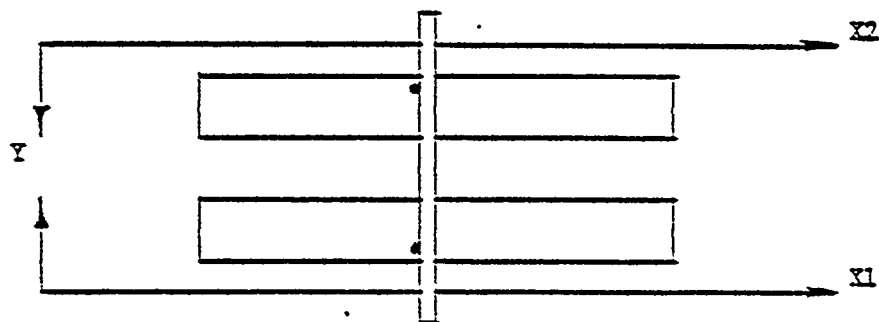
According to the machine operator at the NC burning machine, the results of burning errors are sometimes too obvious to overlook. Checking and maintenance of the machine is being regularly performed and a written record is being accumulated. What should be done now is to record the measured data.

- * During the time of the last survey, two plates were measured as shown in the attachment papers. The error of $1/8"$ in the length of $37' - 6 \frac{5}{6}"$ was detected in a square shaped piece. Another error of $1/8"$ in the length of $86"$ was found in a flange bracket. Those errors are considered to be excessive for an NC machine.

- * Recommended checking procedure.

For reference, IHI's method is introduced as follows:

- For precise checking, a jig with a ball-point pen is attached at the marking torch.
- Perpendicularity check of the torch girder (Y-axis) to the driving railways (X-axis). (Synchronize check).



- o $\Delta X = 15'$ Marking by the ball-point pen or zinc
- o Then $\Delta X = -15'$ Marking
- o Check the discrepancy of the two marked lines
- Checking the rack pinion (lengthwise check)
- o $\Delta X = 15'$ Marking
- o Then $\Delta X = -15'$ Marking
- o Measure the both length marked line
- Check the back lash
- o $\Delta X = 10'$ Marking
- o Then $\Delta X = -C_1$ (cl = 3/8")
- o Measure C_1

(I) **No** countermeasure for deformation by heat torsion are considered.

Briding between pieces is not **considered**.

Pending-cut is not considered. As an example, at the part *where heat* is concentrated, the edge line with cut-cuts must be considered. For a piece with a narrow width, pending-cut is also necessary.

Long strip scrap should be cut in small pieces, because its movement during cutting may cause some deformation.

(2) Frames bent by the method of hammering after heating in the furnace was found to be precise, however many flaws by hammering could be seen.

B. BERTY

5-10-79

COM TO MASTER HEAD

37'-6 3/8"

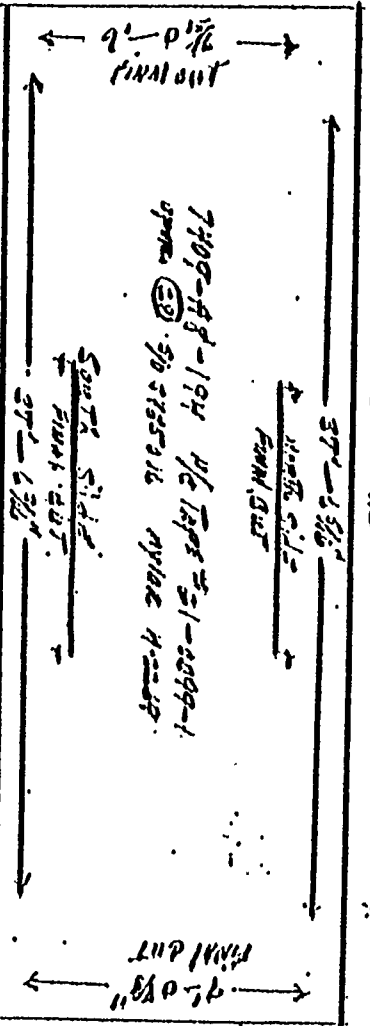
37'-6 3/8"

7409-48-194 1/2 lps 31-0099-1
open (2) 30 3735016 nplac 4-22-49

SOUTH SIDE
FINAL CUT

37'-6 3/8"

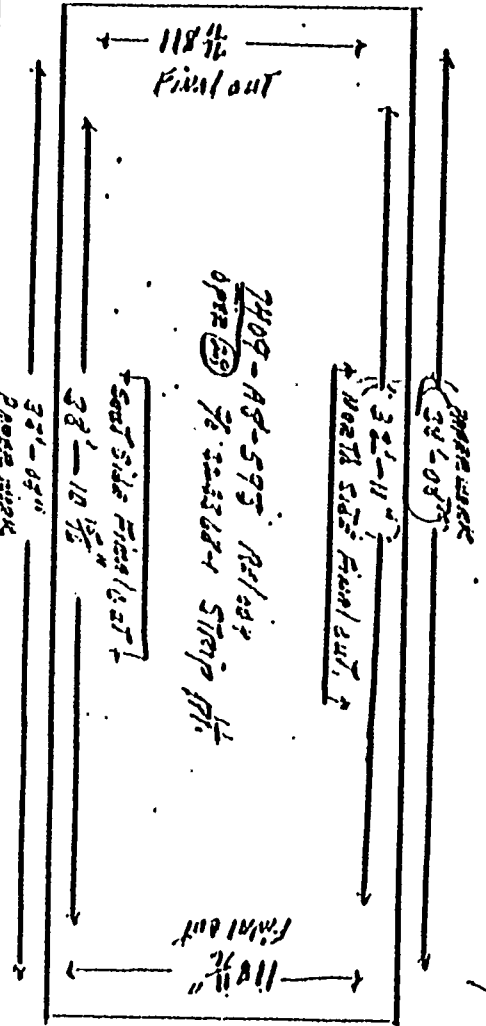
WAST END
REAL MAP
9'-0 1/4"



FINAL CUT
REAL MAP
9'-0 1/4"

(1)

BUTT 9/8
WAST END, PAPER WORK
118 3/8"



FINAL CUT
WAST END, PAPER WORK
118 3/8"

BRKTS

Machine cuts
8441

36"

36"

[10-338 (516)]

[10-334 (516)]

Machine cut
(36")

[10-335 (516)]

[10-334 (516)]

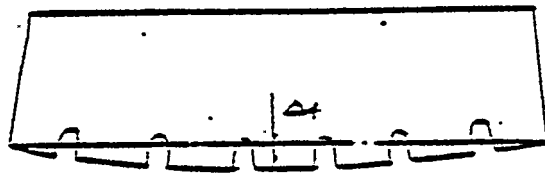
36"

Machine cut
33"

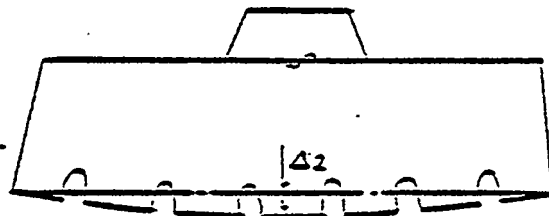
5) sub-Assembly

- (1) **When** welding, shrinkage **allowance is** not considered.

shrinkage and deformation due to **butt welding** of plates **and** fillet welding **stiffeners** to the web plate cannot be neglected. Actual shrinkage and **deformation was found as shown in the** sketches below, which was recorded during our stay. Another deformation was found in the other *web* plate.



$\Delta 1 = 1/4"$
Measured after
gas cutting



$\Delta 2 = 3/4"$
Measured after
plate welding

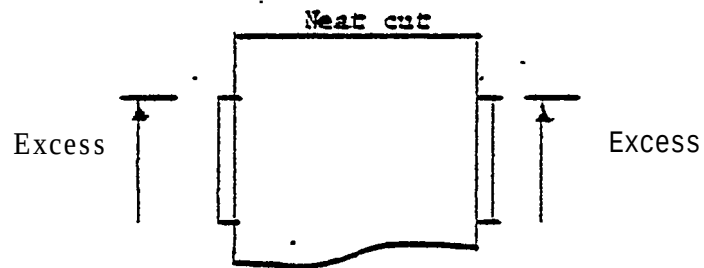
As shown in the above figures, deformation of 1 (1/4") is presumed to be occurring during gas cutting because there is no bridging at the edge of cutouts. Deformation of 2 (3/4" ... 3/4" - 1/4" = 1/2") was obviously caused by plate welding. If this sub unit is sent to assembly without reformation, fitting this web to longitudinal frames and skin plate is not easy; the cutouts will often need to be cut.

In order to prevent this deformation, the following alternate method is effective.

Welding plates before NC gas cutting

After fitting all face plates and stiffeners to the plate, welding follows.

(2) Some excesses were found to be inconsistent.



of course, this is not the responsibility of sub-assembly. The problem lies in the fact that the inconsistency is not found until subassemblies are assembled. The inconsistency is not noticeable because the drawing does not detail the excess and the only place the information can be found is the NC data or on the template.

6) Assembly

- (1) When welding, shrinkage allowance is not considered.
- (2) Match marks marked in advance are not suitable. The match marks are too short and placed intermittently, therefore fitting is not easy **because the previously fitted structures hide it. A consideration** for this problem necessary, as described in 2) of this paragraph.
- (3) There is no written checking. procedure or idea of the vital **dimension.**
- (4) Assembling curved **shell** unitj on PIN/JIG
 - The foundation of PIN/JIG is poor.
 - Supporting jigs are not set normally. (*perpendicular to pin?*)
 - Positioning of **places is very rough.**
 - Dimensions to be checked are not **prepared. in advance.**

The diagonal length of **a unit is** not prepared by Mold Loft.

(5) Lap connection between Longitudinals and stiffeners on a web.

Even in the parallel body, lap connection is adopted to compensate for the errors and misalignment. Lap connection is unsuitable from the viewpoint of strength at the connected part or for saving man power in welding.

(5) (Continued)

Taking into account the workmanship at NASSCO, it will not be difficult to change the method to butt and simple fillet *Welding*.

~~Introduction of IHI's experience on this~~ subject is significant. When IHI decided to abolish the lap connection more than 6 years ago, objection from production people, especially cially veteran foremen, occurred. However, no particular problems came about through the change.

7 Erection

The shipwright method performed at NASSCO is much the same as IHI's method. A *shipwright* report is written both at the beginning and end of production (see the attached paper). However, since no written standard practice exists, the shipwright must depend on the experienced personnel. If the standard practice is written, technical transfer to the less experienced personnel will be facilitated.

One more problem is that the necessary dimensions for checking are not prepared by Mold Loft but calculated or derived from the off-see table printed by erection personnel. It is recommended that this data should be prepared by the Mold Loft.

②

SHIPWRIGHT REPORT

3-1

LOWER INNER SEQ A2-2

S/

HULL - 7409



39' BTK

BEGINNING PRODUCT

FR 61

3/8

3/8 CUT

FR 63

3/8

3/8 CUT

FINAL PRODUCT

FR 61

3/16 IN

3/16

3/16 CUT

FR 62

3/16 IN

3/16

3/16

3/16

3/16 CUT

3. RECOMMENDATION FOR THE ACCURACY CONTROL FROM IHI

Cancerning the **present Accuracy Control system** at NASSCO, the **problems** described **in** the **previous chapter** can be categorized into the **following** three (3) **areas:**

- 1) Quality Control **Standard.**
- 2) *Excess Standard in consideration* with Shrinkage Allowance.
- 3) *Standard for production practices* and working practices considering the flow of information and data.

The following are recommendations on the subject **from IHI**. Some **IHI** documents are referred to in connection with the recommendation.

3.1 Establishment of the **Quality** Control Standard of NASSCO

*The first recommendation from IHI is to **establish a Quality Control Standard**. It should indicate the allowable tolerance levels in keeping with the effort and cooperation of every phase of the production process. Also it should indicate corrective action in case an error exceeds the allowable limit. The Quality Control Standard covers the basic item of errors that occur in every phase of the production process. On special cases, supplemental additional description is necessary. It therefore follows that the Quality Control Standard be called ~~the~~ **"Constitution of Quality Control"**.*

*Since the **Quality Control Standard indicates the allowable limits** a managing **method for errors**, it can be said that the **Quality control Standard** describes the potentiality of Quality Assurance at **NASSCO**. Upon introduction to the shipyard, Quality control Standards can be the **goal** of NASSCO activities. Through accumulation of the measure data for Quality Control, the potentiality and ability of Hull Construction at NASSCO should be visible.*

After establishing this system, it can be referred to at any time or any place as the base of Hull Construction, through which the study improvement can be widely developed. In addition, if this standard approved by the classification society in total, it becomes unnecessary to be approved every time a new contract is signed.

3.1 Establishment of the Quality Control Standard of NASSCO (Continued)

IHI has established a similar standard called SPAIS (The **Shipbuilding Process** And Inspection Standard). Some revisions are issued every year **after authorization by the classification societies** and by the ship owners.

The following documents of IHI are attached for reference.

- (1) **An extract of the** SPAIS (The Shipbuilding Process And Inspection Standard) Quality Control Standard (Hull Part)
- (2) Management **for** Hull **Construction** Materials **Defects**. ("F" series).
This **is to indicate** the the procedure for hull construction of the "F-series" ship.

3.2 Establishment of Excess Standard in consideration with Shrinkage Allowance

Excess is one of the most essential factors to consider in the dimensional control of hull construction. Excess as a necessity should be deeply studied from the data and the experience of the shipyard. At present, excess is used to compensate for all errors which occur through the production process, and excess is always set at the edge plate. However, excess used to compensate for the shrinkage when welding is very important for maintaining precise shapes of the total ship. It is necessary to take into consideration the excess at the stiffener/ longitudinal frame space to compensate for shrinkage while welding as well as at the edge of plate.

The method of handling excess at IHI is briefly presented as follows

1) Element of shrinkage

Shrinkage occurring through the production process can be classified into the following elements.

(1) Corrective action to maintain the shape of ship at erection

Shrinkage allowance for welding joints and reforming by line heating are defined through the experience.

1) Element of shrinkage (Continued)

(2) Allowance for fillet welding (A):

There should be a shrinkage allowance for fillet welding between ~~internal~~ members **to the** skin plate. The shrinkage is caused in the direction normal to the welded line.

(3) Allowance for reforming by line heating after assembling (3):

There should be a shrinkage allowance for reforming by line heating which is treated on the opposite surface of the skin plate along the welded internal members after assembly. The shrinkage is caused in the direction normal to the welded line.

(4) Allowance for welding plate (E):

There should be a shrinkage allowance for welding plates in a block.

(5) Allowance for fillet welding at the internal member (a):

There should *be* a shrinkage allowance for fillet welding between stiffeners, such as flat bars and brackets, and a web plate.

(6) Allowance for reforming by line heating after sub-assembling (b):

There should be a shrinkage for reforming by line heating which is treated on the opposite surface of a web plate along the welded stiffeners.

1) Element of Shrinkage (Continued)

(7) Allowance for welding plates (a):

Shrinkage allowance for welding plates in an internal member

(8) *other elements*

shrinkage allowance for **welding** and heating in a piece or block with a special shape.

2) Excess treatment

There are two (2) practical ways to handle excess derived from shrinkage allowance as listed above.

(1) Undivided whole excess at the edge of a block or a sub

The total excess required is set at the edge of a block or a sub without division. This method facilitates the dimension at the marking phase, however, spacing of longitudinal frames of the fabricated block become different from the designed.

(2) Separately distributed excess

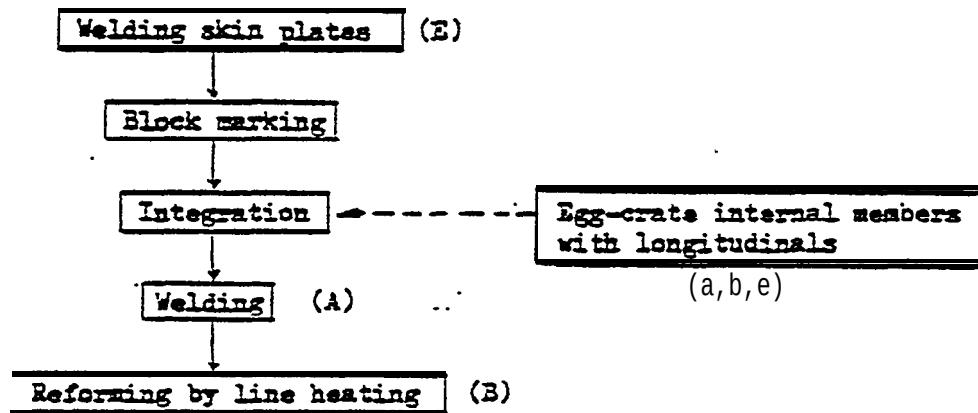
Corresponding to the characteristics of shrinkage, excess separated and distributed to the spacing of longitudinal members as well as the plate edge.

This method makes it possible to fabricate a block or a sub in the exact dimension as designed, however it is not easy to determine the dimension at the marking phase.

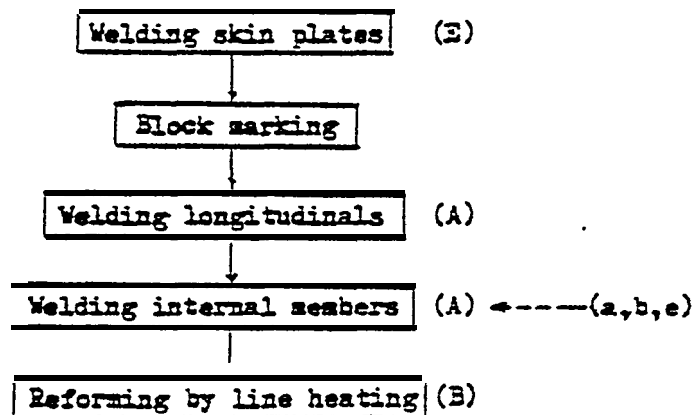
3) **Excess treatment to be matched with the assembling method**

Assembling method can be divided into the following two (2) categories. One is the egg-crate method. The other is the method of pre-welding longitudinal frame to the plates.

Egg-crate method



Pre-welding longitudinals to the plate



As shown in the above flows, the fabrication sequences (welding sequences) are different from each other.

This means that the shrinkage by welding results in the different sequences. Therefore in order to prevent gaps, it is necessary to allow the required excess at the connection part of the skin plates the internal members and the **longitudinals.**

In addition, the inter-relationship between the skin plates and the internal members should be reinforced.

There are **four methods** for distributing **shrinkage** taking **into** consideration the excess treatment **method** and the fabrication **method** as shown below.

Fabrication Method Excess Treating Method	Egg-crate Method	Pre-welding Longitudinal
Undivided whole excess at the plate edge	For: <u>skin plate</u> <u>internal mem-</u> <u>bers</u>	For: <u>skin plate</u> <u>internal mem-</u> <u>bers</u>
Separately distributed excess	For: <u>skin plate</u> <u>internal mem-</u> <u>bers</u>	For: <u>skin plate</u> <u>internal mem-</u> <u>bers</u>

3.3 Establishment of a Standard for *production practice* and *working practice* considering the flow of information and data

The two (2) standards previously recommended are said to be fundamental functions and data which should be used by all organizations of the shipyard. On the other hand, the third recommendation is to establish the concrete standard practices at NASSCO, which will define the goal and improve quality potential.

To establish the standard practices for each shop, the role of each must be clearly reviewed in the production process flow, that is, the input and the output should be clear. The necessary data and information to obtain high accuracy in a shop should result from the output in its preceding phase.

As described before, workmanship at NASSCO is considered to be satisfactory. The problem is that the potentiality depends on personal experience since the practices are not written at this time. If the practice is written into the standard with some improvements, a uniform quality can be maintained by different personnel, therefore training new personnel becomes much easier.

1) production standard practice

Each shop has its own standard practice.

(1) Standard Practice for working drawing.

(2) Standard Practice for Mold Loft

1) Production practice standard (Continued)

(3) Standard Practice for Fabrication

(Marking, Burning, Bending)

(4) Standard practice for Assembly

(5) Standard *Practice* for Shipwright

(6) Standard practice for welding

Standards should not contradict each other should be maintained or revised, if necessary, when a fabrication method is improved.

2) The contents Of **the standards**

~~The~~ contents of be the standards are as follows:

- (1) Check points
- (2) Checking dimension
- (3) Checking method
- (4) Allowable tolerance
- (5) Checking procedure for jigs and machinery
- (6) Feedback and treatment

3) **An example for assembly****(1) For a flat block (Skin plate)**

- Plate arrangement (positioning, Match mark)
- Welding (Misalignment, Gap)
- Block marking (Diagonal length, width, straightness)
- Opening holes

3) An example for Assembly (Continued)

(2) For a curved shell block

- Supporting jig (Normality, Height)
- Plate arrangement (Jig position)
- Datan line for joint
- Block marking (Four edges Diagonal length)
- Opening holes

(3) For fitting

- Eliminating welding bend **at** the cross **point of** joints and internal structures
- Gas cutting (**Gas** notch, Roughness, Cheek line)
- Edge point **of** webs
- Edge **point of** frames
- Fitting angle, of webs **agaisrt** the skin plate
- Fitting angle **of** frames against the skin **plate**
- **Fitting** collar plate
- **Misalignment** and gap **at the cross point of**
 internal members

(4) Grinding u p

- **Wrong** bend
- Bead at temporary piece **for** fitting

3) An example for Assembly (Continued)

(5) Reforming by like heating

- Connecting part **at the edge of** block
- *Burning* tamperature
- Location

(6) Finished up

Concerning the **above**, the actual examples from IHI shall be presented
in the next chapter.

4. INTRODUCTION OF IHI ACCURACY CONTROL SYSTEM

In order to clarify the **procedure** of Accuracy Control, the **IHI** Accuracy Control System is introduced as one of the actual examples. The following flow chart indicates a total scope of the IHI Accuracy Control System (see Fig. 2).

As shows in the flow the following items are clearly defined.

- (1) Working flow from Basic Design through production process.
- (2) Connection between working flow and organization.

(3) Location and role of the standard

SPAIS The Shipbuilding Process And Inspeition **Standard**
 Excess Standard.
 Working **Practice** Standard

(4) Accuracy Control data for the actual ship

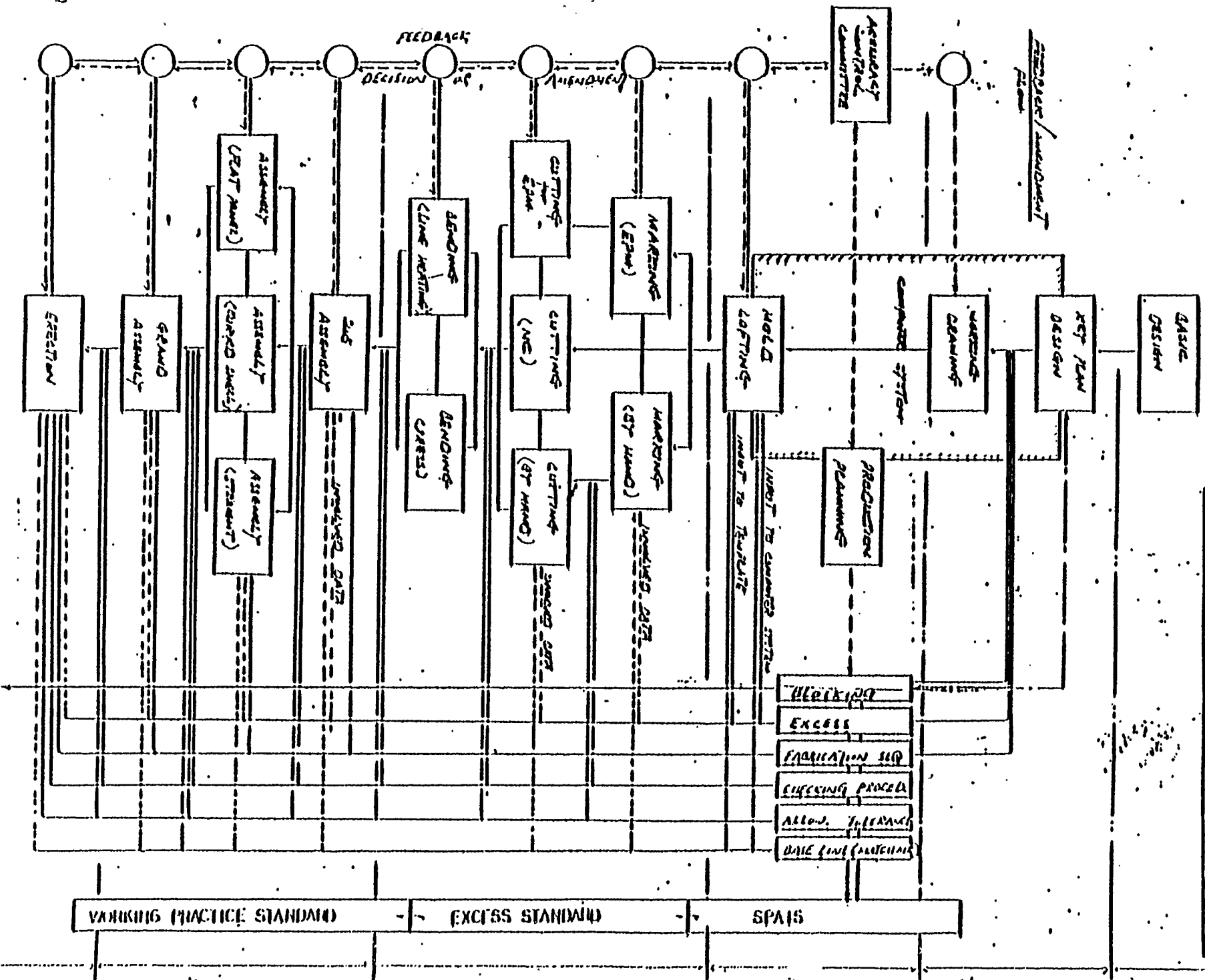
- **Blocking** (Block division)
- **Excess**
- **Fabricacion** sequence
- **Checking** proced-
- Allowable tolerance
- Base line (March mark)

These data are defined and ~~administared~~ by production planning uader the authorization of the Accuracy Control Committee.

(5) Where and how are those information recorded and distributed?

(6) Feedback/Amendment flow

Fig. 2 INFORMATION FLOW OF THE DESIGN CONTROL SYSTEM



A detailed description on the IHI system is presented in the follow documents:

(1) "IHI Accuracy Control System"

The following are referenced in the above document.

- 1) Accuracy Control - Check points, Checking Dimension, Check Method based on Fabrication sequence future - 32 bulkers prepared by IHI.
- 2) Accuracy Control Check Sheet for Future - 32 Bulklers - prepared by IHI.
- 3) Accuracy Control - The Scheme of the Added Materials and Phase for Finishing up for the Future - 32 Bulklers at IHI AIOI-Shipyard, prepared by IHI.
- 4) Standards and Tolerances for Maintaining High Accuracy at AIOI-Shipyard, prepared by IHI.

* Hull Block construction in Kure Shipyard of IHI.

* Base Line effective for maintaining high accuracy included in the output through engineering and lofting.

5. THE EXPECTED SCHEDULE FOR THE 2ND SURVEY AND IMPLEMENTATION AT NASSCO

The following is the proposed schedule for implementation of Accuracy Control and the 2nd survey at NASSCO.

* 1st week - 2nd week

~?l=atioxl of IHI's report on the 1st Survey.

* 2nd week - 3rd week

Discussion and reconciliation of recommendation from IHI.

* 4th week - 6th week

Detailed survey at each shop to document (learn) the A.C. activities.

it appears to be. easier to start from the actual activities than preceded with the study on the basic standard. Through the three-weeks study, NASSCO can draft up its own basic standards referring to IHI's standard.

AN EXTRACT OF THE SPAIS OF IHI
The Shipbuilding Process And Inspection Standard)
QUALITY CONTROL STANDARD
(Hull part)



JUNE, 1979

ishikawajima-Harima
Heavy Industries Co., Ltd.
TOKYO JAPAN

REF. NO. KCT034

QUALITY CONTROL STANDARD

(HULL PART)

I.H.I. KURE SHIPYARD

QUALITY CONTROL DEPARTMENT

G. Kade

① MAR. 31. 1977

品質管理課 船体部 船体組

H. Amami

1
2
3
4
5
6
7
8
9
10
11
12

INTRODUCTION

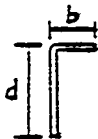
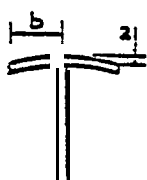
All newbuilding I.H.I Kure shall be constructed and inspected in accordance with "Quality Control standard".

It is the intent of this standard to supplement "shipbuilding Process and Inspection Standard" which is established by I.H.I.

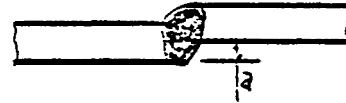
INDEX

Gas cutting (Notch)	2
Fabrication	3
Misalignment in butt joint	4
Misalignment in fillet Connection	5
Gap between butt weld edge	6
Gap between members in T connection and penetrations	7
Gap of laps between members	8
Gap of laps between beams & frames	8
Breadth of lap joints	8
Under-cut in welding	9
Shape of welding beam	9
Other welding item	10
Deformation	11
Distorsion & straightness (Curvature)	12
Line heating method	13

Fabrication

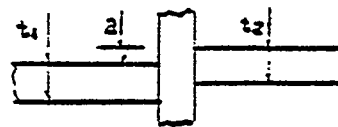
Item	Allowable limit	Remarks
1. Size of Member		
1) General members, compared with correct sizes.	+ 5.0	
2) Especially for the depth of floor and girder of double bottom compared with correct sizes.	+ 4.0	
3) Breadth of face bar, compared with correct size.	-3.0~+4.0	
2. Size		
1) Flange section		
	$b : \pm 5.0$ $d : \pm 5.0$ $(d : \pm 3.0)$	The bracketed ones show the case where strength is especially required. (e.g. longitudinal members, etc.)
2) Built-up section		
	b : nominal breadth -2 d : nominal depth ± 2	
3. Angle		
1) Flange section		
	± 4.5 $\frac{100}{100}$	compared with template
2) Built-up section		
	$a \leq \pm (3 + \frac{b}{100})$	

Misalignment in butt joint



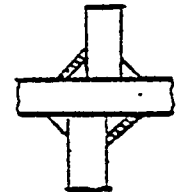
Item	Allowable limit	Remarks
1. skin plates (Bottom shell, side shell & deck plate) and longitudinal strength members	$a \leq 0.15 t$ ($\therefore \text{max} = 3.0$)	1. When 'a' exceeds that allow limit, the butt shall be rea the butt shall be realigned and reinforcement shall be done by welding or by using gusset plates or by using other means as approved by the classification society.
2. Bulkhead plates and interior members (including face plate)	$a \leq 0.2 t$ ($\therefore \text{max} = 3.0$)	2. When 'a' exceed the allowab limit, the reinforcement by welding shall be done or th plate shall be realigned af mutual discussion among bui buyer and classification so

Misalignment in fillet connections

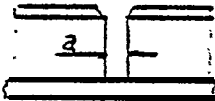
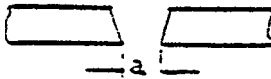


Where $t_1 \geq t_2$

Item	Allowable limit	Remarks
1. For main structures	$a \leq 1/3 t_2$ <u>In case</u> 1) $1/2 t_2 \geq a > 1/3 t_2$ 2) $a > 1/2 t_2$	When 'a' exceeds the allowable limit, following treatment shall be applied. 1) Weld leg length shall be increased by 10 %. 2) The member shall be re-aligned.
2. For others	$a \leq 1/2 t_2$ <u>In case</u> 1) $a > 1/2 t_2$	The member shall be realigned or fitted with backing strip.

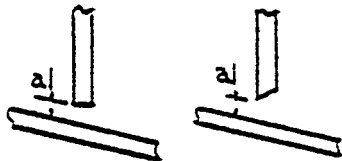


Gap between butt weld edge

Item	Allowable limit	Remarks
1. Butt weld plates 	$a \leq 5$ <u>In case</u> 1) $5 < a \leq 16$ (When PL. thick ≥ 10) $\Delta 5 < a \leq 10$ (When PL. thick < 10) 2) $25 \geq a > 16$ (When PL. thick ≥ 10) $\Delta 15 \geq a > 10$ (When PL. thick < 10) 3) $a > 25$ (When PL. thick > 10) $\Delta a > 16$ (When PL. thick < 10)	When 'a' exceeds the allowable limit the edges shall be treated as follows: 1) The edge shall be built up by welding with a backing strip, and then back welding shall be done after removing the backing strip and after back chipping.  2-a) When the renewal of a longitudinal member is necessary, the section renewal shall be decided by case, with the agreement of the buyer and the classification society. For the other members, the width of at least 300mm shall be renewed. 2-b) If 2-a is not applicable, the edge shall be built up by welding, and then the butt shall be welded.  3) The members shall be partially renewed in the same way as specified in above paragraph 2-a.
2. Butt weld of sections 	$a \leq 5$	When 'a' exceeds the allowable limit the gap shall be treated in the same way as the butt weld plates.
3. CES welding 	$17 \leq a \leq 40$ <u>In case</u> 1) $40 < a \leq 40 + t$ 2) $a > 40 + t$	When 'a' exceeds 40mm, the gap shall be treated as follows: 1) The edge shall be built up by welding. 2) The plate shall be partially renewed.
4. Electro gas welding 	$10 \leq a \leq 30$ <u>In case</u> 1) $30 < a \leq 30 + t$ 2) $a > 30 + t$	When 'a' exceeds 30mm, the gap shall be treated as follows: 1) The edge shall be built up by welding. 2) The plate shall be partially renewed.

Gap between members in T connection and penetrations

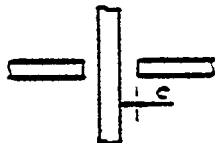
1. T connection



- 1) $3 < a \leq 5$ 1)
- 2) $5 < a \leq 16$ 2)
- (When PL.thick ≥ 10)
- Δ $5 < a \leq 12$

- 3) $a > 16$ 3)
- (when PL.thick ≥ 10)
- Δ $a > 12$
- (when PL.thick < 10)

2. Members penetrating through bulkhead plates



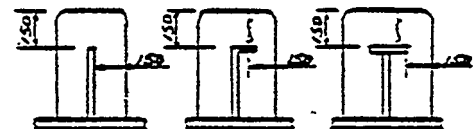
C or $Cl \leq 3$

In case

- 1) $3 < C$ or $Cl \leq 7$ 1)

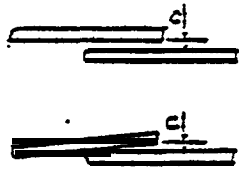
When 'C' or 'Cl' exceeds the allowable limit, the slot shall be treated as follows.

- 2) C or $Cl > 7$ 2)

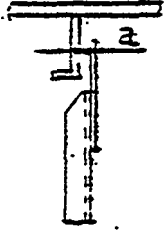


If the penetrating members are designed with a lapped collar plate, the collar plate shall be replaced.

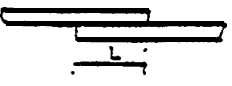
Gap of laps between members

Item	Allowable limit	Remarks
3. Lap weld 	$c \leq 3$ <u>In case</u> 1) $3 < c \leq 5$ 2) $5 < c$	When 'c' exceeds the allowable limit, following treatment shall be applied. 1) Weld leg length shall be increased by 'c' mm. 2) The member shall be realigned.

Gap Of laps between beams & frames

Item	Allowable limit	Remarks
	$a \leq 3$	When 'a' exceeds the allowable limit, the members shall be realigned.

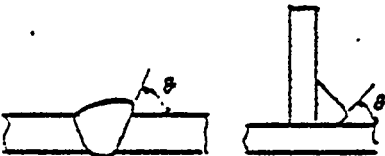
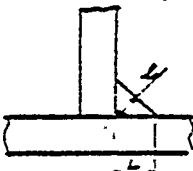
Breadth of lap joints

Item	Allowable limit	Remarks
Breadth of lap 	L=rule requirement <u>In case</u> 1) Shortage of lap $\leq t$ 2) Shortage of lap $> t$	When 'L' is less than the rule requirement, the joint shall be treated as follows. 1) The edge shall be built up by welding where the lap is short. 2) The plate in shortage of lap shall be partially renewed or if applicable, the joint may be modified to a butt joint.

Under-cut in Welding

Item	Allowable limit	Remarks
1. For butt welds		
a) For main structures within 0.6L $\bar{E}$ (skin plate, longitudinal member and principal transverse supporting members)	max depth: 0.5mm (length of more than 90mm)	When under-cut exceeds the allowable limit, the under-cut shall be filled up by weldings. However, the filled up welding shall not be ground off.
b) For other members	max depth: 0.8mm	
2. For fillet welds	max depth: 0.8mm	

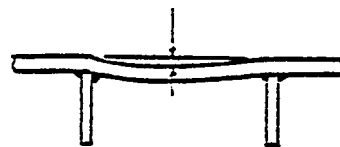
Shape of welding bead

Item	Allowable limit	Remarks
1. Height of reinforcement	not defined	
2. Breadth of bead	not defined	
3. Flank angle	$\theta \leq 90^\circ$	In case where θ is over 90° , it is to be repaired by grinding or welding to make $\theta \leq 90^\circ$.
		
4. Leg length	L : leg length l : throat depth $\geq 0.9L$ $\geq 0.9l$ 	In case where it is over tolerance limits, weld up over it.

Other welding item

Item	Allowable limit	Remarks
2. Short bead		
1) Higher tensile steel (50 kg/mm ² class)	≥ 50 mm	In case where short bead is used unavoidably, preheating is neces at 100 ± 25°C.
2) Mild steel	not defined	When short bead is made erroneous remove the bead by grinding, and weld over 50mm after checking roo crack or heel crack.
2. Arc strike Higher tensile steel (50 kg/mm ² class) and grade E steel of mild steel	prohibit arc-strike	In case where arc-strike is made erroneously, one of the following repair method is applied. 1) Weld over 50mm bead on the arc-strike. 2) Remove the hardened zone by grinding. 3) Apply post heating at 350 - 650

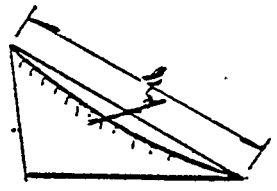
Deformation



Division	Item	Allowable limit mm
Shell plate	Parallel part side shell	6
	Parallel part bottom shell	6
	Fore and aft part	7
Double bottom tank top plate		6
Bulkhead	Longitudinal bulk-head	7 (t ≤ 3
	Transverse bulkhead	8 (t :
	(Swash bulkhead)	8
Strength deck	Parallel part (between 0.6 L B)	6
	Fore and aft part	8
	Covered part	9
Second deck	Bare part	8
	covered part	9
Fore-castle deck Poop deck	Bare part	6
	Covered part	9
Super-structure deck	Bare part	6
	Covered part	9
House wall	Outside well	6
	Inside Wall	6
	Covered part	9
Web of girder and trans		7
Floor & girder in double bottom tank		7

Distorsion & Straightness (Curvature)

with angle?

Item	Allowable limit	Remarks
1. Distorsion of beams, frames or stiffeners (per L Span)	1) $\delta \leq 7$ 2) $\delta \leq (5 + \frac{2\ell}{1000})$ 3) $\delta \leq 12$	1) When $\ell \leq 1000$ 2) When $1000 < \ell < 3500$ 3) When $\ell \geq 3500$
2. Distorsion of girder and long. (per 1 span)	1) $\delta \leq 5$ 2) $\delta \leq (3 + \frac{2\ell}{1000})$ 3) $\delta \leq 10$	1) When $\ell \leq 1000$ 2) When $1000 < \ell < 3500$ 3) When $\ell \geq 3500$
3. Straightness in the plan of flange and web	± 25 (per 10m length)	
4. Tr. BKM & stiff. with web (when free edge)	$\delta = \ell \times \frac{8}{1000}$ (max. 12)	
5. Pillar (between deck)	1) $\delta = 6$ 2) $\delta = \ell \times \frac{1.2}{1000}$ (max. 12)	1) When $\ell \leq 5.000$ 2) When $\ell > 5.000$ 

Line heating method

Kind of steel	Max. permissible temperature	Max. temperature for commencing w. cooling	Remarks
Mild steel	900 °C	850 °C	Air cooling and water cooling
H. Z. steel	900 °C		Air cooling
	900 °C	500 °C	Water cooling
	650 °C	650 °C	Water cooling

MANAGEMENT FOR HULL CONSTRUCTION MATERIALS DEFECT
("F" series ship)



JUNE, 1979

Ishikawajima-Harima
Heavy Industries Co., Ltd.
TOKYO JAPAN

No . KCT035

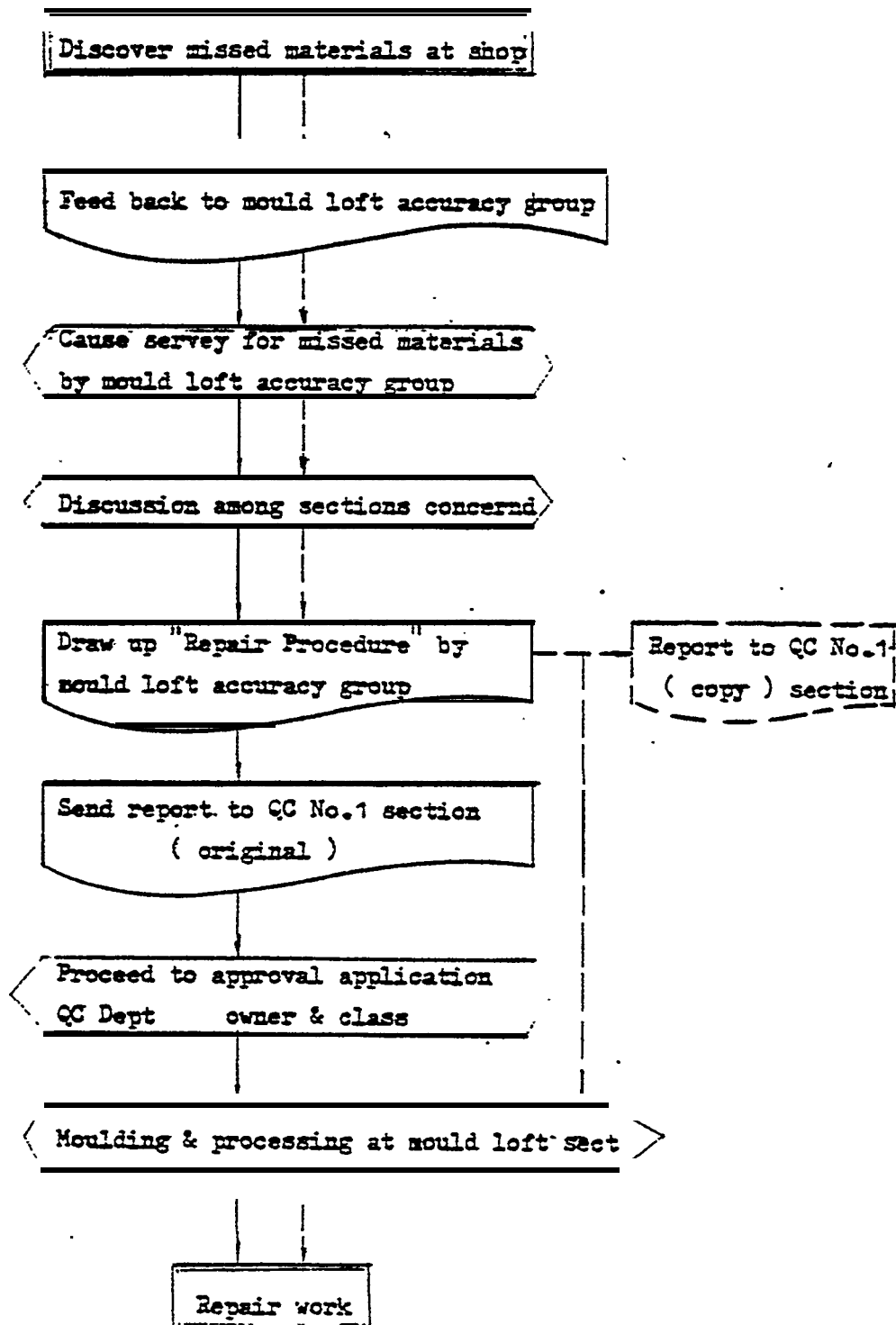
CONTENTS

Management for Hull Construction Materials De fects	1/11
• <i>Management</i> Flow Chart for miss-manufactured Materials	2/11
Repair Procedure for Hull Construction Materials	3/11

Management Flow chart for Miss Manufactured Materials

→ :Material to be approved

--> :Other Materials



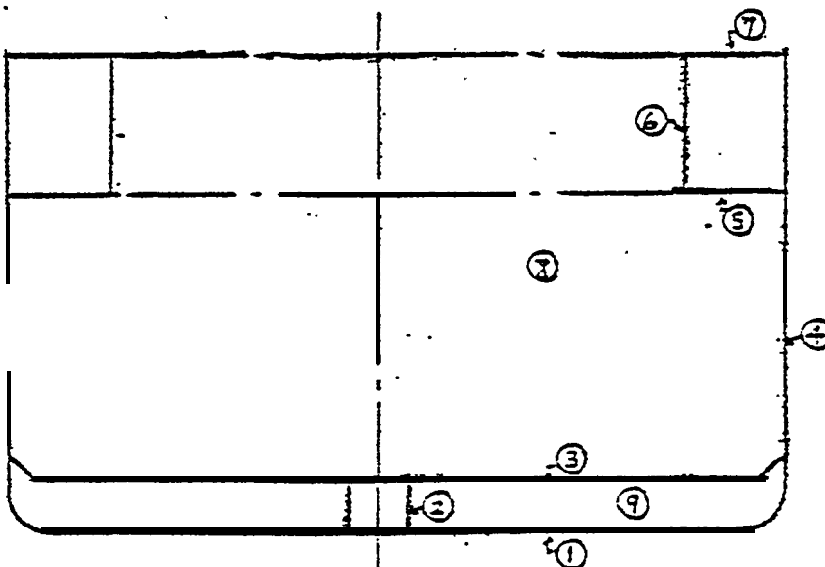
Management for Hull Construction Materials Defects

("F" Series)

- 1) As for repair of defect, The area necessary for approval by the owner and classification society will be shown in the following sketch. (Item ① ~ ⑨)
- 2) The defective materials of the area except mentioned at should be repaired in the yard side according to " Reps procedure for hull construction materials "

The area to be repaired after approval

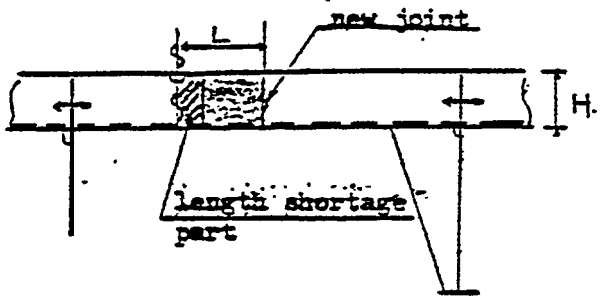
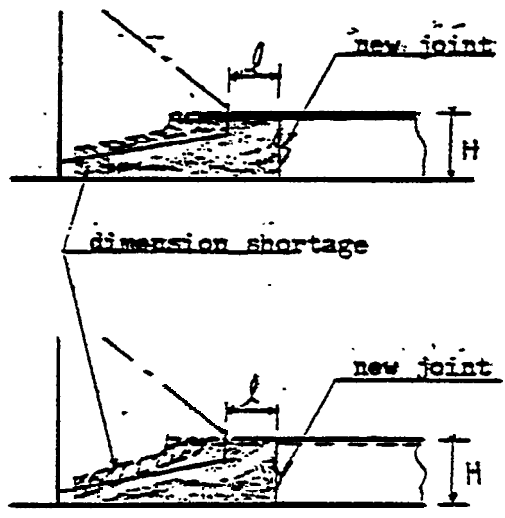
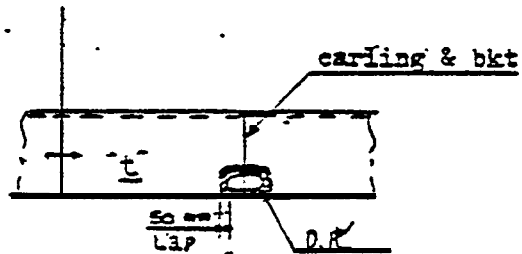
- ① --- BOTTOM SHELL & BILGE SHELL
- ② --- LI W.T GIRDER
- ③ --- DOUBLE BOTTOM
- ④ --- SIDE SHELL
- ⑤ --- RETRACTABLE TWEEN DECK
- ⑥ --- LII HATCH SIDE GIRDER
- ⑦ --- UPPER DECK
- ⑧ --- TRANSVERS B&B
- ⑨ --- W.T FLOOR

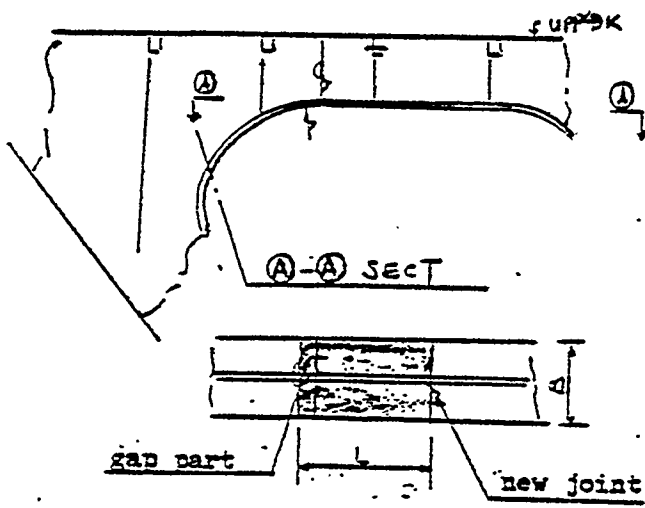


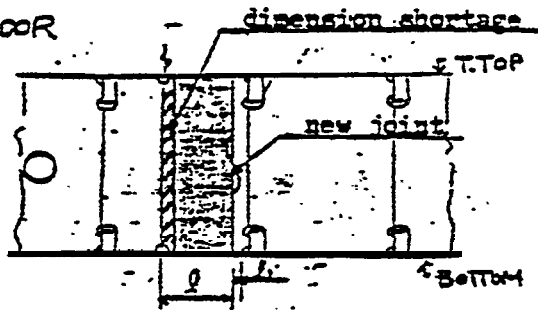
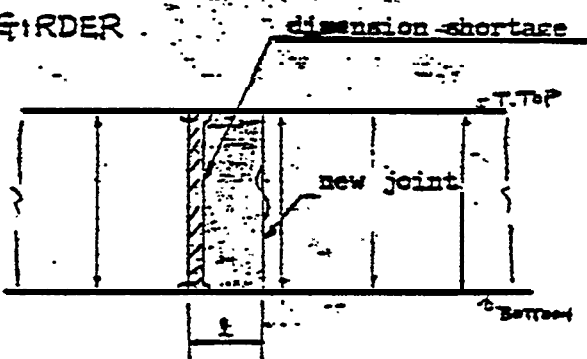
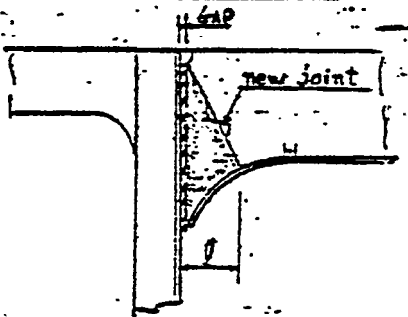
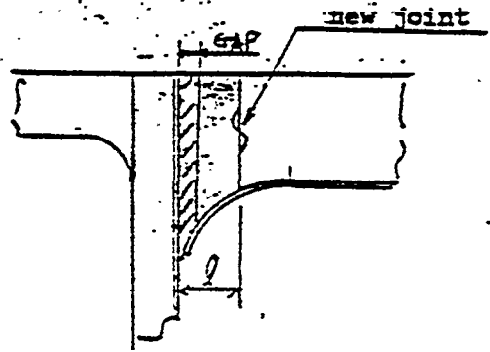
SECTION MANAGER OF
No.1 QUALITY CONTROL SECTION

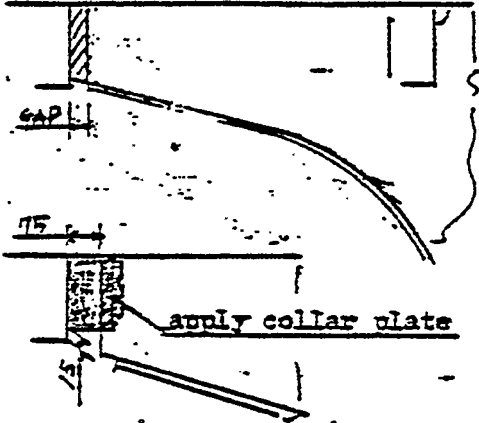
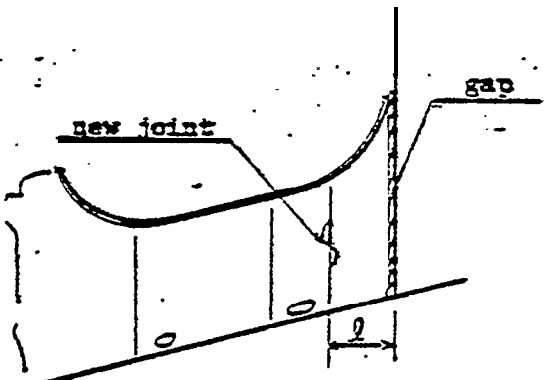
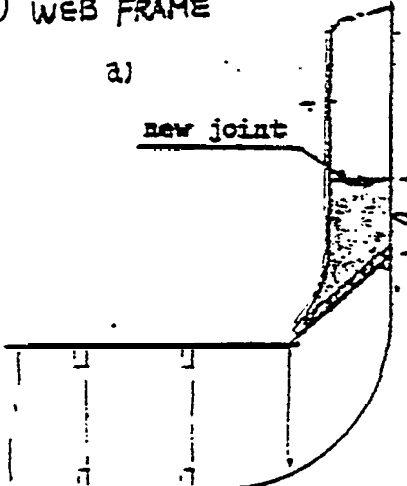
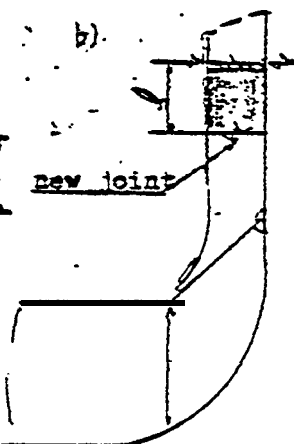
[Handwritten signature]

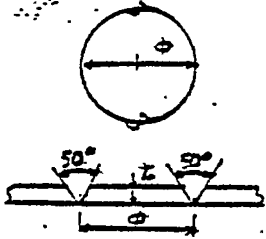
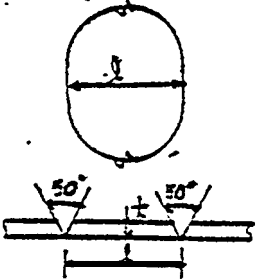
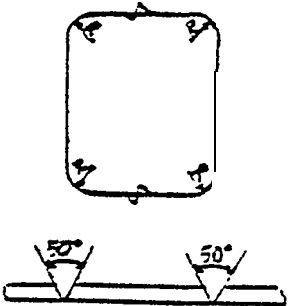
Repair procedure for hull construction materials

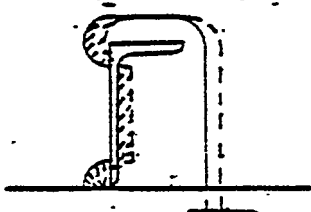
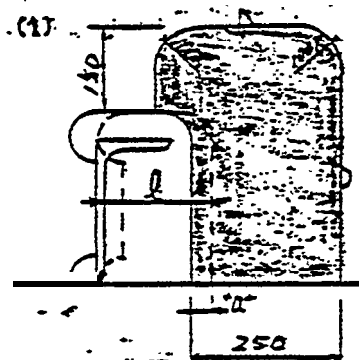
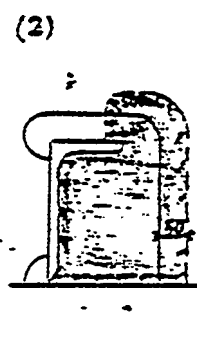
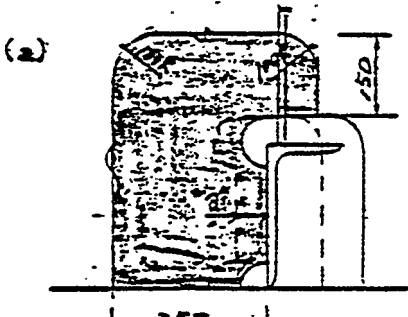
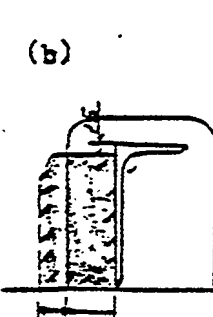
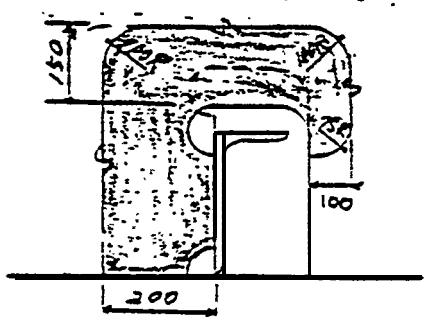
Division	Item	Remarks
ANGLE STIFFNER	(1) <u>In case of length shortage</u> 	a) In case of $H \leq 300$ $L = 600$ b) In case of $H > 300$ $L = 2H$
	(2) <u>In case of lap shortage & poor end part</u> 	$l = 150$ $l = 150$
	(3) <u>In case of materials contact with drain hole</u> 	a) thickness of doubler plate equal to mother material "t" b) doubler plate is to be fitted on skeleton side

Division	Item	Remarks
BUILT-UP LONG	(1) <u>In case of length shortage</u>	follow to "angle stiffener"
	(2) <u>In case of lap shortage & poor end part</u>	- do. -
	(3) <u>In case of materials contact with drain hole</u>	- do. -
FACE PLATE		a) In case of $B \leq 200$ $L = 3B$ b) In case of $200 < B \leq 300$ $L = 600$ c) In case of $B > 300$ $L = 2B$ (max. 1,000)

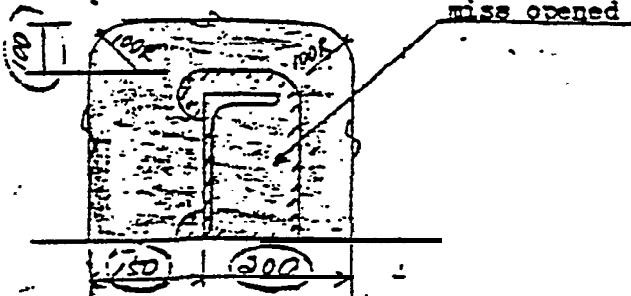
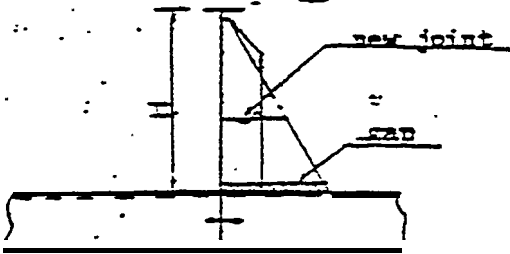
Division	Item	Remarks
FLOOR GIRDER WEB PAINT STR. etc	(1) FLOOR 	$l \geq 300$ $(l_1 = \text{MIN } 50)$
	(2) GIRDER 	$l = 450$
	(3) WEB <u>a) In case of small gap</u> 	1) $l = 300$
	<u>b) In case of big gap</u> 	2) $l = 300$

Division	Item	Remarks
	c) <u>Gap in way of stiffener end</u> 	
	(4) <u>PANT. STR (TRANS & GIRDER)</u> 	$l = 300$
	(5) <u>WEB FRAME</u> a)  b) 	a) $l = 300$ b) $450 \leq l < 600$

Division	Item	Remarks
HOLE	(1) Circle Type 	<u>Important member</u> a) when, $t \leq 13$ $\min \phi = 200$ b) when, $t > 13$ $\phi = 15 \times t$ $\max = 450\text{mm}$ <u>Other member</u> a) when, $t \leq 16$ $\min \phi = 200$ b) when, $t > 16$ $\phi = 12 \times t$
	(2) Oval Type 	- do. -
	(3) Square Type 	for temporary $(\min "R" = 15)$

Division.	Item	Remarks
SLOT	(1) "A" type (slot : miss position) a) In case of "a" $\leq$ 50 	slot : leave as it is. oblique lined part to be gas cutted.
	b) In case of "a" $>$ 50 (1)  (2) 	(1) slot size when, $l > 210$ (2) slot size when, $l \leq 210$ apply collar plate
	(2) "B" type (slot : miss position) (a)  (b) 	(a) when, "a" $>$ 75 (b) when, "a" $\leq$ 75 apply collar plate
	(3) "C" type (slot : over size in height) 	

Division	m	Remarks
	4.) "D" type (slot : short size in height)	apply collar p
SLOT	5.) "E" type (slot : miss position in way of block joint)	(a) when, "a" > (b) when, "a" ≤ apply colla
	6.) "F" type (miss position of adjoined slot)	
	7.) "G" type (miss position of adjoined slot)	

Division	Item	Remarks
SLOT	(8) "H" type (slot : miss open)  The diagram shows a cross-section of an H-type slot. The top flange has a width of 100mm. The web has a thickness of 100mm. The bottom flange has a width of 150mm and a thickness of 300mm. A label 'miss opened' points to the gap between the web and the bottom flange.	
BKT & FB	 The diagram shows a cross-section of a joint. A label 'new joint' points to the top flange. A label 'gap' points to the space between the web and the bottom flange.	(a) when, $H \leq 550\text{mm}$ renew (b) when, $H > 550\text{mm}$ partial renew (300mm)

IHI ACCURACY CONTROL SYSTEM



JUNE, 1979

Ishikawajima-Harima

Heavy Industries Co., Ltd.
TOKYO JAPAN

REF. NO. KCTC36

CONTENTS

1.0	Preface	1.0-1
2.0	IHI Accuracy Control System	2.0-1
2.1	Basic Philosophy in Promoting Accuracy Control at IHI	2.0-1
2.2	Accuracy Control Procedures for IHI Future-32 Bulklers	2.2-5
	1) A.C. Engineer Attendance at the Preliminary Design Phase	2.2-5
	2) Accuracy Control Activities in Production Planning and Construction Process	2.2-9
	3) Analyzing Mesured Data	2.2-10
	4) Feed Back	2.2-14
	5) Tolerance on the Gap at Butt Welding	2.2-35

1.0 Preface

Activity for keeping high accuracy of ship's hull as a part of quality control has been performed at every shipyard of IHI. This activity is promoted by Production Control Department under the support of whole organization of the shipyard from Engineering Department to Hull Construction Department.

As described in the following chapters, this activity is a systematic and integrated approach to achieve the aim given to the shipyard. i.e. how to construct a ship in safe and highly productive manner.

The terminology of "Accuracy Control" may be new word but its idea shall be understood through this brief paper. Accuracy control can be said one of the concentrated know-how of IHI's shipbuilding technology accomplished through the Long experience still being refined every day.

2.0 IHI Accuracy control System

Though final inspection of hull Structure is reminded to be important in the meaning of gurantee of ship's quality, IHI considers that quality control through the production process ~~must be more important.~~

~~IHI Accuracy Control~~ is a system to be supported by all organizations of the shipyard from Engineering, Mold Lofting, Marking.

a ship in safe, in high quality, in high productivity and eventually in low cost. In that meaning, the terminology of "Accuracy Control" is distinguished from "Quality Control" or "Quality Assurance". ?

2.1 Basic Philosophy in Promoting Accuracy Control at IHI

Even though there might be many ways of accuracy control, IHI considers that the biggest theme in hull construction is to keep high accuracy of the shape of hull units at the erection stage.

In other words, the theme is to minimize the works at erection with the effort by the preceding phases such as assembly, sub-assembly, fabrication and engineering, including mold lofting. Because at erection stage, various kinds of hard works shall be caused by an inaccurately constructed unit such as:

- . Too many gas cutting to adjust erection joints.
- . Welding with a backing strip to fill up a too big gap at a joint.
- . Cutting off previously welded parts and rewelding to set right the connecting parts at a joint.

2.1 Basic Philosophy in Promoting Accuracy Control at IHI (Corkaured)

- o Too much gas cutting for adjustment to erection joints.
- o Welding withh a backing strip to fill an oversized gap at a joint.
- o Cutting off previosly welded parts and rewelding to align the connecting parts at a joint.

ALmost all of this work needs to be performed on high scaffolding where working conditions are neither safe nor convenient.

It must be recognized that accuracy in erection is a result of accuracy in the preceding steps to erection such as marking, cutting, bending, fitting and welding.

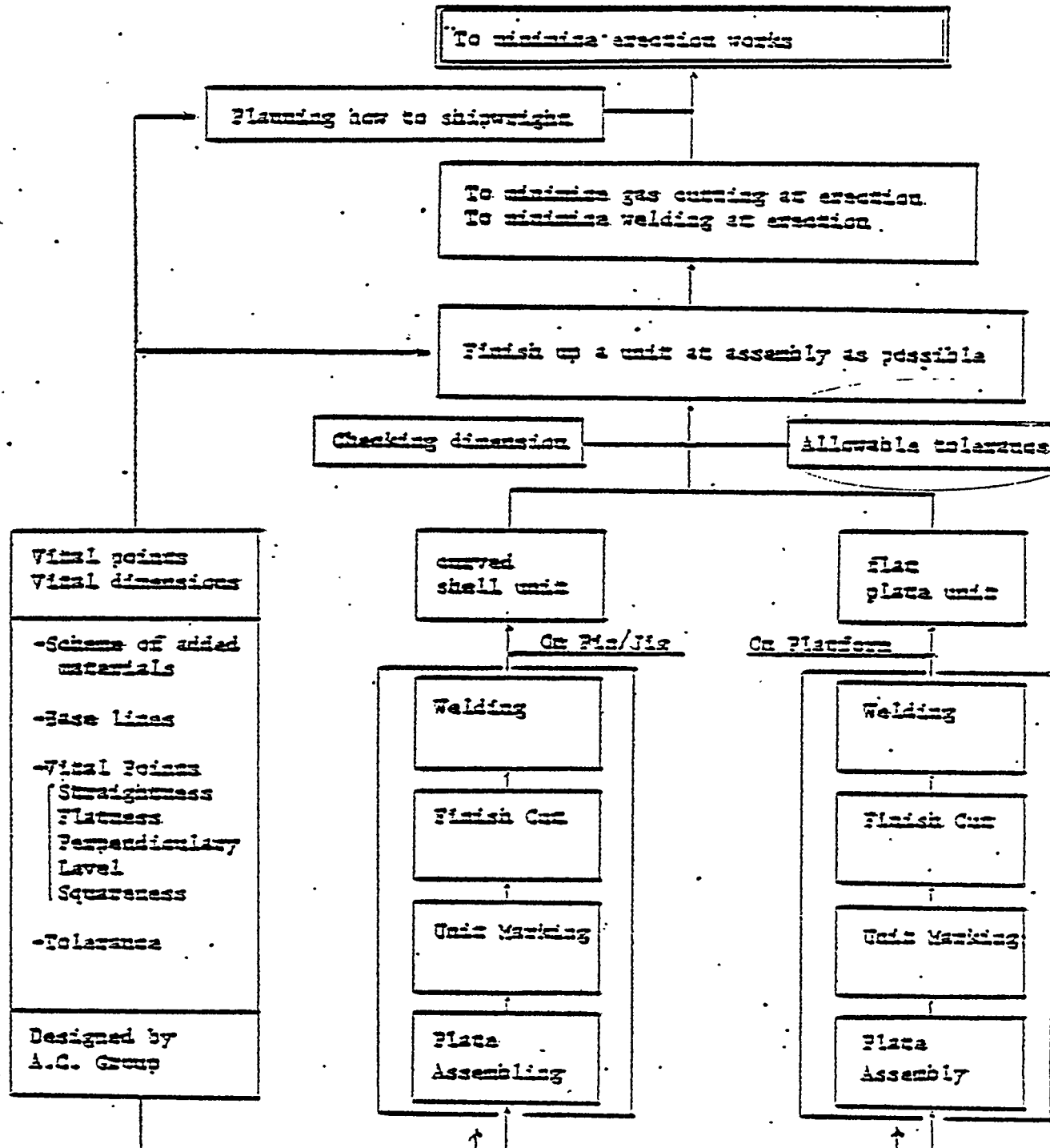
Before introducing the actual method used in Future-32 Bulkera, a brief explanation on the concept of IHI Accuracy Control is presented in the following (2) flow charts:

Flow chart - 1: Concept of Accuracy Control in IHI

Flow Chart - 2: Data Flow of Accuracy Control in IHI

Flow Chart - 1

Concept of Accuracy Control in Erection



Engineering &
Lorfting

Flow Chart-2

Data Flow of Accuracy Control in the
Media

For Marking &
Cutting

Checking Points

Precise Shape Taking
Account of Plate Thick-
ness

Edge Preparation
Straightness
Smoothness of Surface

NC Data
Ruler
Template
Instrument
Gas Purity
Machinery

For Bending

Checking Points

Sight Line for Shaping
Degree of Knuckle

Taking Account of Spring
Back

Template

Shrinkage
Elongation

For Assembly

Checking Points

Fitting
- Fitting Angle
- End Point of Stiffeners
- Alignment
Finish Cut
- Check Dimensions
Over All Block
Welding
- Welding Sequence
Base line for Assembly

Template

Jig/Bed
Measurement

Error in
Fitting
Shrinkage

For Erection

Checking Points

Snipwright
Base Line for Erection
Bed of Birth
Flatness
Cocking Down

Measurement

PRODUCTION

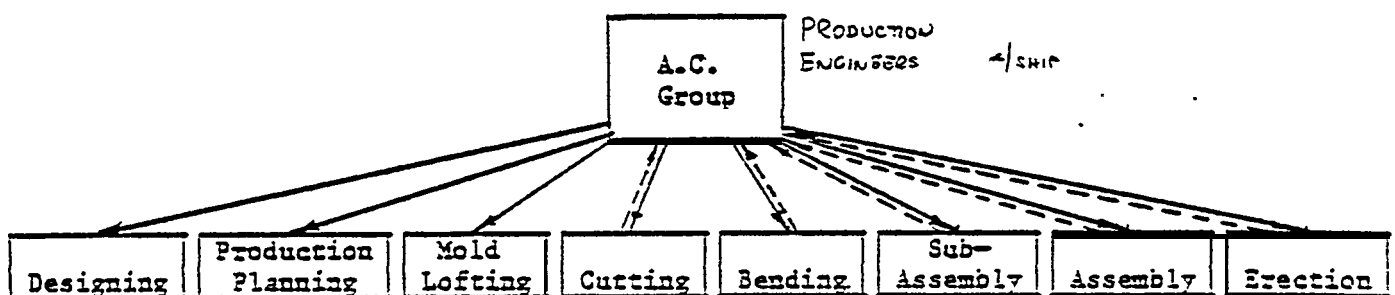
AC Data Accumulation
Improvement of Const. Method

2.2 Accuracy Control Procedures for IHI Future-32 Bulklers

As described in 2.0 of this paper, the activities of Accuracy Control are started before the development of a working drawing. This procedure has not only been used for Future-32 Bulklers but is also applicable to other ships.

IHI's procedures follow a cycle, called the ZD cycle (Zero Defect Cycle), of "Plan Do - See - Action". This procedure attaches special importance to the elements of 'See' and 'Action'. They are vital to the success of work and are linked to the next stages of the plan.

The actual activities at IHI AIOH-Shipyard are presented from design to production as follows: A specialized group called the A.C. Group, four hull production engineers per building berth/dock are assigned. They direct all Accuracy Control activities in every process, with the support of every work shop. The following figure is a data flow chart designed by the A.C. Group.



2.2 Accuracy Control. Procedures for IHI Future-32 Bulklers (Continued)

1) A.C. Engineer attendance at the preliminary design phase

After basic design, Accuracy Control activity commences. At that time, basic drawings are issued; that is, LINES (not fair), MIDSHIP SECTION, CONSTRUCTION PROFILE, GENERAL ARRANGEMENT and MACHINERY ARRANGEMENT.

The A.C. Group participates in designing the Block Division and Erection Sequences. An indepth study from many aspects is conducted on the Cargo Hold Section because it is the most essential portion of hull construction from the viewpoint of concentrated work load. In addition, the cargo hold section is the starting point for the accuracy control of the curved part. The fabrication method of cargo hold units and curved units, shipwright welding methods, and vital points for maintaining high accuracy are studied. Along with the basic planning for hull production preliminary drawings on Shell Expansion, Upper Deck Plan, Inner Bottom Plan, Longitude Bulkhead profile and Section Drawing are developed. These drawings are used for detailing the fabrication method and Accuracy Control Planning. Next the working drawings are developed.

During this process, the following data is generated by A.C. Group :

2.2 Accuracy Control Procedures for IHI Future-32 Bulkers (Continued)

The scheme for the excess and the phase for completion

This scheme is designed to take into account the following fundamental functions:

- * Vital points and vital dimensions to maintain high accuracy.
- * Fabricating sequence and fabricating method for a unit.
- * Erection sequence of units.
- * Welding method.
- * Consideration ~~for shrinkage.~~

~~In this drawing,~~ the following information is involved:

- * Dimensions of excess materials.
- * The phase for completion.
- * Welding method (automatic welding to be adopted)

An actual example is provided in the attached paper, "The Scheme of the Added Materials and the phase for Completion for the Future-32 Bulkers at IHI AI0I-Shipyard".

- o Check points, checking dimension, checking method at Sub-assembly, Assembly and Erection.
- o Instructions for shipwright erection.

2.2 Accuracy Control Procedures for IHI Future-32 Bulkers (Continued)

- o Vital points at the Fabrication phase (Marking, Gas Cutting and Sub-Assembly) and Base Lines to be generated from the Mold Loft.

The three documents listed above are designed to show concrete methods in promoting the Accuracy Control activities in the actual phases of hull construction. The actual example for these is presented in the attached paper "Accuracy Control - Check Points, Checking Dimension, Checking Method Based on Fabrication Sequence for Future-32 Bulkers".

It should be noted that A.C. planning precedes commencement of working drawings, that is, this planning is a guidance to indicate the actual fabricating method for the ship's hull on the working drawings. In addition, through the Planning, discrepancies are forecast and allowance for them is prepared.

2) Accuracy Control Activities in Production Planning and Construction Process

In this phase, the actual measurement is performed in accordance with the plan discussion in previous paragraph.

The Accuracy Control Group has designed a measuring sheet with certain points, such as, checking methods, responsible personnel and frequency of measurement. The actual form is provided in the attachment entitled "Accuracy Control Check Sheet for Future-32 Bulkers".

The actual measuring instruments used, Such as scale, wire, transit, plummet and special jigs are to be used for specific parts which are not easily measured by ordinary instruments.

IHI has a standard and tolerance table for maintaining high accuracy. It was developed as the result of IHI's long experience in this area. The values in the table are generally more strict than that required by ship's owners and classification agency. This is IHI's target at this moment.

With the combined use of the tolerance and check sheet, actual measurement and checking is Conducted.

The actual tolerances at IHI are provided in the attached paper entitled "Standard and Tolerances for Maintaining High Accuracy at IHI AIOI Shipyard".

3) Analyzing Measured Data

Measured data during the production process is gathered by the Accuracy Control Group and analyzed. As a result of the analysis suitable action is taken by A.C. Engineer as follows:

- o Continue more detailed investigation.
- o Review the fabrication method.
- o Investigate instruments.
- o Investigate the foundation, such as platform at Assembly or cribbing at Erection.
- o Coordinate the scheme of hand effort.
- a Change dimension of excess materials (feedback to working drawing).

Daily control of workers is mainly performed by tolerance control that is by checking to see whether errors are within the allowed tolerances. However, for improvement it is not sufficient to check only by the tolerance control method to ensure that all measured data are within the tolerance levels. The characteristics of and tendency towards errors must be clearly identified, so that a statistical method can be adopted to analyze measured data at IHI. Since the theory of statistics is well known, the applied method is briefly described here.

where: $\bar{X}$: Mean Value
 N : Total number of data
 X_i : Data value (error)
 N_i : Data number for value X_i

a) Generally Mean Value is significant only when the data is sampled at random. If data is gathered from a limited range, and it does not present source data realistically.

b) Usually Mean Value of errors are planned zero (0).

So if the actual Mean Value is different from the one planned, it could signify that the Mean Value should be re-planned or the fabrication method should be changed. Refer to the following examples.

c) Examples

Ex 1: Take a premise that the Longitudinal ~~RED~~ under a Tank Top is finally cut at cutting phase with some margin for shrinkage, and Mean Value of measured data after welding at Sub-Assembly presents the shortage comparing with the planned value (zero).

(Judgment)

Check Gas Kerf compensation. Then, if Gas Kerf compensation is good enough, margin for shrinkage was too short.

3) Analyzing Measured Data (Continued)

(Action)

Add the absolute value of the Mean Value to the previous planned margin.

Ex 2: Mean Value of deformation at Tank Top plate was detected by 1/2" at the center of the plate.

T. TOP

(Judgement)

Check the level at the platform on which the unit were constructed.

(Action)

If the Level at the platform is good enough, improvement of fabrication method, such as, "inverse strain" shall be considered.

(3-2) Standard Deviation:

$$\sigma = \sqrt{\frac{(x_1 - \bar{x})^2 + (x_2 - \bar{x})^2 + \dots + (x_i - \bar{x})^2}{N - 1}}$$

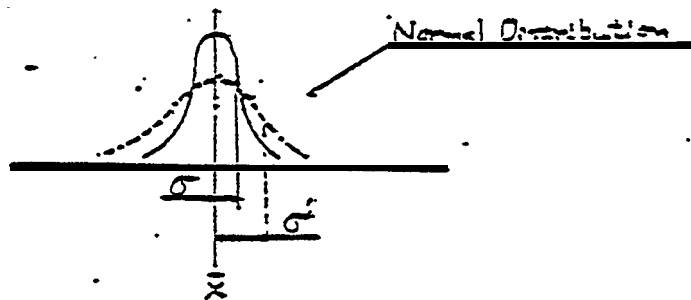
where

σ : Standard deviation
 $\bar{x}$: Mean value of data (error)
 x_i : Data value
 N_i : Data number for data x_i

a) It is clearly understood from the above equation that σ means the Mean Value of Variance of data. This might be more clearly understood if $(N-1)$ is replaced by N in the equation.

Strictly speaking, σ is the mean variance of the measured data from the Mean Value of the measured data.

b) From this fact, the following analysis is possible. A large valued σ compared with the past record, means that there is a large variance in the fabrication method itself. The fabrication method should be reevaluated for uniformity and by personal opinion differences should be eliminated.



c) Example:

A large σ compared with the past record was detected at the length of the Longitudinal frames which were fabricated manually .

(Action)

Examine how and by whom these frames were made. The plan of the fabrication method should be fully investigated.

4) Feed Back

Through analysis of the measured data, suitable action should be taken for the next unit and for the next ship. The following changes made from feed back due to Accuracy Control activity.

- o Change dimensions of excess materials (feed back to working drawing)
- o Add Base Lines in the output from Mold Lifting (feed back to Mold Lifting)
- o Change fabrication methods (preventing heat distortion, fabricating sequence)
- o Reinforce platform at Assembly.
- o Consider Cocking-Down in cribbing.
- o Adjust Gas Kerf compensation.

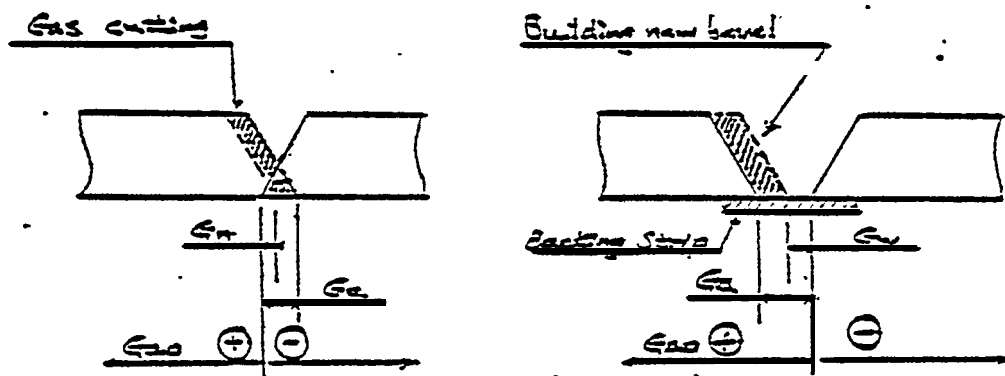
Accuracy Control Engineers are responsible for these actions. In addition, it should be noted that these actions lead to a final (complete) plan and close a cycle (Accuracy Control Cycle).

PLAN —> DO —> SEE —> ACTION

Through cycled activity, information and data is accumulated in the shipyard.

5) Tolerance on the Gap at Butt Welding

Though the meaning of the allowable tolerances on error may be easily understood, it may be interesting to note the gap tolerance at the butt weld.

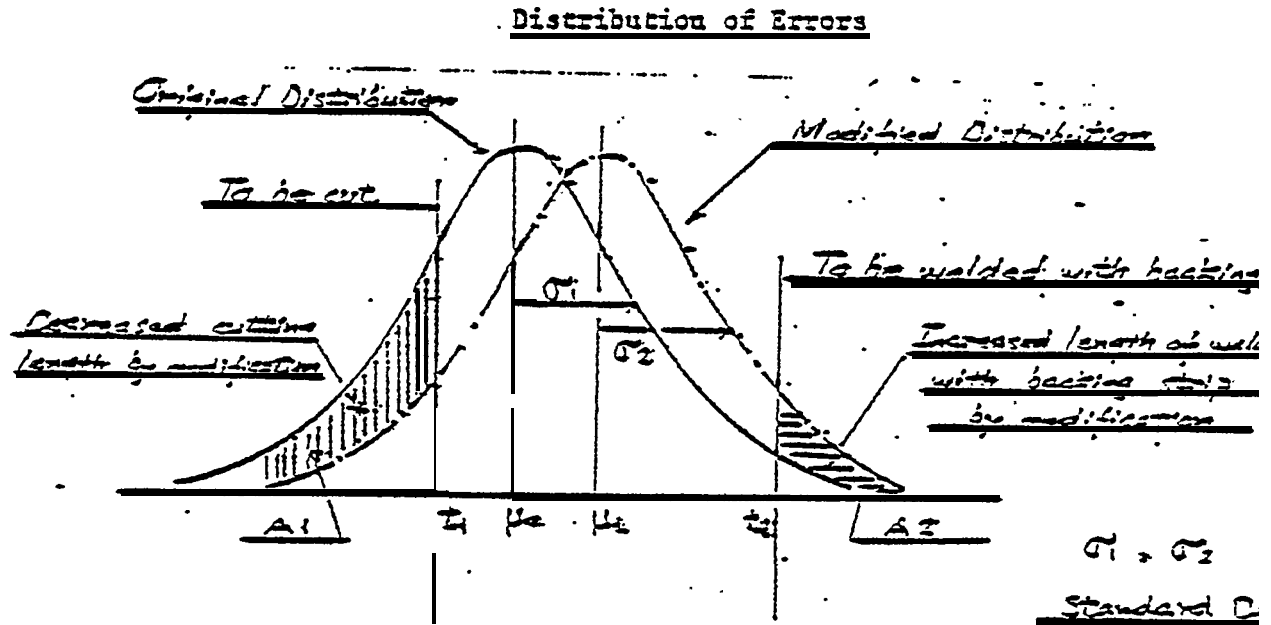


(5-1	$G_a < G_n$	——	To be cut up to G_a
	$G_a > G_w$	——	To be built up normal bevel using backing strip
	$G_n < G_a < G_w$	——	Normal welding
	<u>G_a</u> is actual gap.		

Therefore, G_n is the lower limit and G_w is the upper limit of tolerance on the root gap for welding.

5) Tolerance on the Gap at Butt Welding (Continued)

(5-2) Modification of distribution of errors according to the change of fabrication method.



As shown in the above figure, distribution of errors can be intentionally changed by modification of fabrication method.

When the original distribution is supposed to indicate length of butt welding at erection, the ratio between "gas cutting" and "welding with backing strip" can be intentionally changed only treating the mean value being shifted without any other treatment.

This suggests, that in case' welding with a backing strip is more easily accomplished than gas cutting for erection work, it is recommended that the mean value of gap in the direction of decreasing gas cutting be shifted.

Moreover taking into account the standard deviation σ_1 and σ_2 , A_2 becomes much smaller than A_1 in the modification of the distribution.

ACCURACY CONTROL

CHECK POINT CHECKING DIMENSION, CHECKING METHOD

BASED ON FABRICATION SEQUENCE

FOR FUTURE-32 BULKERS

- (1) Check point, checking dimension and checking method at Sub-assembly and Assembly based on the fabrication sequence of a unit.
- (2) The same information at Erection.
- (3) How to do shipwrighting based on the erection sequences.
- (4) Vital points at fabrication phase (Marking, Gas Cutting, and Sub-Assembly) and Base Lines to be involved in the output from Mold Lofting.

PREPARED BY IHI

REF. NO. KCT037

ACCURACY CONTROL

CHECK POINT, CHECKING DIMENSION, CHECKING METHOD
BASED ON FABRICATION SEQUENCE FOR
FUTURE-32 BULKERS

This paper is to display a concrete method to proceed the activities of Accuracy Control for the Future-32 Bulklers. In this paper, the following information is involved.

- (1) Check point, checking dimension and checking method at Sub-Assmbly and Assembly based on the fabrication sequence of a unit.
- (2) The same information as (I) at erection.
- (3) How to do shipwirghting bsd on the erection sequence.
- (4) Vital points as fabrication phase (Marking, Gas Cutting and Sub-Assembly) and Base Lines to be involved in the output from Mold Lofting.

This kind of paper is designed by Accuracy Control Engineers in IHI not only for Future-32 bulkers but alos any kind of ship. This activtty of Accuracy Control through this procedure is called "special control" which means "specially designed procedure for the Future-32 Bulklers". "Special Control" is contrasted with the "Regular Control which is proceeded by ordinary allowable- tolerance control and from which "Special Control" is derived.

2) Actual activities

In order to get clearer pictures in order to understand the practical method of the accuracy control activities, the nominated experts group of NASSCO performed the A/C process under the conduct of the IHI engineers.

Following activities were actually performed:

- * Design unit assembling method
- * Design data sheet for measurement
- * Analysis of measured data

We are convinced that NASSCO can apply this to the other actual units in the same manner by themselves.

With respect to the above, more detailed description is presented in the following chapters.

3) Connection with Line Heating Technology

Line heating technology was also transferred to NASSCO by another IHI team. It should be reminded that the technology is an effective and powerful one to support A/C activities in the process of hull construction.

It has two main aspects of functions in it. The primary one is, of course, to bend precisely and economically curved plates of not only simple curvature but also tight-complexed curvature. The secondary one is to straighten the deformation caused in the process of hull construction. The important here is to straighten the deformation in the earlier phase as possible without leaving it to the succeeding phases.

With respect to bending curved plates by line heating technology, more suitable templates must be prepared by adding the required data to the present templates in the Mold Loft.

From the view point as described in the above, it is recommended that application of line heating technology and preparatory works for it are integrated in the total A/C activities.

1. Design Unit Assembling Method

Unit assembly method should be studied before the start of assembly. In addition, the study of facilities where the unit is built should also be involved since the assembly method depends on the facilities.

The following should be clearly described in the unit assembly method:

- 1) Assembly sequence
- 2) Welding sequence
- 3) Vital dimensions

In studying the critical itmes described above, the following points should bee considered:

1.) Platen for assembly:

When a platen and jigs are set up, the shape and size of a unit should be considered as follows:

- Flat/curved
- size of unit
- weight
- Assembling status of the webs such as the height, weight and loading direction.
- Condition of the internal members.

- 2) Landing sequence of pieces to be assembled: An appropriate method to set preventive supports, suck as strong backs, should be studied.

- 3) Welding scheme: - The most important consideration here is to select carefully the proper welding method and sequence in order to minimize deformation.
- 4) Assembling sequence: - Through the study of the assembling sequence, vital points and vital dimensions are noted. Any discrepancies between drawing implied sequence and assembling sequence is checked beforehand .
- 5) Guarantee of welding quality and maintenance of vital dimensions.

unit assembly method should be designed with these considerations in mind.

2. Design Data Sheet

The numoer of dimensions to be checked varies depending on the capability of the shipyard. It is recommended that NASSCO check as many dimensions as possible until they determine their particular required accuracy.

C

3. Analysis

Analysis of the measured data is not only for recognition of the present accuracy but also for finding problems and solving those by comparing measured data with the standard allowable tolerance of NASSCO.

The important point is that all related personnel should communicate openly with each other without hiding the facts and without unfair blaming.

Since NASSCO has not yet established a clearly defined standard the following recommendations are limited to problems actually found by IHI and to areas where potential problems could arise.

C.

4. Exercise 1 (Flat unit)

The following is a procedure on the A/C activities on a main deck unit.

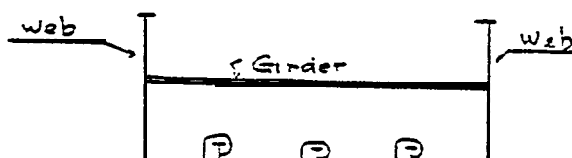
- 1) Design unit assembling method. Refer to Appendix 1 (AP 1-1)
- 2) Design data sheet. Refer to Appendix 1 (AP 1 - 2 to AP 1-15)
- 3) Analysis . Refer to Appendix 1 (AP 1-16 to AP 1-18)
- 4) Noted problems:

- a) Platen for assembly is not level.

During the time of discussion with the members of Team #2 (experts group), the platen was said "to be flat" by all of them. However, in fact, it was found not to be flat when measured. IHI recommends checking all platens and adjusting.

- b) Additional work was required for inaccurately fabricated girders in relation to longitudinal positioning.

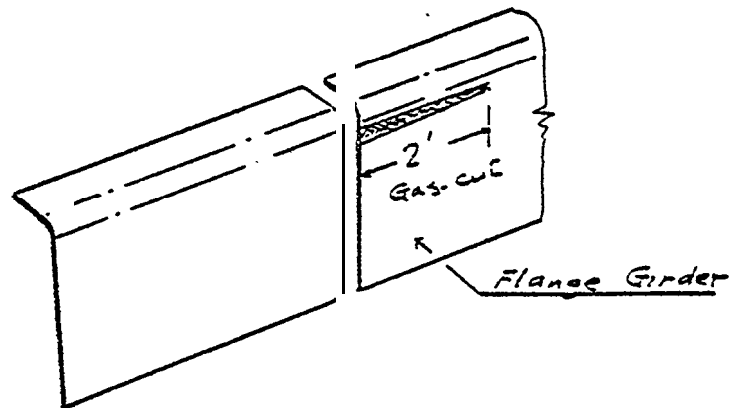
As drawn below, girdes slots had to be gas cut during assembly because they were not aligned with the actual longitudinal placement. The NC tape produced by mold loft was found to be correct when checked against the drawing. Judging from this, the errors appear to have been caused by the NC burning machine. Therefore, the NC burning machine should be carefully and regularly checked. According to the machine operator, mechanisms such as the driving motors are a problem.



Since the NC burning machine is one of the most vital Pieces of equipment at NASSCO, it is strongly recommended that repair and recalibration be done as soon as possible.

- c) Misalignment of the flange girders: As drawn below, the flange girders were misaligned at assesbly, so that the bent part of a 2' (two foot) length was gas cut at assembly. This misalignment is considered to have been caused by a bending error. Therefore, it is recommended that bending methods for flanges be reviewed and revised. Since a flange girder is very popular in NASSCO design, the accuracy of a flange girder (at fabrication) is vital.
- d) Length of the pieces are inaccurate: As described in "analysis" of this chapter, control of length accuracy is lacking. It follows that the work load incurred by this error multiplies with each subsequent production process, because accuracy of length is the primary element of accuracy control. Therefore, it is necessary to attack the source of the errors.

It is recommended by IHI to check the burning process, not only NC burning, but also hand cutting.



C

5. Exercise 2 (curved shell unit)

Following is a procedure on the AC activities on a curved shell unit.

- a) Design unit assembling method. Refer to Appendix 2 (AP-2-1 to AP-2-2)
- b) Design data sheet. Refer to Appendix 2 (AP-2-3 to AP-2-14)
- c) Analysis.
- d] *Noted* problems:

1) Pin/jigs are poor:

As described in our first survey report, the condition of Pin/jigs is poor. It should be improved as soon as possible. The platen leveling is also poor, and it is strongly recommended this be corrected.

2) Calculating method for the jig-height:

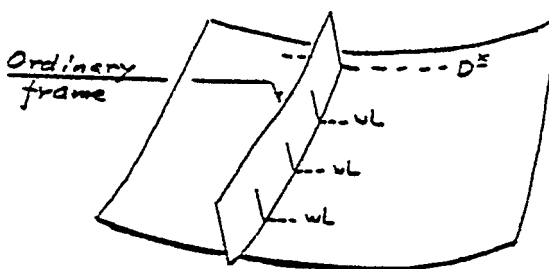
There exists no standard to determine the necessity of jigs for any given init curvature. in addition, there is no standard to establish the datum plane for jig height calculation and as a result, selection of jig height is left to the judgment of the loftmen. In reatity, it is reasonable and more efficient to establish the datum plane following the assembling sequence.

3) Reference line:

The necessity and purpose of the reference line is not clearly understood by MASSCO. On an ordinary hull frame, these are many WL (water line) marks.

However, the hull fitter does not use any of these lines but refers instead to the main deck line. His judgment is correct in making this choice and it is considered that marking the WL is a waste of time and promotes confusion. The same thing can be said in BL (buttock line).

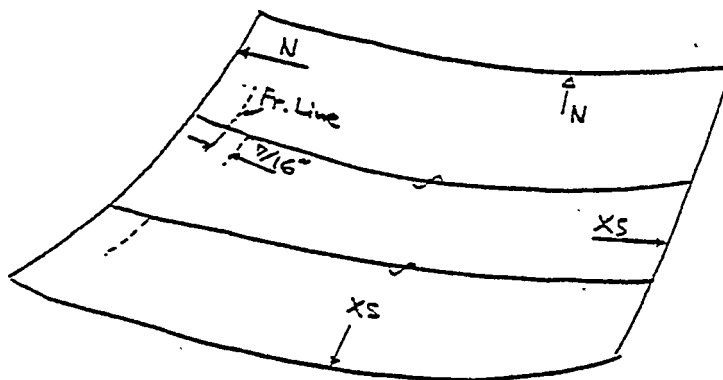
It is recommended to minimize the number of reference lines.



4) Discrepancy of the frame line marked on the plate:

As drawn below, a frame line was found to be in discrepancy by $7/16"$ - The frame line was very near the block butt which was neat cut.

It is considered that this was caused by the error of the NC burning.



C.

6. Epilog

Through our activities with the experts group of NASSCO, NASSCO prepared the primary plan of how to proceed and how to implement the accuracy control at NASSCO as shown in the next two (2) pages.

IHI hopes that that NASSCO establishes its own accuracy control procedure along our recommendations.

We appreciate your kind cooperation especially the cooperation and help given by Team #2.

C,

ACCURACY CONTROL (Prepared by NASSCO)

The Steering Committee consisting of J. Smith, A. Giorgis, K. Evans, C. Jensen, J. Lightbody, and K.K. Christensen recommends that Accuracy Control be implemented at NASSCO.

The degree of implementation is recommended as follows:

1. Short Term
2. Intermediate Term
3. Long Range Plan

Short Term is considered to include those areas where A/C can be instituted with minimal or no cost and can be started almost immediately.

The following are felt to be examples of Short Term items which can be started and completed in about a 3-6 months' timeframe:

- o Documentation of Burning Machine Accuracy.
- o Production of more check tapes by computer.
- o Provide more dimensional information to Yard Operations for checking purposes, welding allowable tolerances.
- o Provide formalized methods for Yard Operations to feed back A/C problems.
- o Commence development of Standard Repairs documentation.
- o Commence development of plans for education in A/C Procedures.
- o Provide for inspection of steel plate upon receipt in yard for flatness freedom from laminations, etc.
- o Define NASSCO's capability to maintain Accuracy Control:
 - a. Under current facility constraints.
 - b. With upgraded facilities/cost.
- o Continue training in line heating without an automated facility.
- o Develop interim Working Practice/Procedures/Standard formats/Date analysis techniques, etc.

Intermediate Term is considered to include those areas where accuracy can be increased at some nominal cost and within some reasonable time, e.g., 12 months. The following are felt to be examples of Intermediate Term items:

- o Upgrade of Platen (i.e., level platen area)
- o Upgrade of burning equipment.
- o Upgrade of Pin/Jig platen.
- o Development and publication of NASSCO A/C Standards, including:
 - a. Excess allowances including shrinkage.
 - b. Fabrication, Production and Working Practices for all Departments.
 - c. A/C Tolerances
 - d. "Repair" Manual
- o Publication of "pocket sized" manual to be distributed to the field.
- o Implementation of Education Program in Yard Operations.
- o Development of an Automated Line Heating Facility.
- o Development of Management Reports.

Accuracy Control
Page 2

A Long Range Plan is considered to be activities beyond a one year time frame. The following are considered to be examples:

- o An analysis (overview) of the first year of operations with recommendations for the future.
- o A revision to the A/C Standards, tolerances and Working Practices should be approved, published and distributed.
- o The Accuracy Control Standards book should be submitted to the Regulatory Agencies for approval.
- o Upon approval, these Standards should, by reference, become a part of Ship Specifications and Contract Terms and Conditions.
- o A capital expenditure plan for upgrading of facilities should reflect, in part, those deemed necessary to support Accuracy Control.

MEANS OF IMPLEMENTATION

- o The implementation of A/C would be through an organization which would be a part of Yard Operations.
- o This organization should be formed immediately, headed by the eventual Chief of Accuracy Control.
- o This Chief would coordinate the efforts of the A/C Committee (Team #2) to remedy the defects of the Short Term Plan. As the organization evolves, it would take over the functions of Accuracy Control.
- o The Steering Committee would be appraised regularly of progress and direction and would remain in an advisory capacity to the A/C Group.

COST OF IMPLEMENTATION

The immediate needs are for four technicians and a Manager or Chief, transferred from other duties within NASSCO. Office space, telephone and access to reproduction/printing capabilities are required. Estimated Short Term Costs are:

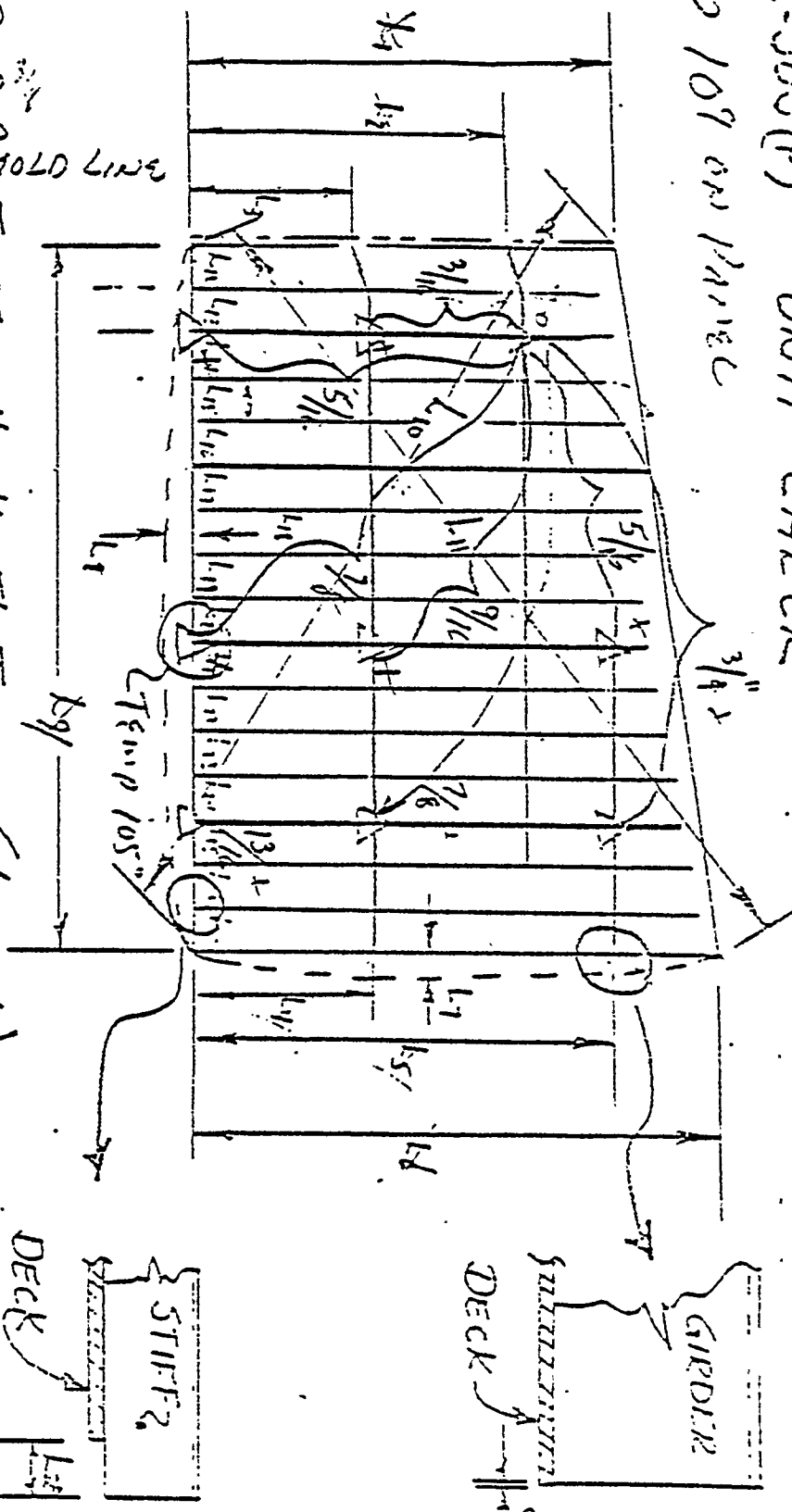
Leader (Supt level)	\$ 30,000
Four (4) Technicians (FM level)	\$ 72,800
Clerk typist	\$ 8,800
Office Furnishings	\$ 2,000
	\$113,600
Overhead (106%) of Labor	118,300
TOTAL	
	\$231,900

Offset - The cost referred to above, translated into manhours at \$20/hour, is equal to 11,600 hours. The approximate cost of \$232,000 would appear to be easily offset by the savings of 12,000 hours. For example, the manhour estimate for the Carlsbad Class for cost numbers in the 100 series is 372,000. The three (3) ships, the estimate is 1,116,000 manhours. Thus, the equivalent cost is 1.03% of the total fabrication, subassembly, erection and fitting costs of the 3 Union Oil Product Carriers.

ASSY AL-300(P) UNIT CHECK

Temp 109 on panel

AP-1 2

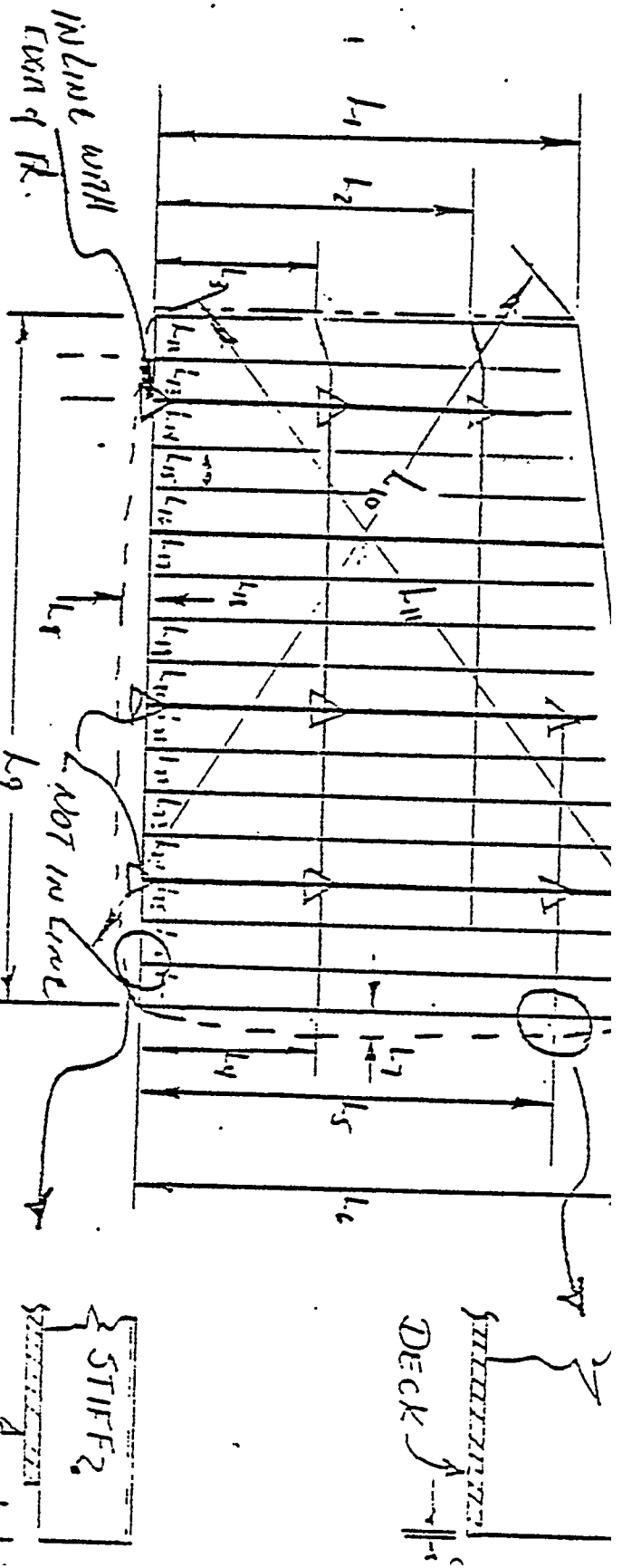


NOTE Δ REF. POINTS TO CHECK FLATNESS (LEVEL)

REF. DIM	ACT. DIM	Δ DEY	Δ AL
31'-6 7/16"	31'-7 1/16" + 5/8"		
23'-2 3/8"	23'-2 5/8" + 3/4"		
14'-4 1/16"	14'-4" - 1/16"		
14'-7 1/2"	14'-7 3/4" - 1/8"		
29'-4 1/2"	29'-4 1/4" - 1/8"		
38'-2 1/16"	38'-4 5/16" - 1/8"		
		1/4" 392	
35'-9 1/2"	35'-8 7/8" - 1/8"		
27'-2 1/16"	27'-3 1/16" 0		
52'-5 1/16"	52'-4 15/16" - 3/8"		
2'-0"			
2'-6"			
2'-6"	33'-8 3/8" 0		
2'-6"	31'-2 3/4" + 1/8"		
2'-6"	28'-2 3/4" - 1/8"		
2'-6"	26'-2 7/8" + 1/16"		
2'-6"	23'-2 1/16" - 1/16"		
2'-6"	21'-2 3/4" 0		
2'-6"	18'-2 3/4" 0		

[illegible]

NOTE Δ REF. POINTS TO CHECK FLATNESS (LEVEL)



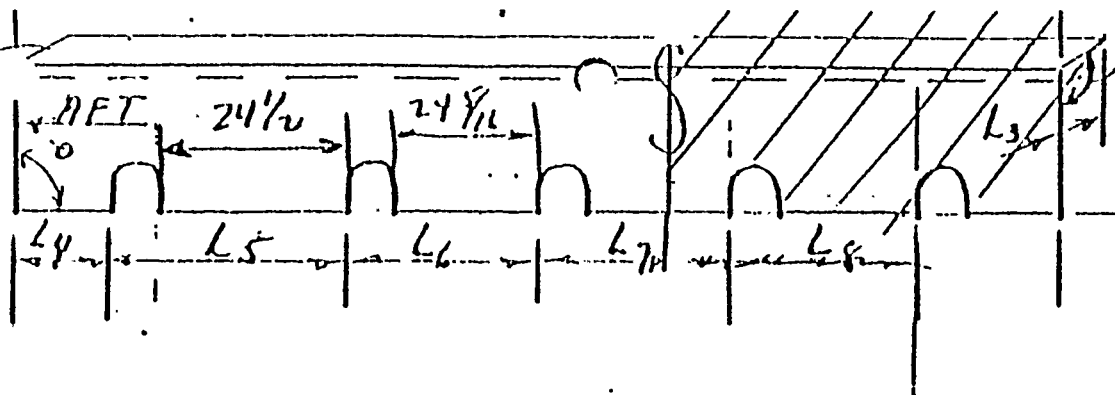
SIEDERS 20
L 87

28

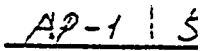
HTS FROM

1C TAPE #

11-0788-2

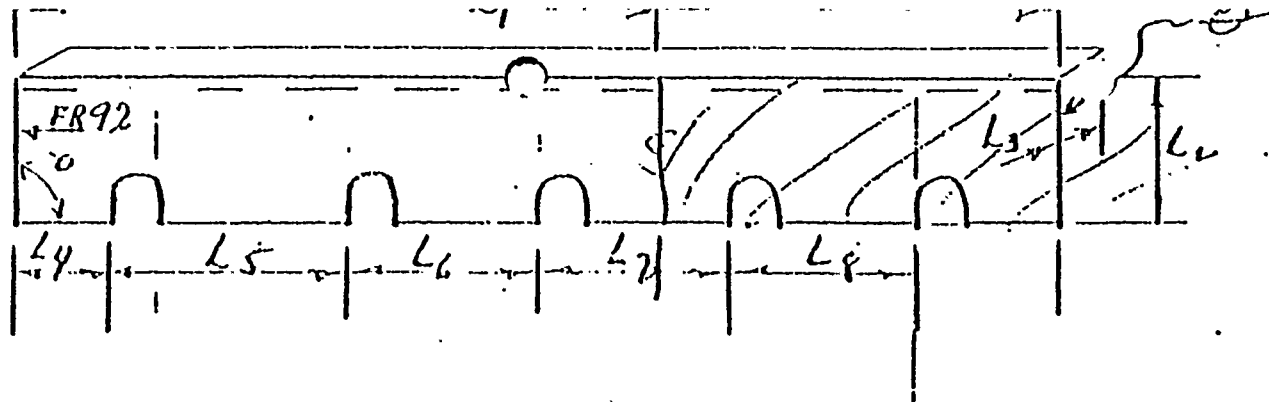


RT	L	DES. DIM.	ACT DIM	Δ REV.	Δ AL	ϕ P	ϕ L	CHECKER	REMARKS
13677 13678	1	9'-0 3/4"	8'-11 5/8"	-1 1/8"					
	2	24"	24 7/16" 24-1/4"	? 7/16"					
	3	4"	4"	-0-		97°			
	4	1'-5 7/8"	1'-5 3/4"	-1 1/16"		90°			CUT OUT HAND HAND BURN
	5	2'-6 1/4"	2'-6 1/4"	-0-					
	6	2'-6 1/4"	2'-6 1/4"	-1/8"					
	7	2'-6 3/8"	2'-6 1/4"	-1/4"					
V	8	4"	4"	-0-		45°			



RT	DES. DIM.	ACT. DIM.	Δ. DEY	Δ. AL	CHECKER	REMARK
1157	18' 7 3/8"	19' 5 7/8"	-1/8	-1/8		19' 6 1/8"
1158	36"	35 7/8"	-1/8	0		36" ± 3/8"
1159	4°	4° 48'	0	0		
1160	15' 9 1/2"	15' 9 7/8"	-1/8			
1161	36"	35 11/16"	-11/16			
1162	4°	3° 35'	+1/8			19' Δ 1/4"
1163						
1164						
1165						
1166						
1167						
1168						
1169						
1170						
1171						
1172						
1173						
1174						
1175						
1176						
1177						
1178						
1179						
1180						
1181						
1182						
1183						
1184						
1185						
1186						
1187						
1188						
1189						
1190						
1191						
1192						
1193						
1194						
1195						
1196						
1197						
1198						
1199						
1200						

21 0804-1



RT	L	DES. DIM.	ACT DIM.	Δ REV.	Δ AT	$\odot$ P	$\odot$ A	CHECKER	REMARKS
7103	1	9'-11 1/2"	9'-11 5/16"	- 3/16"					
7932	2	2'-4"	2'-1 1/8"	+ 1/8"					
	3	4'	1 - 4 1/8"	+ 1/8"		90°	89°		
	4	2'-5 3/8"	2'-5 3/8"	- 0 -		90°			
	5	2'-6"	2'-6 1/8"	+ 1/8"					
	6	2'-6"	2'-6 1/8"	+ 1/8"					
✓	7	2'-6 1/8"	2'-6"	- 1/8"					

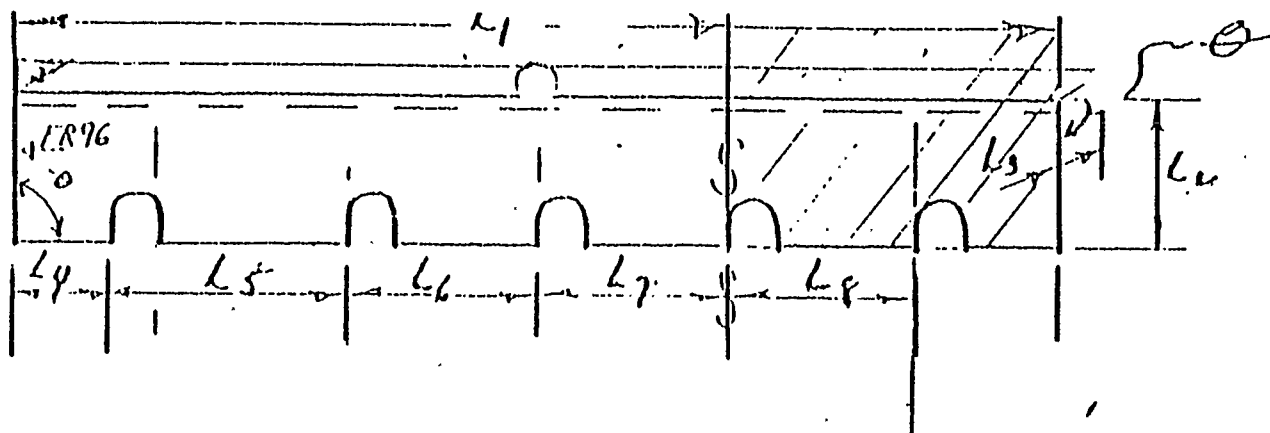
AP-1
6

23

AP-1 6

UTS FROM
% TAPE #

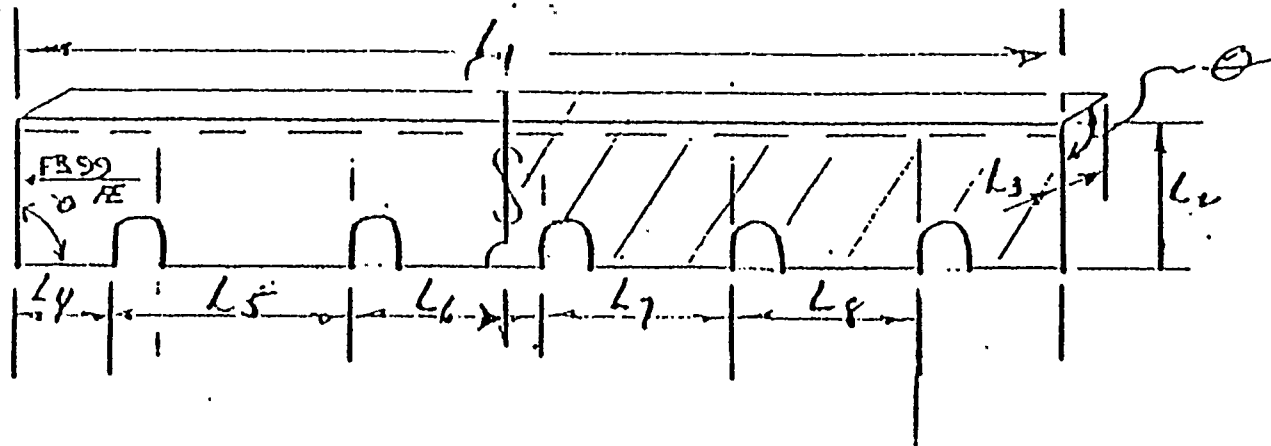
1-0788-2

[illegible]

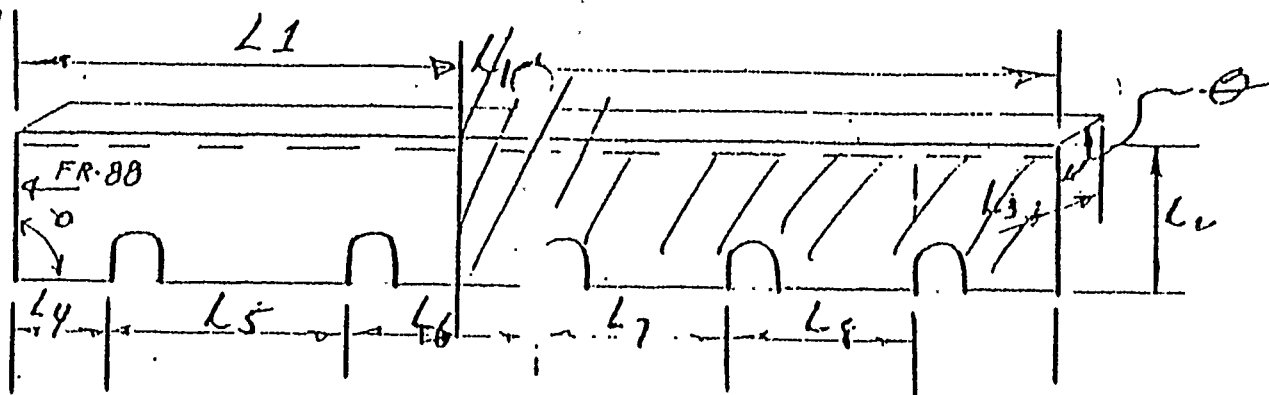
AP-1

GIRDERS

CUTS FROM
N/TAPE# 21-0789

[illegible]

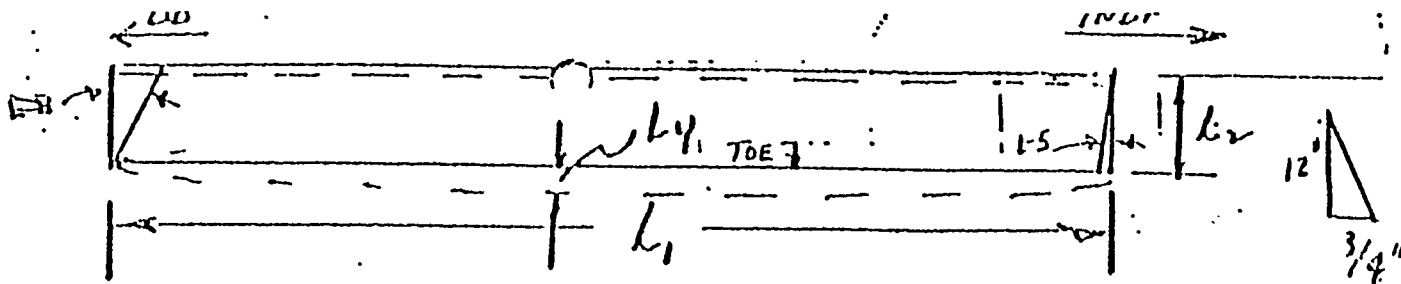
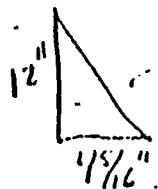
21-0787-1



PART	L	DES. DIM.	ACT DIM	Δ DEY.	Δ AL	$\angle$ P	$\angle$ C	CHECKER	REMARKS
17-7941 9-7942	1	6'-2 1/2"	6'-2 1/2"	0					
	2	2' 4"	2' 3 3/4" 24	- 1/4"					
	3	4"	4 1/8" 25	+ 1/8"		90°	90°		
	4	2' 5 3/8"	2' 5 1/16" 25 1/2	+ 1/8" - 5/16"		90°	90°		
	5	2'-6"	2'-5 7/8" 26	- 1/8"					
V	6	1'-3 1/8"	1'-3 1/2" 1-3"	- 1/8" + 3/8"					

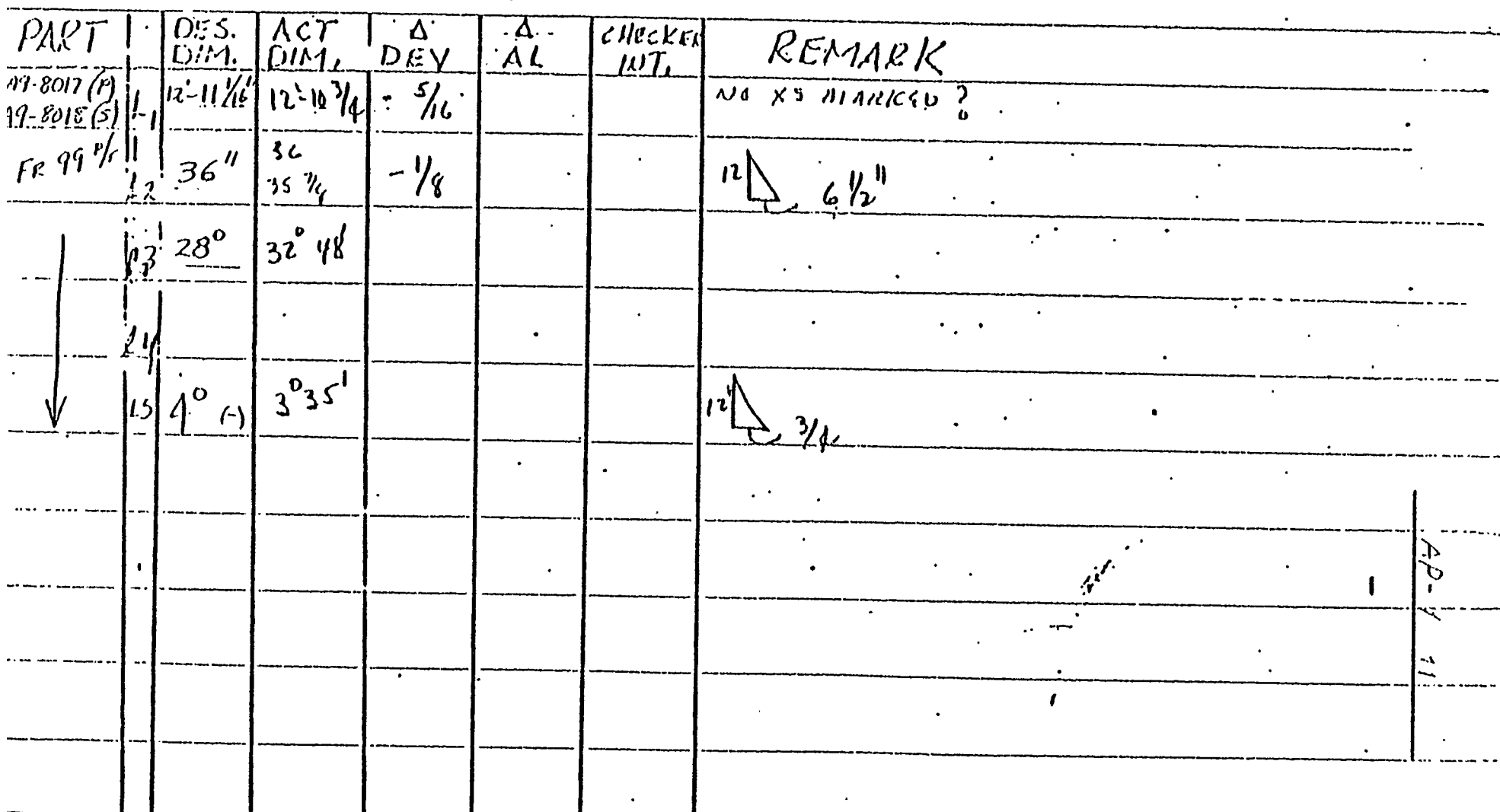
AP-1
9

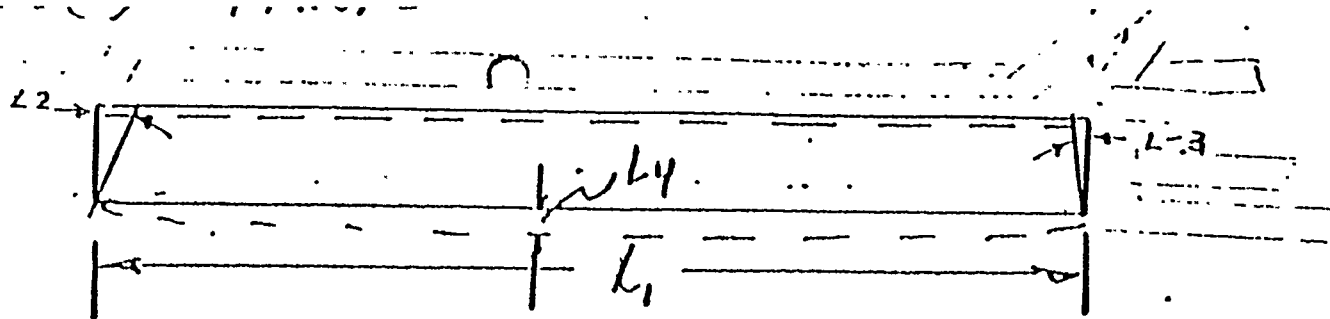
AP-1



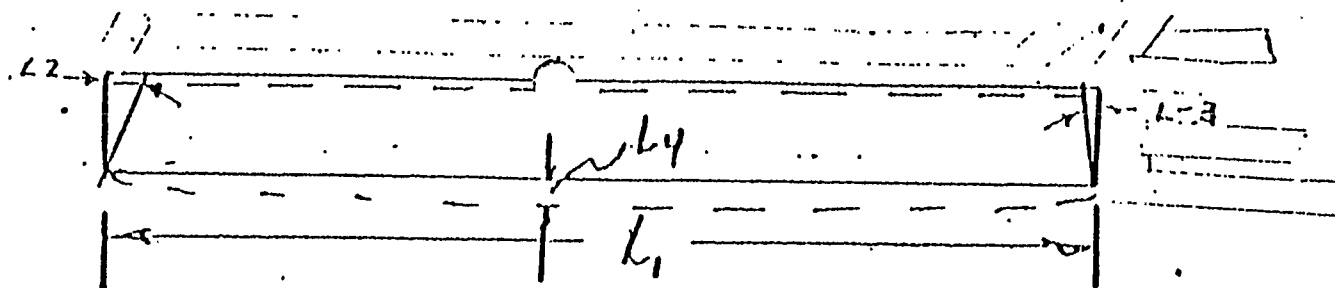
PART	DES. DIM.	ACT DIM.	Δ DEY	Δ AL	CHECKER INT.	REMARK
1-7971 (P)	13'-0 1/16"	13'-1 7/8	+ 1 1/16			MARKED 1 1/2" X 5
7972 (S)		36 3/4	+ 3/16			
2-7973 (P)	36"	36 1/8	+ 1/8			
	22°	21° 4'	56'			12" 4 1/4"
	1°	3° 35'	25'			SEE ABOVE
1-7973 (P)	14'-10 7/8"	14'-10 7/8	0			
7974 (S)		36 5/16	+ 1/16			
2-7975 (P)	36"					
	20°	21	1°			
	1°	3° 35'	25'			

AP-1
10



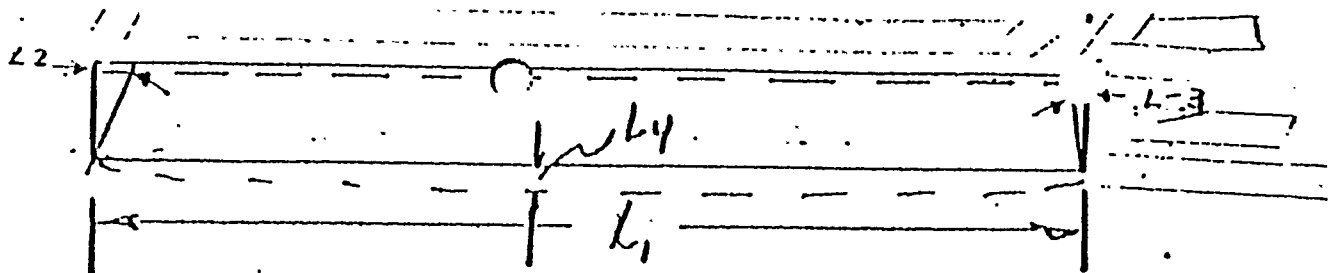


PART	DES. DIM.	ACT DIM.	Δ DEV	Δ AL	CHECKER INT.	REMARK
AG-8051 L1	37'-0 1/4"	37'-0 1/2"	- 5/16			
	14°	12° 36'				7/8
	4°	3° 35'				1/4
AG-8053 FR 87	36'-8 1/4"	36'-8 1/8"	- 1/8			
	14°	14° 30'				1"
	4°	4° 30'				5/16
AG-8055 FR 87	35'-10 3/4"	36'-10 3/8"	- 3/8			can out of alignment
	14°	12° 20'				1/8
	4°	4° 30'				1/16



PART	DES. DIM.	ACT DIM.	Δ DEV	Δ AL	CHECKER INT.	REMARK
N7-8057 PC 90	L1 35'-5 1/2'	35'-5 7/16'	+ 5/16			
	L2 15°	14° 30'				1"
	L3 4°	2° 42'				3/16
	L4					
N7-8059 PC 91	L1 35'-0 5/16"	35'-0 1/4"	- 1/16			
	L2 15°	14° 30'				1"
	L3 4°	2° 42'				3/16
	L4					
N9-8061 PC 93	L1 34'-1 3/16"	34'-1 3/8"	+ 3/16			
	L2 16°	14° 30'				1"

AP-1
13



PART	DES. DIM.	ACT DIM.	Δ DEY	Δ AL	CHECKER INT.	REMARK
A4-8063 FR 94	L1 33'-7 3/8"	33'-7 6/8"	+ 1/4"			
	L2 17°	15° 40'				1 1/16
	L1 4°	3° 35'				1/4
	L2					
A4-8065 FR 95	L1 33'-1 1/8"	33'-1 1/8"	0			
	L2 17°	15° 40'				1 1/16
	L3 4°	3° 35'				INRD BEV. 4" 1/4
	L4					
A4-8067 FR 97	L1 32'-0 5/16"	32'-1"	+ 11/16"			
	L2 18°	17° 16'				1 3/16
	L3 4°	3° 35'				+
	L4					

A4-1
14

10671

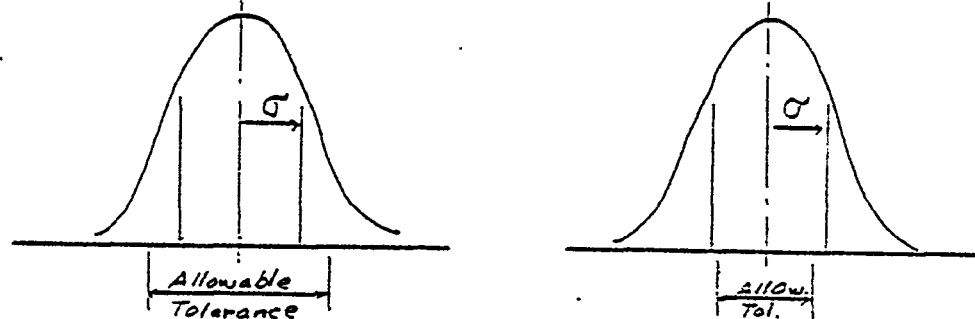
32

Data AnalysisAP-1-16

First, the measured data is rewritten into the table for data analysis which is convenient to calculate. (See Table 1). As seen in the table, there are four errors outside the effective range. These should be eliminated since they are mistakes and not a problem of accuracy.

For this measurement, $\pm 2/16"$ is considered to be the appropriate range of the errors in the coordinate system of "error frequency". Then the mean value of errors is calculated and by using that the standard deviation value is easily calculated. The relationship among this distribution of errors, the mean value of the errors and the standard deviation value is shown in Figure 1. This figure shows the following:

- 1) The mean value of errors is $1.2/16"$.
- 2) The value of the standard deviation is $3.8/16"$. This means that about $2/3$ of all the data is within $\pm 3.8/16"$ from the mean value ($-1.2/16"$).
- 3) The practical meaning of the standard deviation:



When the standard deviation is within the allowable tolerances, the accuracy is good enough or the allowable tolerance is too loose (See (a)). When the standard deviation is out of the allowable tolerance region, the requested accuracy is not satisfied or the allowable tolerance exceeds the capability of the shop.

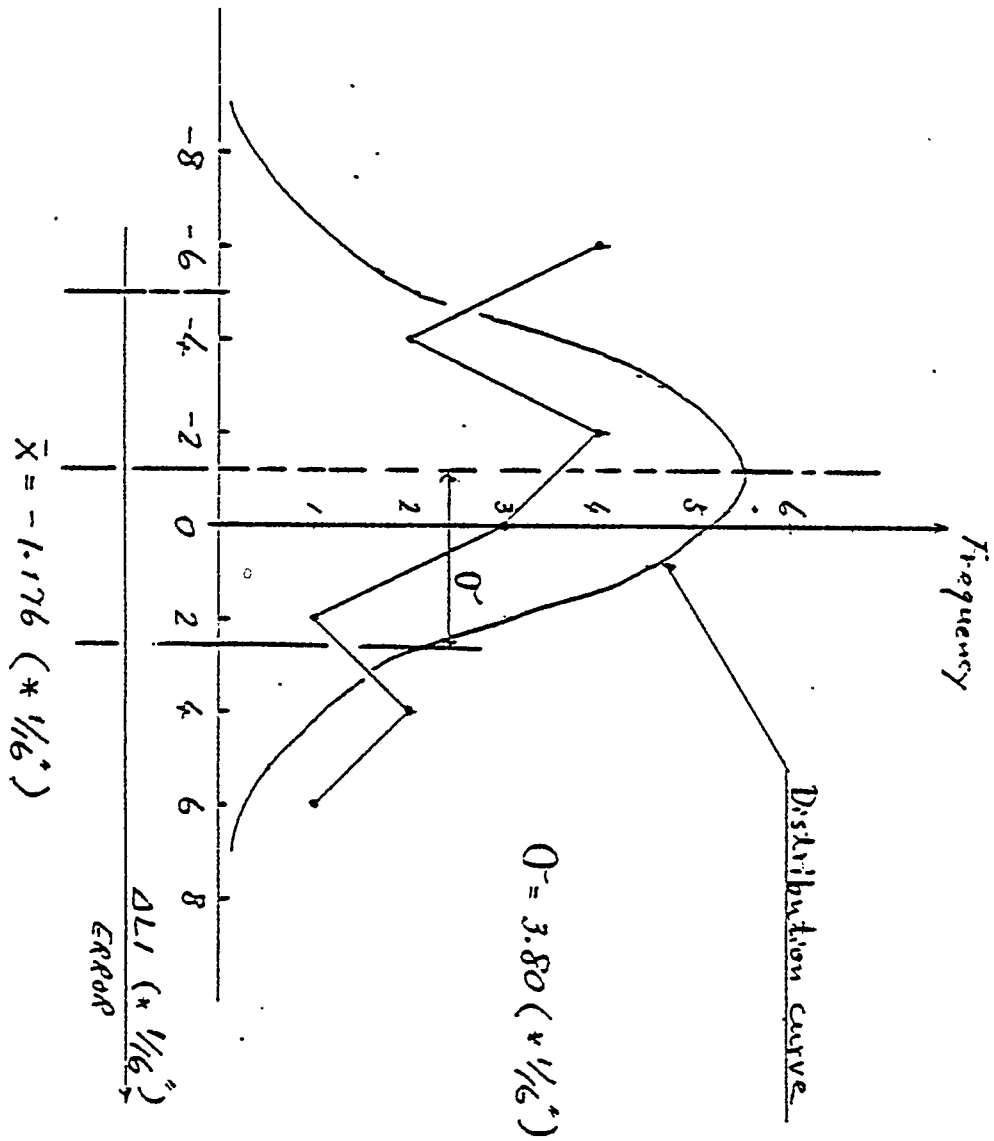
Thus the allowable tolerance should be decided taking into account both the requested accuracy and the capability of the shop.

(Table-1) TABLE FOR DATA ANALYSIS

Error ΔL_1	Frequency	$(\times 1/16")$ $\Delta L_1 - \overline{\Delta L_1}$	$(\Delta L_1 - \overline{\Delta L_1})^2 \times \frac{1}{16}$	
✓ -24/16	1			Mistake
✓ -18/16	1			
- 6/16	1	-4.8	92.16	Effective data
- 5/16	3	-2.8	15.68	
- 4/16	1	-0.8	2.56	
- 3/16	1	7.2	4.32	
- 2/16	2	3.2	10.24	
- 1/16	2	5.2	54.08	
0	3	7.2	51.84	
+ 1/16	0			
+ 2/16	1			
+ 3/16	1			
+ 4/16	1			
+ 5/16	1			
✓ + 11/16	1			Mistake
✓ + 16/16	1			
$\overline{\Delta L_1} =$ -1.176/16 $\div -1.2/16$	N = 21-4 = 17		230.88	

AP-1 18

Fig -1.



5.5 - CUT PLATES BY N/C

APPENDIX-2 AP-2-1

- 1) ROLL PLATES AT ROLLS
- 2(a) FAB. BKTS & COLLARS
- 3) CHECK PIN JIG
- 4) ALIGN PLATE TO REF. FRAME THEN WELD (SAW)
(A9-2302 + A9-2304 + A9-2306)
- 5) RECHECK FOR EXACT POSITION OF PANEL ON P.
& CHECK DIAGONALS.
- 6) CHECK LAYOUT & CLARIFY.
- 7) FIT FRAMES (ORD) A9-2365, A9-2367, A9-2369,
A9-2373, A9-2375, A9-2377,
A9-2381, A9-2383, A9-2385,
& A9-2389,
ALSO FIT WEB - A9-2402 & A9-2404
ALSO FIT STR - A9-2316, A9-2318 & A9-2320
FIT COLLARS & TRIPPING BKTS & LOWER BKT.
(AB-885) (A9-2334 & A
- 8) RECHECK PIN JIG AFTER FITTING WORK ACCOMP.
- 9) BEGIN WELDING:
 - a) ALL VERTICAL WELOS (IAW REF. #) INCLUD.
COLLARS (SHORT ARC) 6 MW
 - b) WELD TRIPPING BKTS (MMA)
 - c) WELD ORD FRAMES & WEBS. IAW REF # (AUTO
 - d) WELD STRS (MMA)
 - e) WELD LOWER BKTS. A9-3968, A9-3970NOTE! UPPER BKTS. SHIP LOOSE. TALK TO UN
- 10) DIMENSION CHECK UNIT.

A2-453

AP-2-2

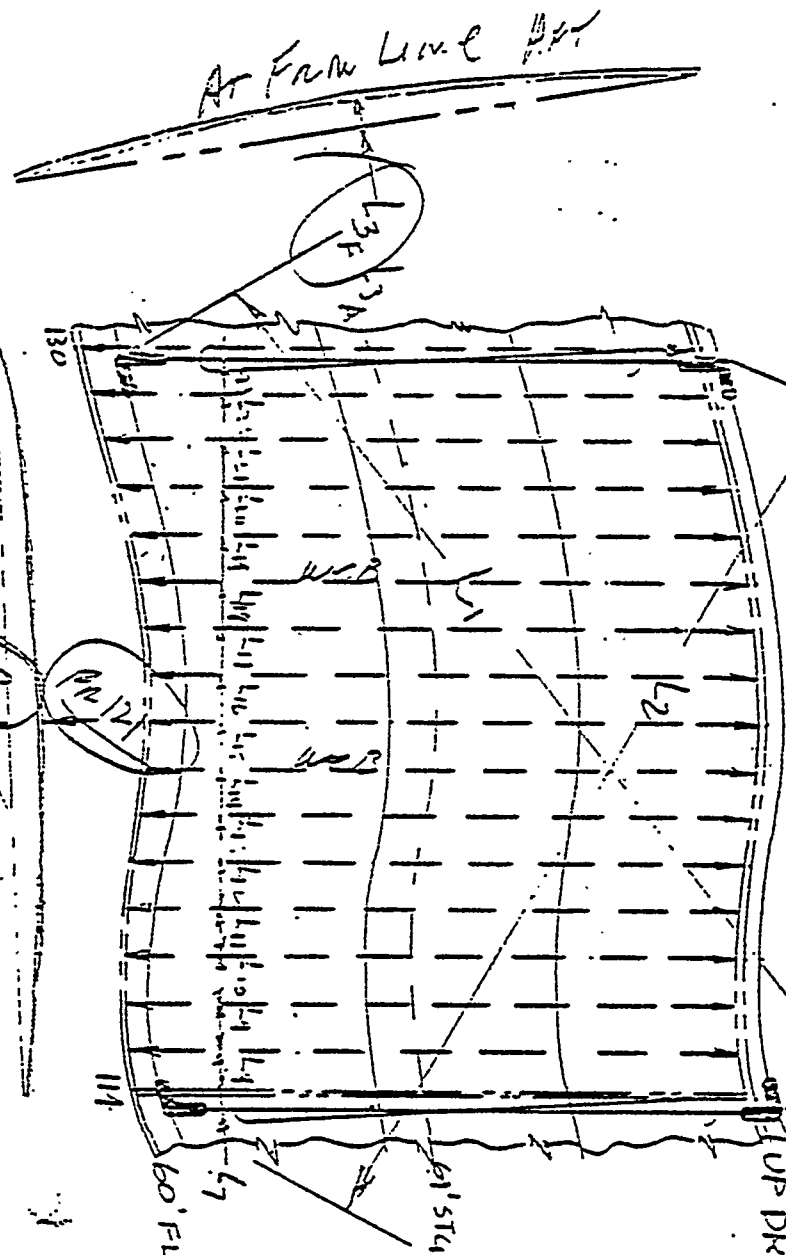
SHT-37

- <11> TURN ASSY THEN FINISH WELDING SEAM IAW REF
- <12> CHECK UNIT
- <13> CHECK SHIP TO RECEIVE UNIT.
- <14> TRIM UNIT AS NECESSARY.

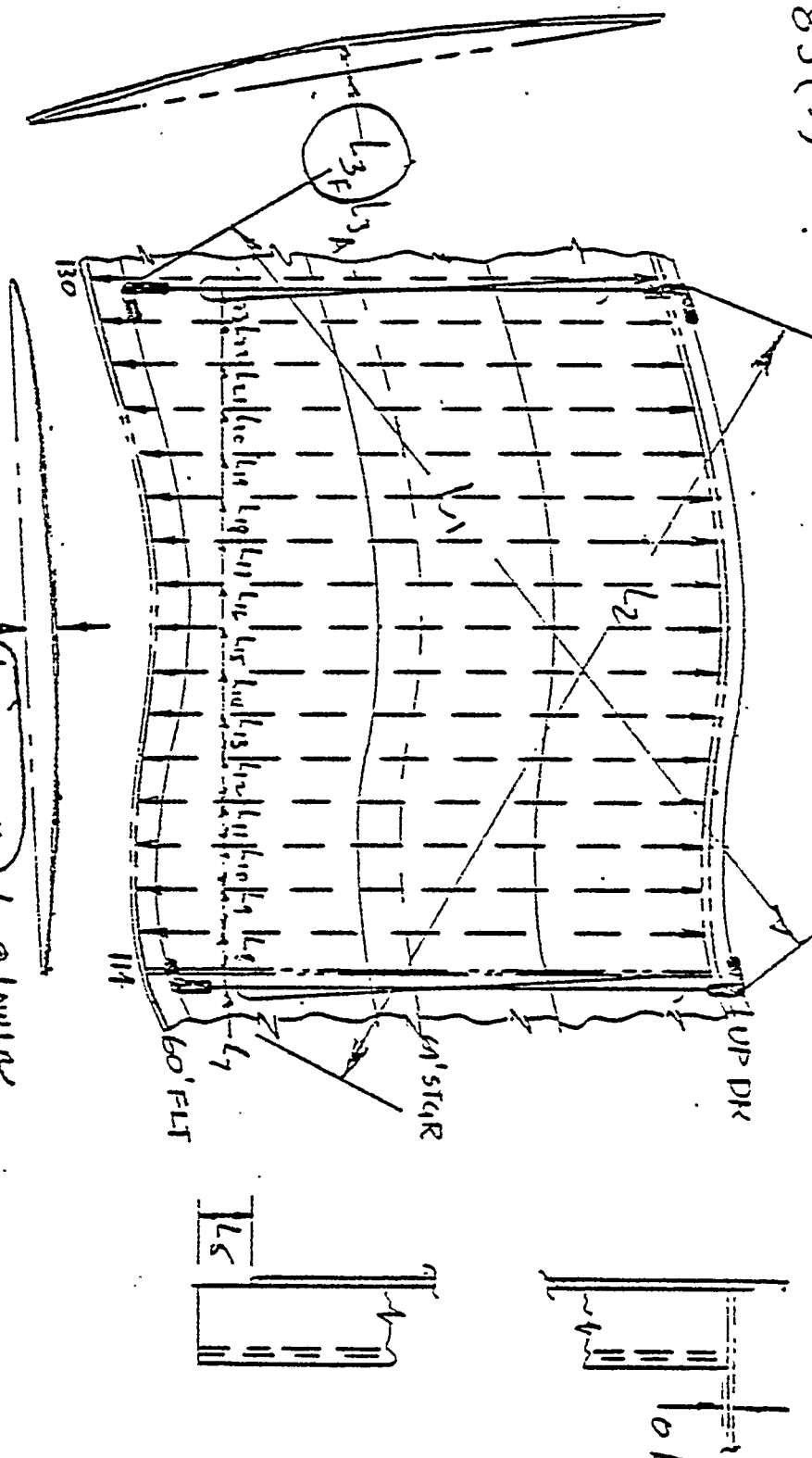
L	--- DIM	RGUT DIM	--- DEV	--- AL
L1				
L2				
L3F		10 5/8"		
L3A				
L4U				
L4B		2 7/8"		
L5				
L6				
L8		25 5/16"		
L9		25 5/16"		
L10C		25 5/8"		
L11		25 5/16"		
L12		25 9/16"		
L13		25 5/16"		
L14		25 13/16"		
L15		25 1/16"		

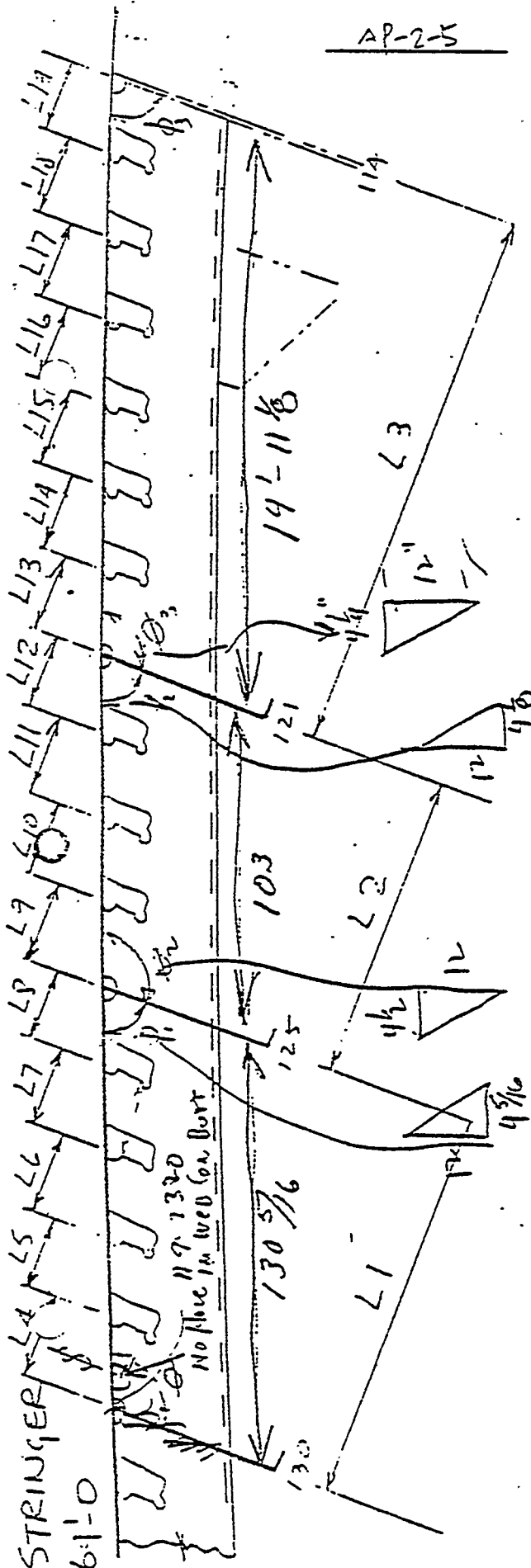
AP-2-3

AFTER UNLOADING



AP-2-L

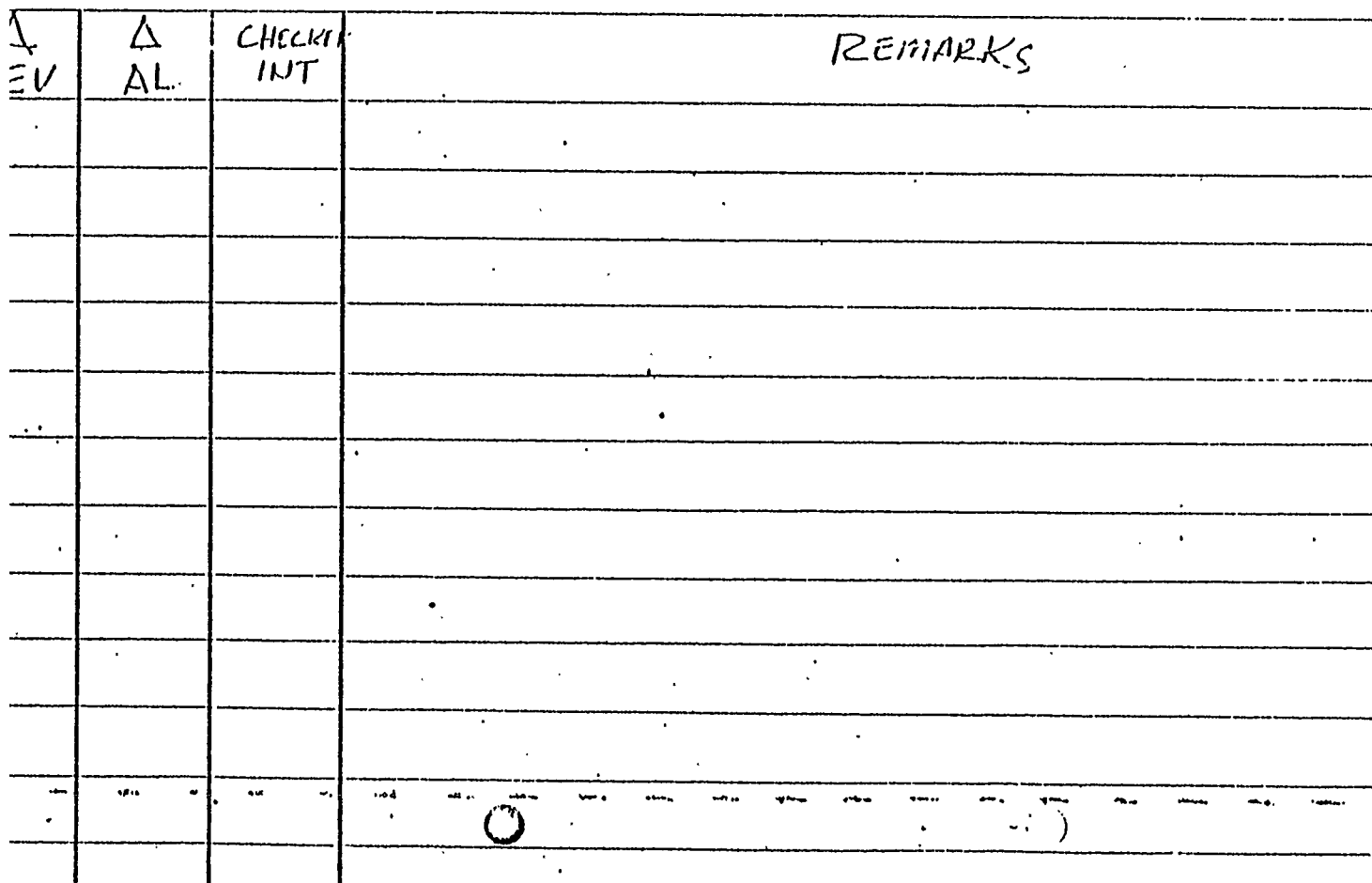
[illegible]



AP-2-5

ART	L	DES DIM	ACT DIM	Δ DEV	Δ AL	L	REMARKS
	L1					L4	24"
	L2					L5	24 1/2"
	L3					L6	24 3/16"
	L4					L7	24 3/16"
	L5					L8	24 3/16"
	L6					L9	24 3/16"
	L7					L10	24 3/16"
	L8					L11	24 3/16"
	L9					L12	24 3/16"
	L10					L13	24 3/16"
	L11						
	L12						
	L13						
	L14						
	L15						
	L16						
	L17						
	L18						

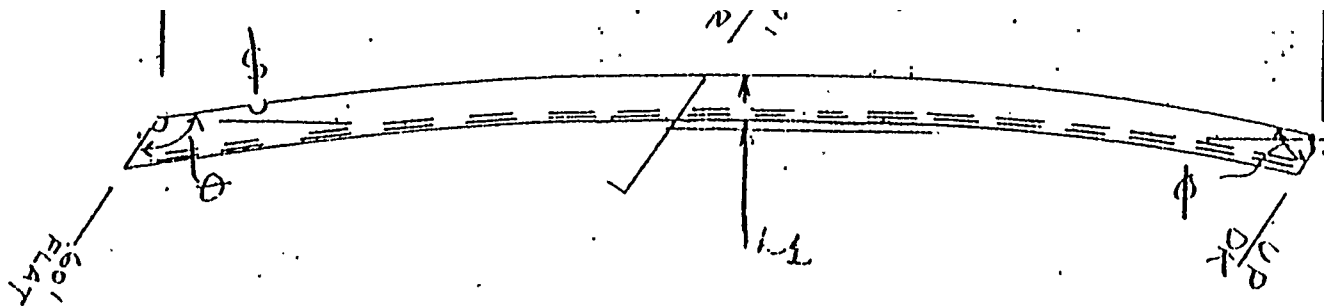
NOTE: DIMENSIONS AFTER COMPLETION OF WELDING WAS





10

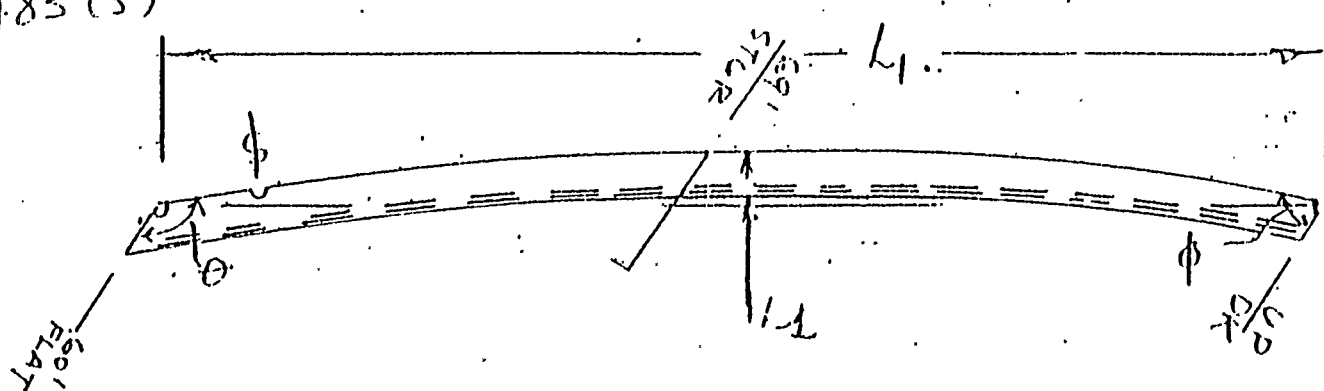
AP-2-9



PART		DES DIM	ACT DIM	Δ DEV	Δ AL	CHECK INT	REMARKS
19-2373	L1	24'-4"	24'-4 7/8"				
	L2						
	Θ	134	134 1/2				
	φ	68	69°				
19-2371	L1	24'-6 1/4"	24'-7"				
	L2						
	Θ	135	136				
	φ	70	68 1/2				

DEP FICHE

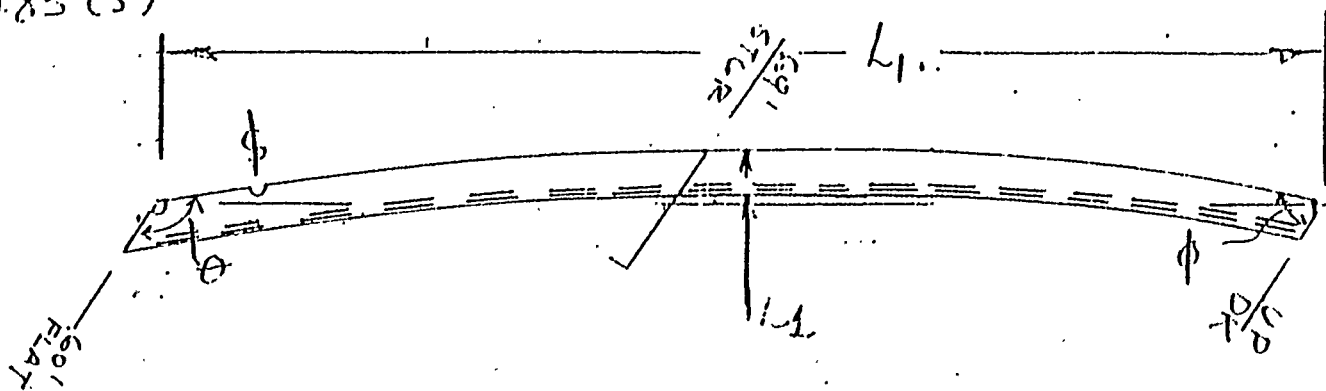
AP-2-10



PART		DES DIM	ACT DIM	Δ DEV	Δ AL	CHECKER INT	REMARKS
7-2377	L ₁	24'-17/8"	24'-3"				
	L ₂						
	θ	133°	133 1/2				
	ϕ	70°	69°				
7-2375	L ₁	24'-3 1/8"	24'-3 5/8"				
	L ₂						
	θ	135	134 1/2				
	ϕ	69°	69°				

DEB FRAME

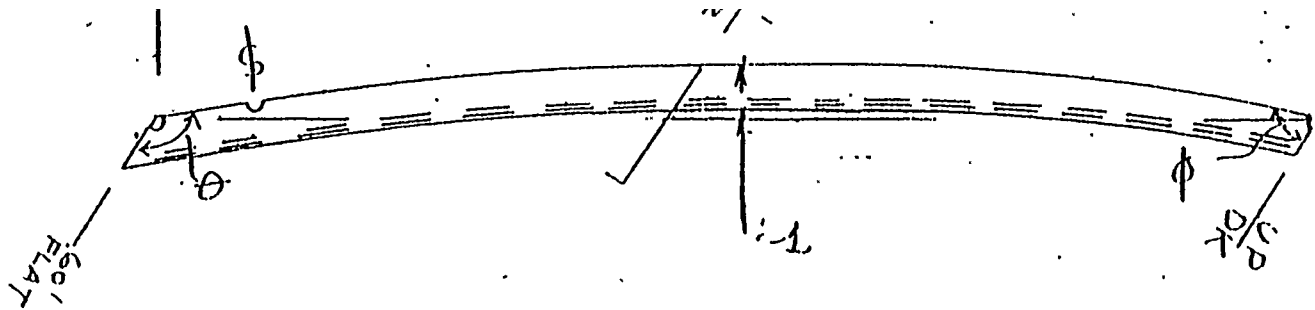
AP-2-12



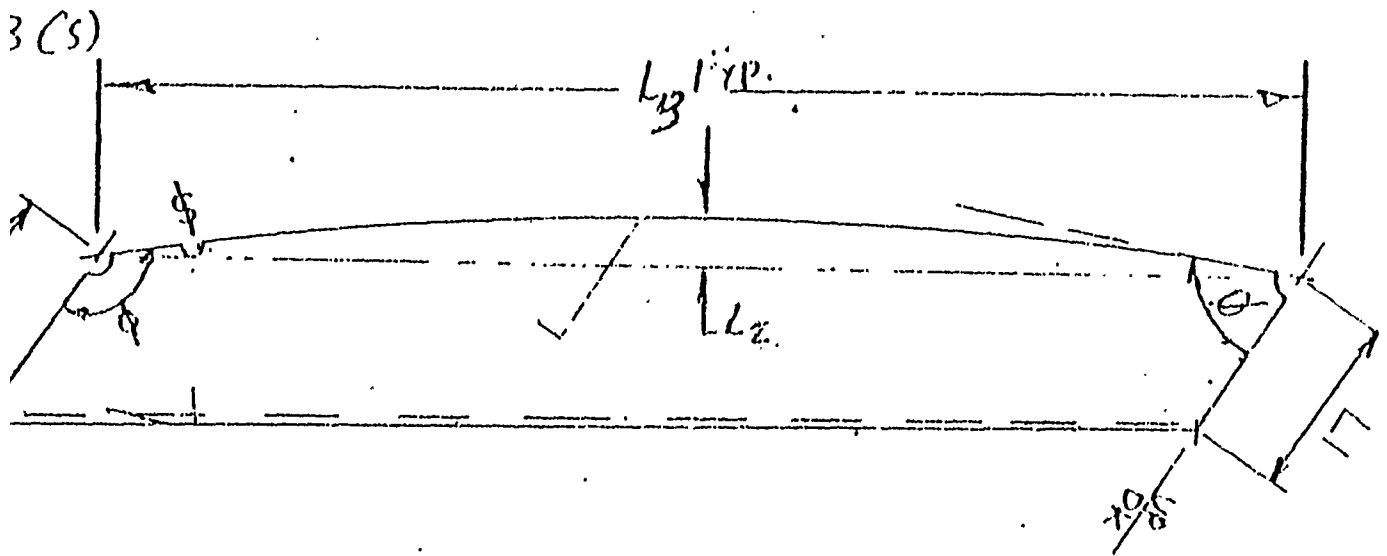
PANEL		DES DIM	ACT DIM	Δ DEV	Δ AL	CHECKED INT	REMARKS
A9-2385	L ₁	23'-8"	23'-9 1/4"				
	L ₂						
	θ	132°	133°				
	φ	69 1/2°	69°				
A9-2393	L ₁	23'-9 3/8"	23'-9 3/4"				
	L ₂						
	θ	131 1/2°	133°				
	φ	68 1/2°	67 1/2°				

AP-2-13

NOTE 1" X 5



BLK		DES DIM	ACT DIM	Δ DEV	Δ AL	CHECKED INT	REMARKS
11-2387	L ₁	23'-6 $\frac{3}{16}$ "	23'-6 $\frac{11}{16}$ "				
	L ₂						
	θ	133°	133°				
	φ	70°	69°				
11-2387	L ₁	23'-7"	23'-6 $\frac{11}{16}$ "				
	L ₂						
	θ	134°	133°				
	φ	71°	69°				



CT M	Δ DEV	Δ AL	CHECKER INT	REMARKS
1/4				
1/8				
0				
1°				
2 1/4				
1/16"				
5°				
10°				

STUDY REPORT ON SHIPBUILDING
FOR
NATIONAL STEEL AND SHIPBUILDING CO.

Volume III
- Palletization -

October, 1979



Ishikawajima-Harima Heavy Industries Co., Ltd.

TOKYO, JAPAN

CONTENTS

	<u>PAGE</u>
CHAPTER 1 - CONCEPT OF PALLETIZATION	
1. Overview of Palletization _____	1
2. Concept of Palletization	
2.1 Introduction _____	12
2.2 The Aims of Palletizing _____	13
2.3 The Relations-hip of <i>Palletizing</i> , _____ Pre-Outfitting and On-board Outfitting	16
2.4 Grouping of Jobs -_____	16
3. Resources of Palletizing _____	18
4, Planning Palletizing _____	19
4.1 Introduction _____	19
4.2 Palletizing by System_____	22
4.3 Palletizing by Zone _____	23
4.4 Grouping by Trade _____	27
4.5 Grouping by Stages _____	29
4.6 Manufacturing of Pallet _____	33
5. Efficiency of Outfitting Jobs _____	35
5.1 System Efficiency _____	35
5.2 Activity Efficiency _____	36
5.3 Palletizing and Efficiency _____	37

PAGE

CHAPTER II - PROCESS OF PALLETIZATION

1. Outline of Process for Palletization	39
1.1 Planning of Outfitting Method	39
1.2 Preliminary Composite Drawing	40
1.3 Scheduling of Material Procurement	40
1.4 Review on Preliminary Composite Drawing	41
1.5 Developing Composite Drawing	41
1.6 Review of Working Drawing	41
1.7 Development of Working Drawings	42
2. Design Phase	48
2.1 Requirement for Design or Production Planning	48
1) Composite Drawing	48
2) List of Material for Outfitting	49
2.2 Drawing Issue Schedule	51
2.3. Composite Drawing	52
2.4 Material List of Pallet (MU)	55
3. Material Control	68
3.1 Scheduling for Material Procurement	68
3.2 Expediting and Palletizing	71
4. Outfitting Production	
4.1 Functions of Organization	80
4.2 Major Activity of Palletizing Planing	84

	<u>PAGE</u>
1) Planning of Outfitting Method and Palletization	84
2) Review of Palletizing	95
3) Review of Composite Drawing	96
4.3 Material Marshalling and Palletizing	98
1) Role of Material Preparation Group	98
2) Organization	99
3) Material Preparation	100
4) Inspection	100
5) Palletizing	101
6) Transportation	102
7) Marshalling Area	102
8) Facilities	102
CHAPTER III - ZONING AND SYMBOL MARK	108
1. Composition of Zone Symbol	108
2. Zones and Symbols of Level A	110
3. Zones and Symbols of Levels B and C	114
3.1 Fore part "F"	114
3.2 Shell plates "S"	115
3.3 Upper deck "U"	116
3.4 Aft part "A"	117
3.5 Weather part of accommodation and engine casing "W", "E"	118

	<u>PAGE</u>
3.6 (Living) Accommodation " L "	119
3.7 Machinery room "M"	120
3.8 Pump room and tank part of tanker "P",- "T" —	121
3.9 Parallel part of B/C, O/O, O/B and cargo ship —	122
3.10 Parallel part of container ship, —————	123
3.11 Overall zone "Z" —————	123
3.12 Zoning for electric outfitting —————	124
 CHAPTER IV - ML(F) AND FORM OF MLF-NO. IN IHI (GENERAL)' —	125
1. Definition of ML(F) —————	125
2. Breakdown of outfitting work and MH-No. —————	127
3. Basic form of MLF-No. (common for all parts) —	128
3.1 Basic form —————	128
3.2 Definition by column of MLF-NO. —————	129
 CHAPTER V - CODING GUIDANCE OF MLF-NO, (MACHINERY PART) —	134
1. Piece outfitting on block — —————	134
2, Unit outfitting on block —————	135
3. Machinery unit outfitting —————	136
4. Unit outfitting on board —————	137
5. Piece outfitting on board ————— —	138

	<u>PAGE</u>
6. Guidance for subdivision of a pallet on piece outfitting on block and unit outfitting	144
7. Guidance for subdivision for piece outfitting on board	147
7.1 Piping --- "P"	147
7.2 Control and Automation System --- "C"	150
7.3 Traffic System --- "K"	151
7.4 Machining and Adjusting --- "G"	153
7.5 Ventilation Trunk --- "T"	157
7.6 Foundation Seat --- "F"	158
7.7 Funnel Part --- "U"	159
7.8 Insulation --- "I"	159
7.9 Spare Parts, Accessories --- "X"	159
7.10 Main Engine --- "E"	160
7.11 Boiler --- "B"	161
7.12 Auxiliary Machinery --- "A"	161
7.13 Propeller Shaft --- "J"	162
7.14 Miscellaneous --- "Z"	163
7.15 Joiner Work in Engine Control Room and Work Shop --- "D"	164
7.16 "-" Fitting (Welding) of material temporarily installed at preceding stages	165
CHAPTER VI - AN INTRODUCTORY EXAMPLE OF PALLETIZATION ON NASSCO'S DRAWINGS	166
i. Introduction	166

	<u>PAGE</u>
2: Assumption	168
2.1 Block Arrangement	168
2.2 Zoning	169
2.3. Staging	169
2.4 Machinery Name	170
3. Pallet List	173
4: MLF (Material List for Pallet)	176
4.1 On-Block Stage	176
4.2 Unit Stage (on-Block and Onboard)	178
4.3 Onboard Stage	179
5. Relocation of Pipes	187
6. Other Notes on NASSCO's Drawings	190
CHAPTER VII - AN EXAMPLE OF PALLETIZATION ON IHI'S DRAWINGS	191
1. Composite Drawings	191
2. MLF	193
2.1 On-Block Stage	193
2.2 unit	194
2.3 On-Board stage	195

CHAPTER I - CONCEPT OF PALLETIZATION

1. Overview of Palletization

Until approximately 20 years ago., machinery, -piping, ducts, electrical wires, handrails, ladders, manholes, furniture, and other items referred to as outfitting materials, would be installed on-board while a ship was in berth or at pier. The installation work was usually planned to be carried out system-by-system, and was started after hull construction was completed.

Ballast piping and firemain piping running through one compartment were scheduled separately. Two different groups of workers were engaged in those installations. The number of activities to be controlled for a ship was tremendous and its network was too complicated for satisfactory interface between the systems.

When the ballast piping system had a special connection with the firemain piping system, ballast piping workers whose work progressed more quickly than others, had to wait until the firemain piping installation progressed enough to allow connection.

As the piping installations progressed system-by-system, the work area was scattered over the ship. While a group of workers was mounting a firemain valve on the foc'sle deck, others were installing steam piping on the upper deck, bilge piping in the hold and ballast piping in the double bottom tank.

A group who was going to install a bilge suction manifold might have to hold up work in order to escape from a shower of melted metal which was ejected by another group who were cutting pipe supports, located just over the bilge manifold. Such problems made 2 pipefitting foreman unable to keep track of the current status of his jobs.

When work was to be started, a worker who was in charge of material handling referred to the drawing and went to the warehouse to receive the necessary materials. However, many times a valve was not provided in time because of a stock shortage. The pipefitter then had to fabricate a temporary spool piece to use in place of that valve. When he received the valve, he had to, return to the place where the spool piece was temporarily mounted, to replace it with the valve. This forced him to spend additional manhours in transferring tools with heavy hoses from one area to another.

Every piece of pipe was brought into a compartment through many narrow doors and up and down steep ladders, and to the place where it was to be installed.

Sometimes piping had to be installed overhead in the Engine Room, where the installation was dangerous, but scaffolding was costly. Such an environment would hamper workers' skills and productivity

Today, methods of outfitting have changed notably- Most outfitting work is started and completed zone-by-zone. When looking at the complexity of outfitting jobs controlled system-by-system, an

outfitting planner thought that if he could divide his jobs by zone and complete them independently, job planning could become much easier.

For example, if he had bilge, ballast: firemain, fuel oil, lubricating oil, feed water, low-pressure steam, high-pressure steam and pneumatic air piping running along the access passage, he had to take into account at least 10 elements when scheduling work system-by-system.'

However, if they can be divided into 2 zones and completed independently, the number of activities can be reduced from 10 to 2.

(See Fig. 1-1.)

To begin with, he drew several lines on the upper deck (for example, one centerline and several transverse bulkheads), creating areas within those lines. He called these areas "work zones." He grouped all materials which were to be installed in one "work zone" in the following manner:

Group A (material for pipefitters)

3 straight pipes, 1 bent pipe with branch, 1 stop valve and 1 penetration piece for ballast piping, 2 straight pipes, 1 straight pipe with branch, 4 fire hose valves and their manifolds for firemain piping, 4 pipe supports commonly used for ballast and firemain pipes, bolts and nuts for pipe support, bolts, nuts and packing for pipe joint.

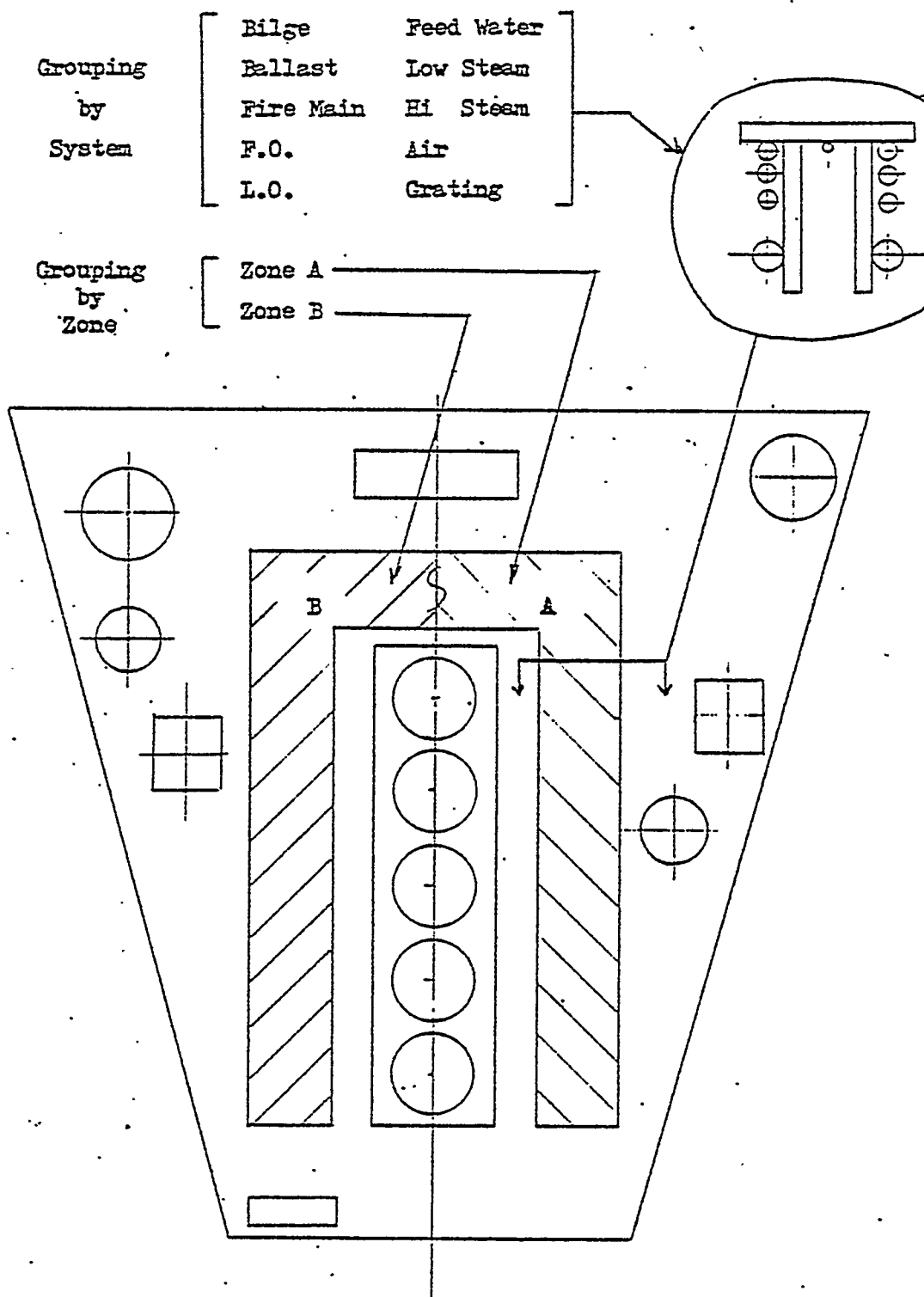


Fig. 1-1

Group B (material for outfitters)

2 manholes, 2 length of handrails, 1 bollard, 1 grating installed over pipes.'

Looking at these material groups, he considered that durations (or manhours) for installation of those grouped materials had to be suitable for control and that the number of activities had to be neither too many nor too few. He thought that appropriate unit activity would be one week in duration on the average and that it would correspond to approximately 30-40 pieces of pipes in the case of pipefitting.

Also he considered that if 1 penetration piece of Group A and 2 manholes of Group B could be installed during the assembly stage of hull structure, he could save Additional, compared with having to install all materials onboard. In that way, workers could be in fresh open air, safe conditions, favorable access conditions, tool availability, and so on. He then decided that those were to be another group, and named it A2. Finally, he settled his groups into Groups A1, A2, B1 and B2 for the particular "work zone."

He also thought that if it were possible that the installation jobs for Groups A1, A2, B1 and B2 were individually accomplished by one worker group of a single trade and at one time. If all of his ideas were possible, it would give him a means of job control. He then called each single unit of installation jobs an "Activity."

Today, he schedules all of his outfitting jobs by "Activity" such as Activity A1, A2, B1 and B2. As he has studied, Activities A1 and B1 will be scheduled for the onboard stage and Activities A2 and B2 for the assembly stage of hull structure. Of course, he is aware that he needs a new activity which has no materials belonging to it, such as adjusting gauges, hydraulic testing, operations, etc.

Now, all materials of Group A are packed in steel containers and lined up at the front of the warehouse when the Group A scheduled issue date arrives. The warehouseman calls them "pallets." The pallet has a small pocket where a material list is attached. From the material list, not only the warehouseman, but also the pipefitter and anyone else who wants to know can understand the following:

-- -- --

What materials should be contained in this pallet? What materials are actually contained? What material are missing because of delayed shipment? Where are the materials in this pallet to be used for? Where is this pallet to be delivered? When is this pallet to be delivered? What stage does this pallet go to? What trade is in charge of this pallet? "

When a foreman is to start an activity, all he has to do is to tell the warehouseman the pallet number corresponding to the activity. (Number of activity and pallet are the same.) The warehouseman then sends the pallet to its own destination.

When pipefitters go to the ship (work zone) as their foreman indicates they will find all of the necessary materials (pipes, valves,

bolts, nuts and gaskets); delivered to the work area. All they have to do is to install materials within a limited area as indicated in the drawing. Connections between different piping systems must be completed as soon as all work in one work zone is completed.

Now activities are scheduled in a workable order. Work is completed zone-by-zone and is not stretched widely. Consequently, the foreman can easily see his job situation. This gives him a flexible operation.

He has now established from experience the advantages for getting more profit on his job by palletizing.in process, .such as:

-One.pallet has- to :include all-materials necessary to complete **one unit of work.** One unit of work means one activity in his network.or one arrow line in his schedule chart (one control unit)

One pallet has to include all materials shown in one pallet zone on the composite drawing. But materials in one pallet may be divided *into some* partitions for each working stage, if necessary. "All materials" means not only major materials but also minor matetials as pipe supports, bolts, nuts, gaskets, etc.

Technical information for improvement on the job has to be fed back to the designer as precisely and quickly as possible so

as to be reflected on the piping design at once. One of the important features included in technical documentation is installation practices, such as installation sequence, location of loose pipe, loose flanges, parts to be preassembled, production stages at which materials are installed, etc.

6 Area or subdivision of pallet zone must be suitable supervised.

He then asks the question, "What groups and/or workers could best utilize palletization?" His reasoning is based on the following:

When the system-by-system process was used, he thought that every particular system required its own special technique or skill. But when pieces of pipe in one pallet are complete set for piping system in a certain area consisting of completed parts (spool piece), all built with particular features required by a particular system, then special techniques skills will not be required:

For example, if high-pressure steam piping is delivered with special copper gaskets, special strong bolt-nuts, special spring hangers, etc., and each of them is identified as to location by referring to a drawing, and that drawing indicates all necessary information for installation such as distances between the pieces and frame lines, height from deck, whether the piece has to be installed permanently or temporarily, whether a flange of the piece has to be "loose" or not, etc., then the piping installation no longer requires particular techniques and skills.

Instead, if a production-oriented zone-by-zone drawing is utilized, the installation becomes simple, such as only putting the pipe piece on a line as indicated in a drawing, tightening flanges after inserting gaskets *which are* delivered with the pipe piece, welding hangers, and so on. He reaches the same conclusion in regard to all other outfitting" materials.

This reasoning suggests a possibility of improving the efficiency of workers' trade in that only one group **of workers** (**in special cases, only one worker**) can accomplish a single activity.

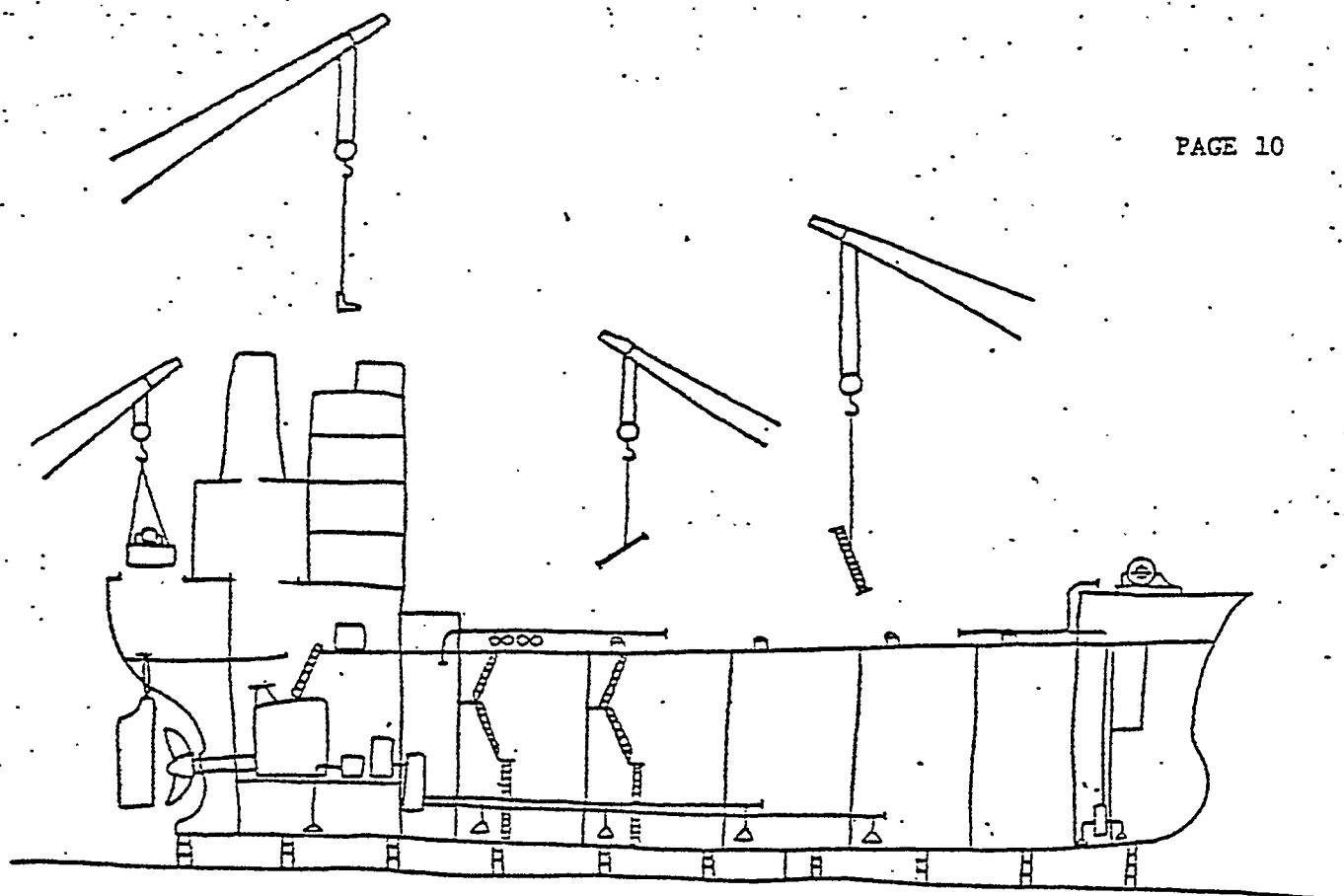
He can now plan an education program for multi-trade workers, the workers who are capable of installing piping, gratings, manholes," bollards, machinery, etc. He concludes that this is a way of attaining higher productivity from the viewpoint of schedule control and of providing greater satisfaction *for* the workers.

Figs. 1-2 and 1-3 illustrate general view to emphasize the difference between outfitting by system and by zone. The former has a trend that materials are loaded and installed piece by piece - inefficiently, while materials of the-latter are loaded and installed in group - efficiently. The difference in efficiency is mainly brought from careful planning by means of zone.

... -

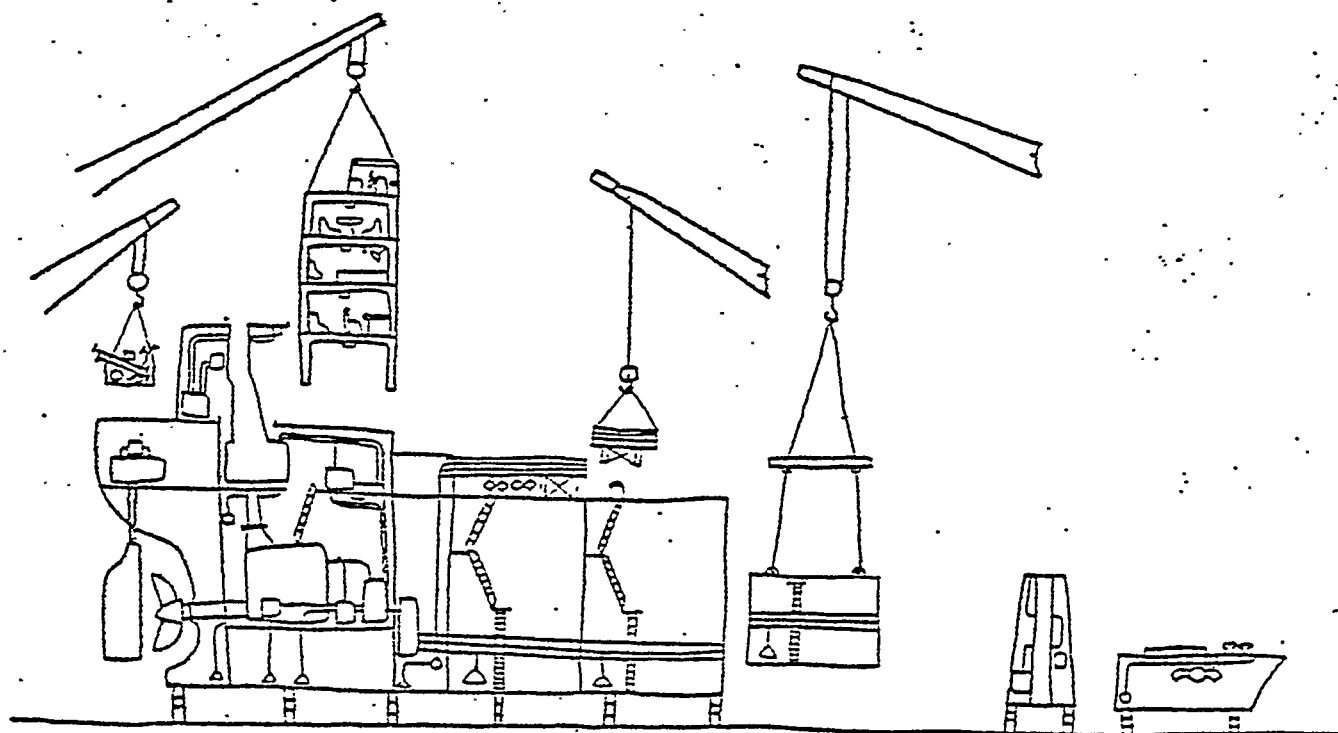
Fig. 1-4 shows machinery and pipes installed by zone on the block before block loading to the due position in the building dock.

Fig. 1-5 shows ducts, pipes and other fittings right below a ceiling of an accommodation space which are being installed by zone on the turned over block before erection.



OUT FITTING BY SYSTEM

Fig. 1-2



OUT FITTING BY ZONE

Fig. 1-3

Fig. 1-4



Erection of grand block outfitted before erection



Fig. 1-5

On-block outfitting

2. Concept of Palletization

2.1 Introduction

When we consider the efficiency of outfitting, it may be necessary to return to the substantial nature of shipbuilding; the main activity is. "Assembly," dealing with and fitting various kinds of materials.

Such a variety of materials means depending generally on the labor-force to perform installation or fitting in a *large* physical area and by prolonging the working period. That also means working-with many kinds of jobs, at the same area, in some orderly *manner*." The weights of *all* materials range from the heaviest, which is lifted by machinery, to the lightest, which is carried by hand. These methods may produce idle time. This is the essential point to be *taken* into account when considering the efficiency of outfitting.

In summary, every material of some 50,000 items in a ship goes through several fabrication processes: as to *raw material*, from the purchased time until manufactured and fitted onboard; as to finished product, from the purchased time until fitted and tested. Until a ship is completed, we can assume that there are some 500,000 processes. Only one hour of idle time on one process means some 500,000 hours of idle time in all.

This idea leads one to consider whether it is possible to reduce the idle time by reducing the number of processes when dealing with many materials at the same time. The idle time between processes is reduced accordingly in amounts down to 10,000 hours, provided some 50 processes are dealt with as a process.

The idea of fundamental demand for palletizing is described here in part.

2.2 The Aims of Palletizing

- 1) To control the material flow starting with designing or production planning to fitting on the spot and to make it a unit of the flow.
- 2) To control the manhour flow in production and to make it a *unit* determined by the flow.

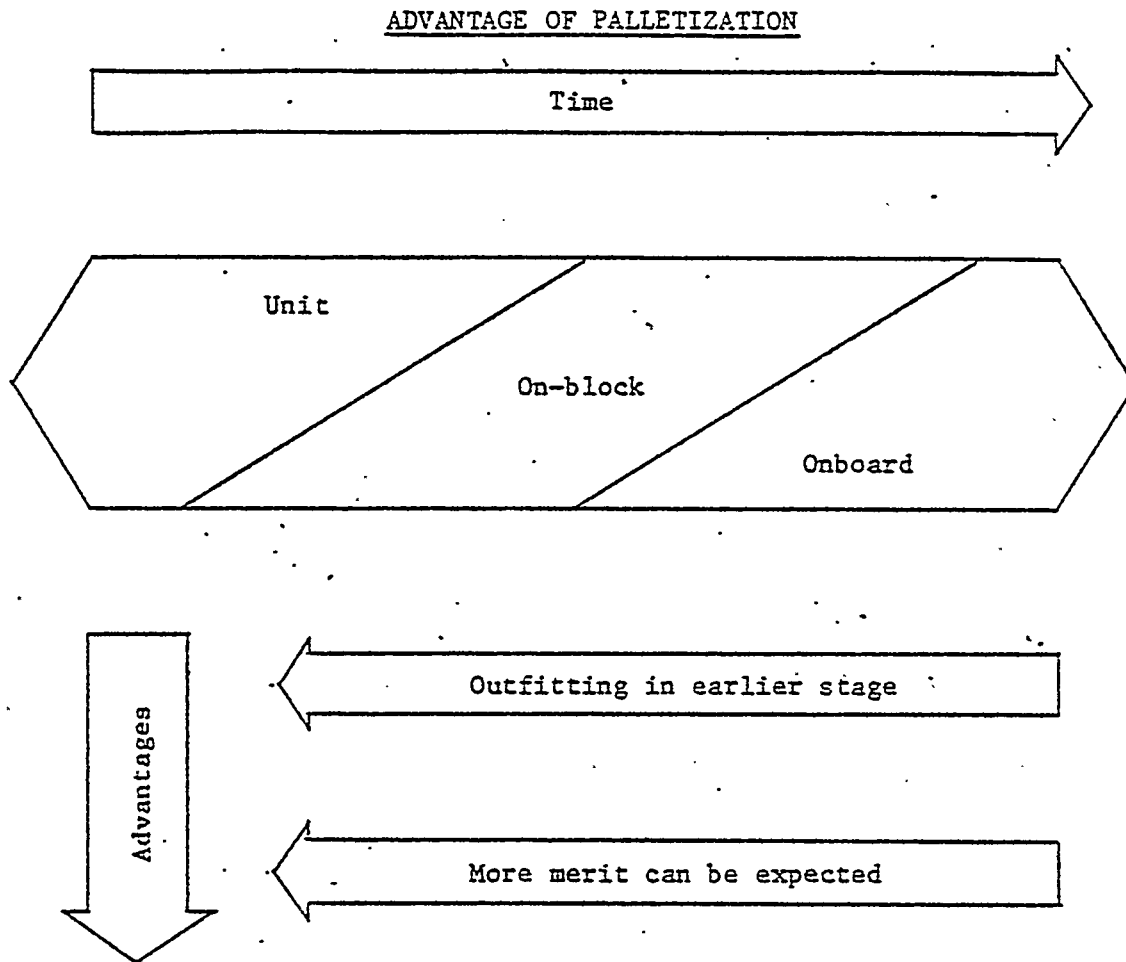
These two main aims can be broken down as follows:

- 1) To be aware of the jobs of one pallet as the unit of a job, and to make the job itself highly qualitative and highly efficient.
- 2) To regard the unit of a job as a process, to optimize the process flow and to simplify scheduling.

- 3) To regard all material as a part of the whole ship rather than as a part of each system; in other words, to make it nonfunctional or physical through the development of composite drawings in design.
- 4) To be aware of the pallet as a unit of material procurement control which starts with the design department's specifying the materials, thus making it a unit or a base, of drawing issue control.

It is not necessary to explain the above aims in great detail as *they* only refer to the most important aspect of the design. Even if palletizing without design is provided, it is essential to plan for palletizing. What kinds of materials are grouped? How do we get these materials in time as a whole? The design intention, actual drawing and the material specification lists are necessary to answer such questions. The progress of planning for palletizing is based on the development of the design, so that development of the drawing, the drawing issue schedule, and the list of materials are developed in a fashion to support the palletization concept.

properly speaking, design in relation to the drawing and the material specifications is the starting point of material flow *Of* production. Briefly stated, the aim of palletizing is to make the flow of men and materials in the factory systematic from design through production.



1. To minimize work onboard (low-efficiency work) and to increase work in shop (high-efficiency work).
2. To complete work zone-by-zone in order to make control easy.
3. To avoid trouble with hull construction and its work process.
4. To shorten total outfitting work period.
5. To improve efficiency of jumbo-sized facilities of berth/dock and shop.

Fig. 1-6

2.3 The Relationship of Palletizing, pre-Outfitting and Onboard Outfitting

The aims of palletizing are to provide --- materials for on-board outfitting as well as for pre- outfitting (= pre-erection outfitting). Although the merits of pre-outfitting are independent of the philosophy of palletizing, pursuing the merits of pre-outfitting will lead to palletizing.

In pre-outfitting, a certain regional unit will be specified; for example, compartment or zone of a ship, some group of fittings surrounding a certain machinery, or some group of tubings. In palletizing, such a regional unit may be further divided into sub-regions from the viewpoint of job procedure and functionally separate stages.

Thus the unit of palletizing can be determined with only the intention of optimizing of the job itself, whether it may be either pre-outfitting or onboard outfitting. This important feature shows that, conversely speaking, planning for palletizing is indispensable for both pre-outfitting and on-board outfitting.

2.4 Grouping of Jobs

As we discussed, there are many elemental-jobs in the outfitting field. They join together to form a network which is a powerful tool in outfitting job control. But the scope of the elemental jobs is too great to be controlled well, and must be reduced.

ACCURACY CONTROL

CHECK POINT, CHECKING DIMENSION, CHECKING METHOD

AT SUB-ASSEMBLY AND ASSEMBLY

BASED ON THE FABRICATION SEQUENCE OF A UNIT

PREPARED BY IHI

BOTTOM CENTER UNIT
FABRICATION SEQUENCE
1A) A.C. CONTROL POINT

SUB-ASSEMBLY

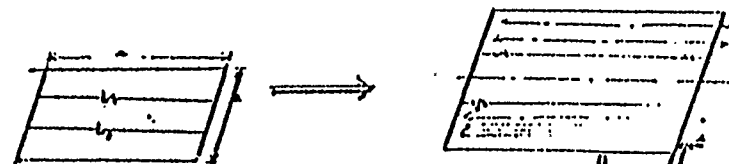
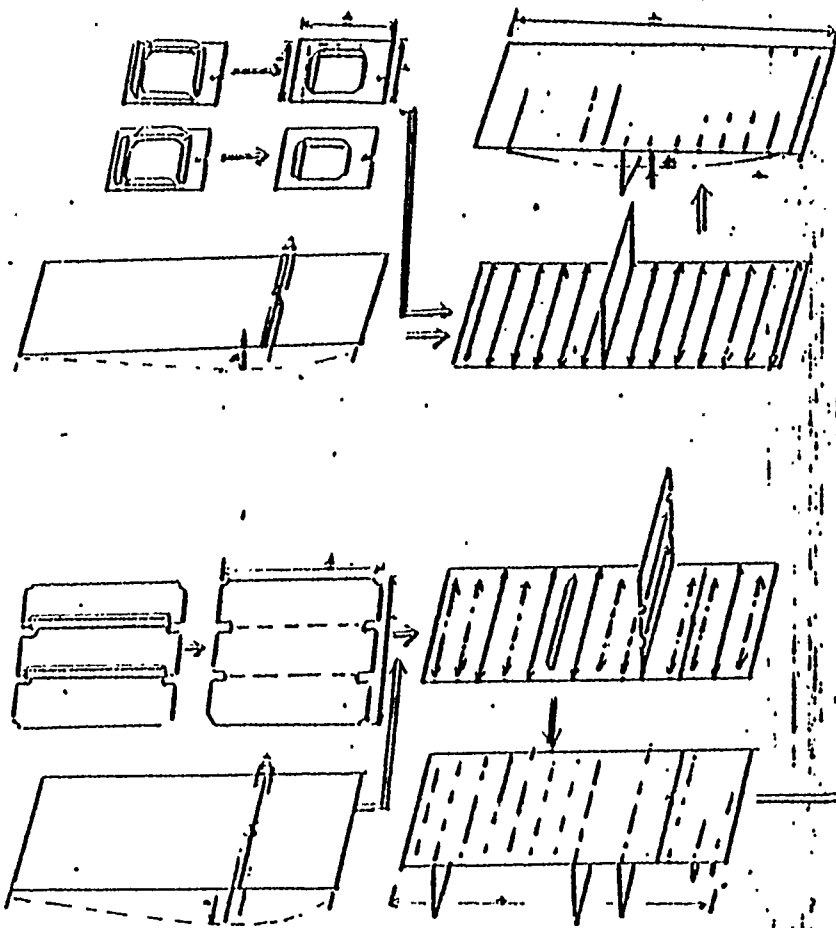
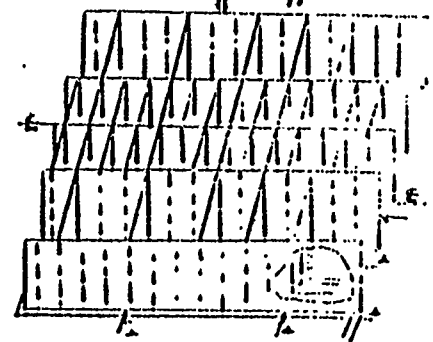


PLATE ASSEMBLY



ASSEMBLY
BOTTOM BASE

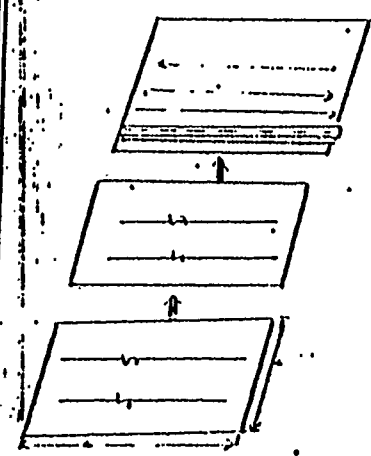
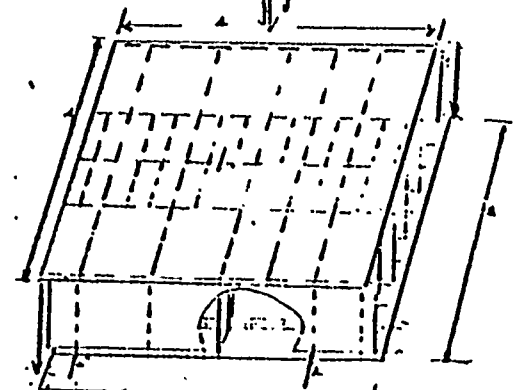


PLATE ASSEMBLY

T. TOP BASE

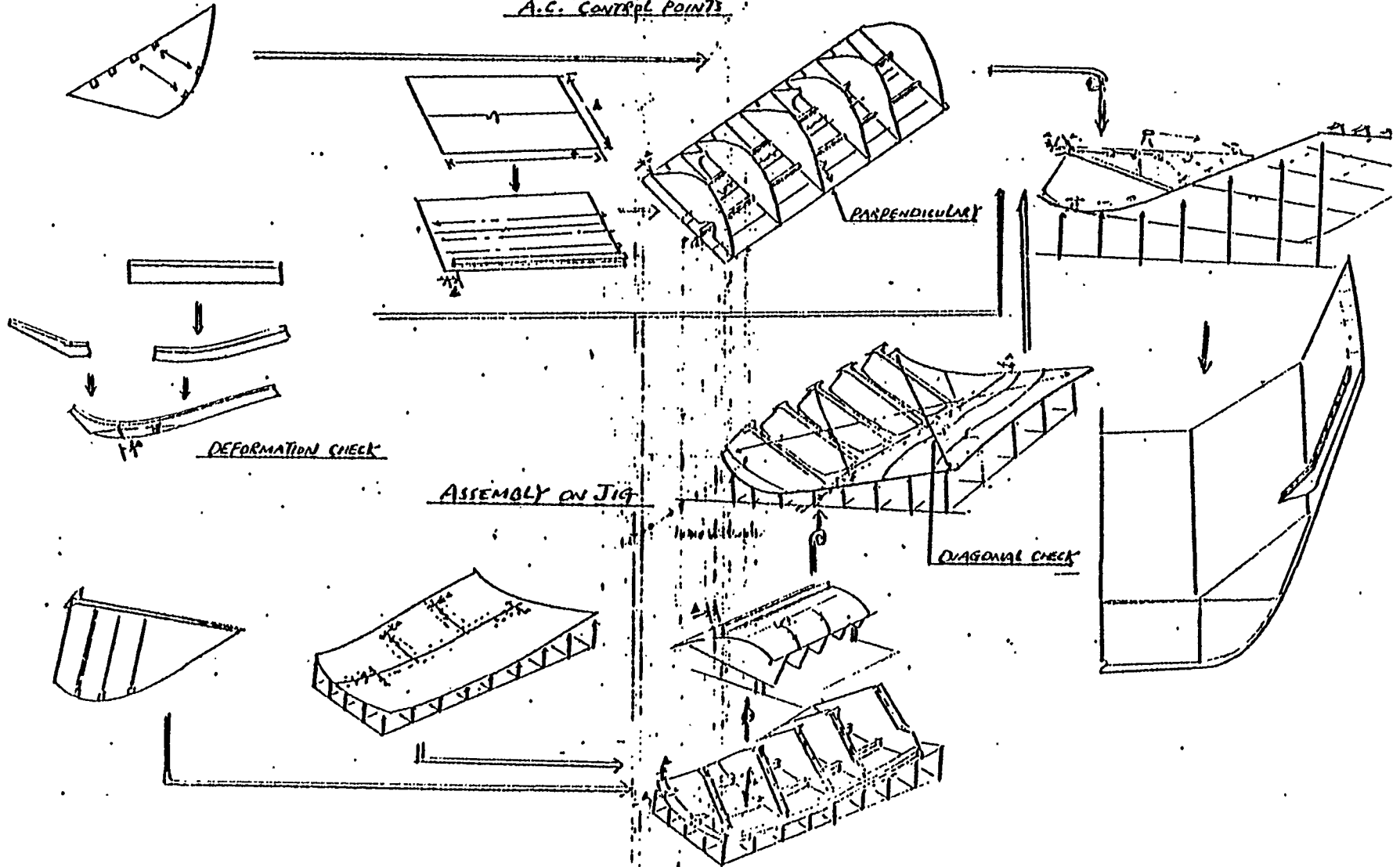
CHECK
T. TOP LEVEL
PERPENDICULAR



BILGE SHELL UNIT (CURVED)

FABRICATION SEQUENCE

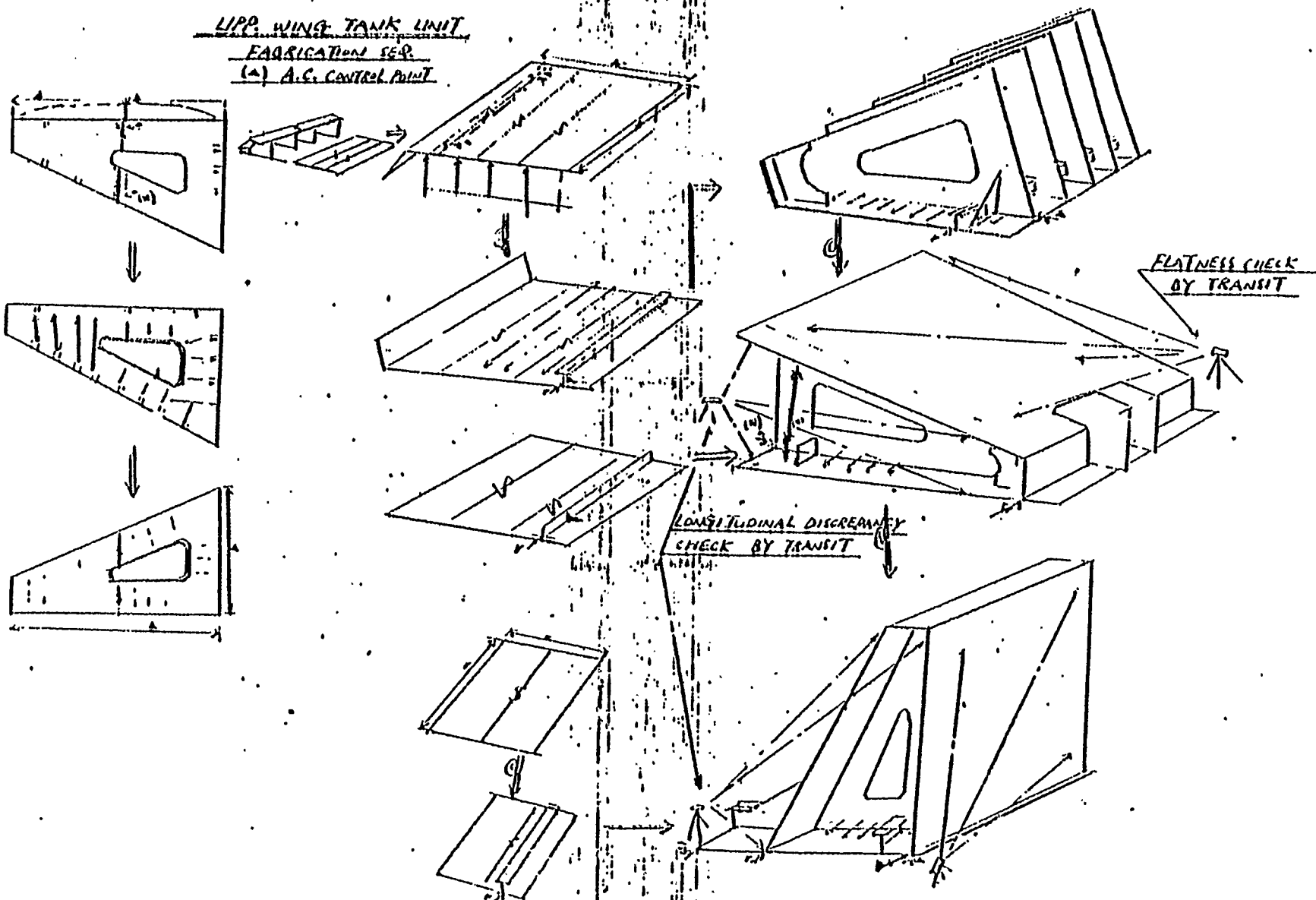
A.C. CONTROL POINTS



LIP, WING TANK UNIT

FABRICATION SEQ.

(A) A.C. CONTROL POINT

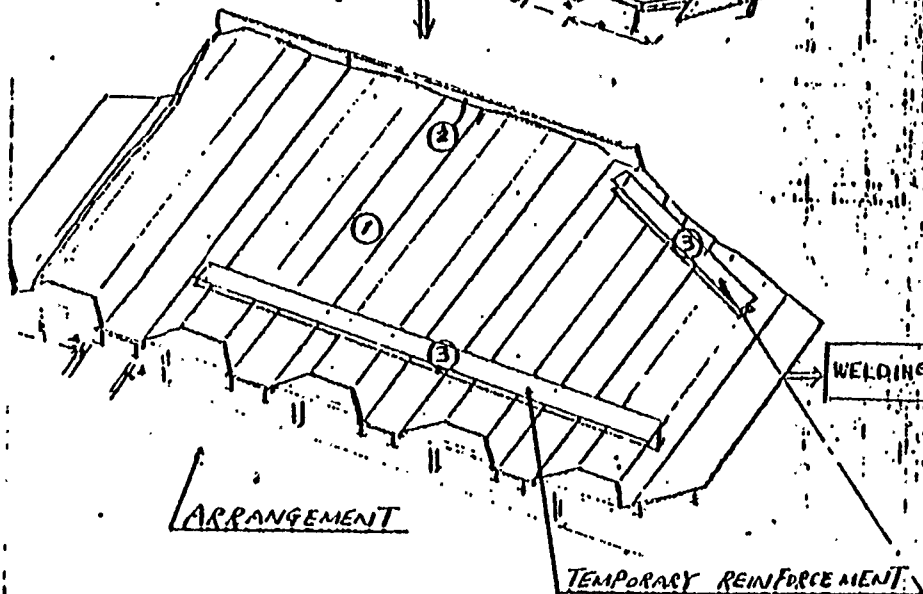
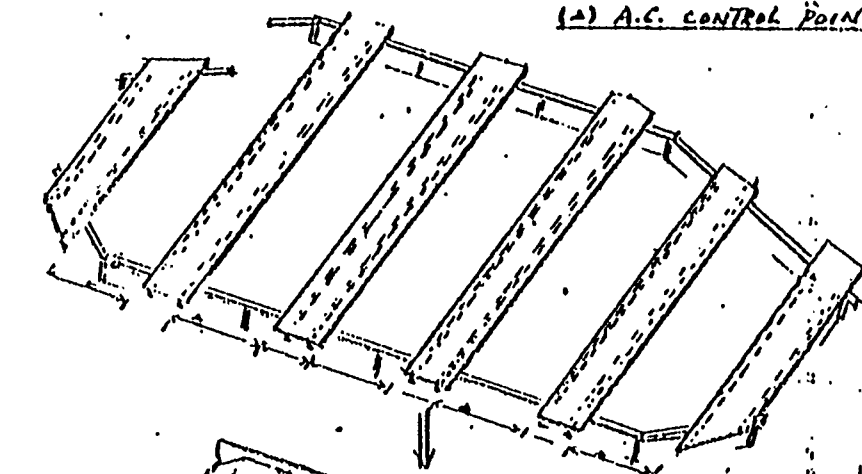


FOUNDATION LEVEL CHECK

CORRUGATED DEEP. BHD

FABRICATION SEQUENCE

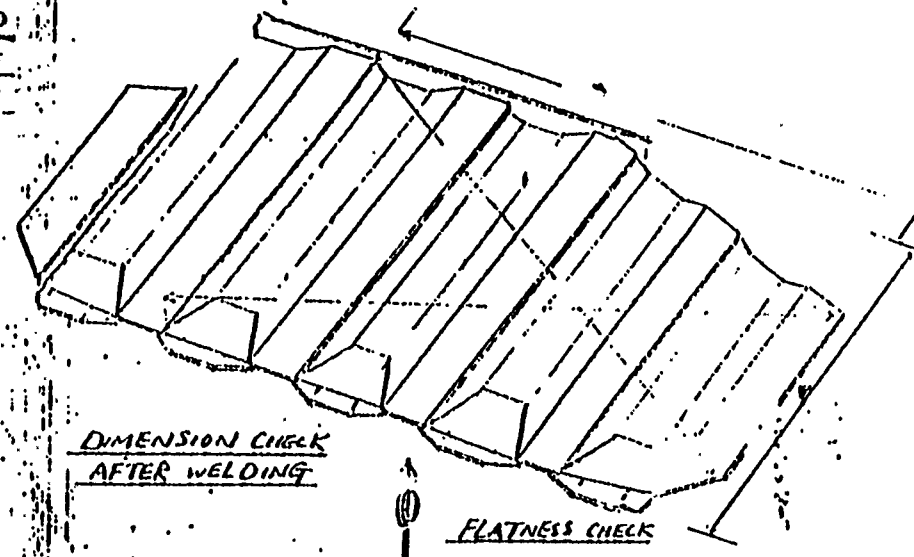
(A) A.C. CONTROL POINT



ARRANGEMENT

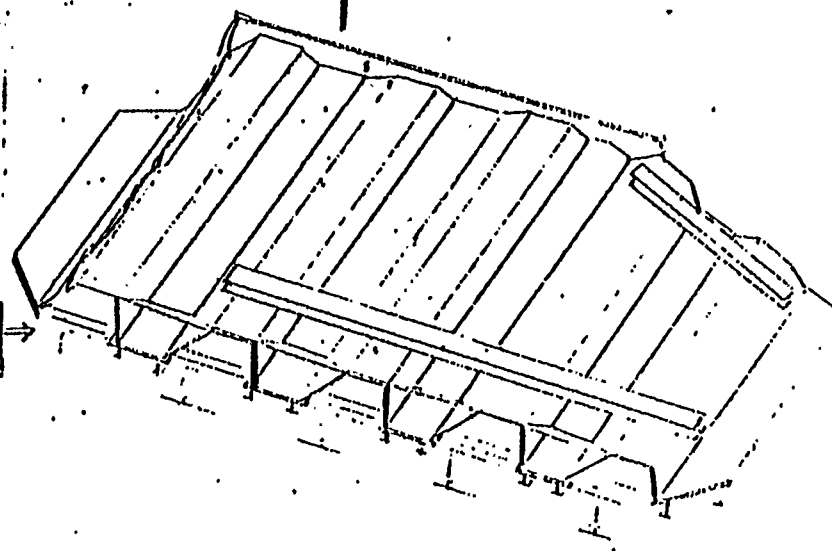
TEMPORARY REINFORCEMENT

WELDING

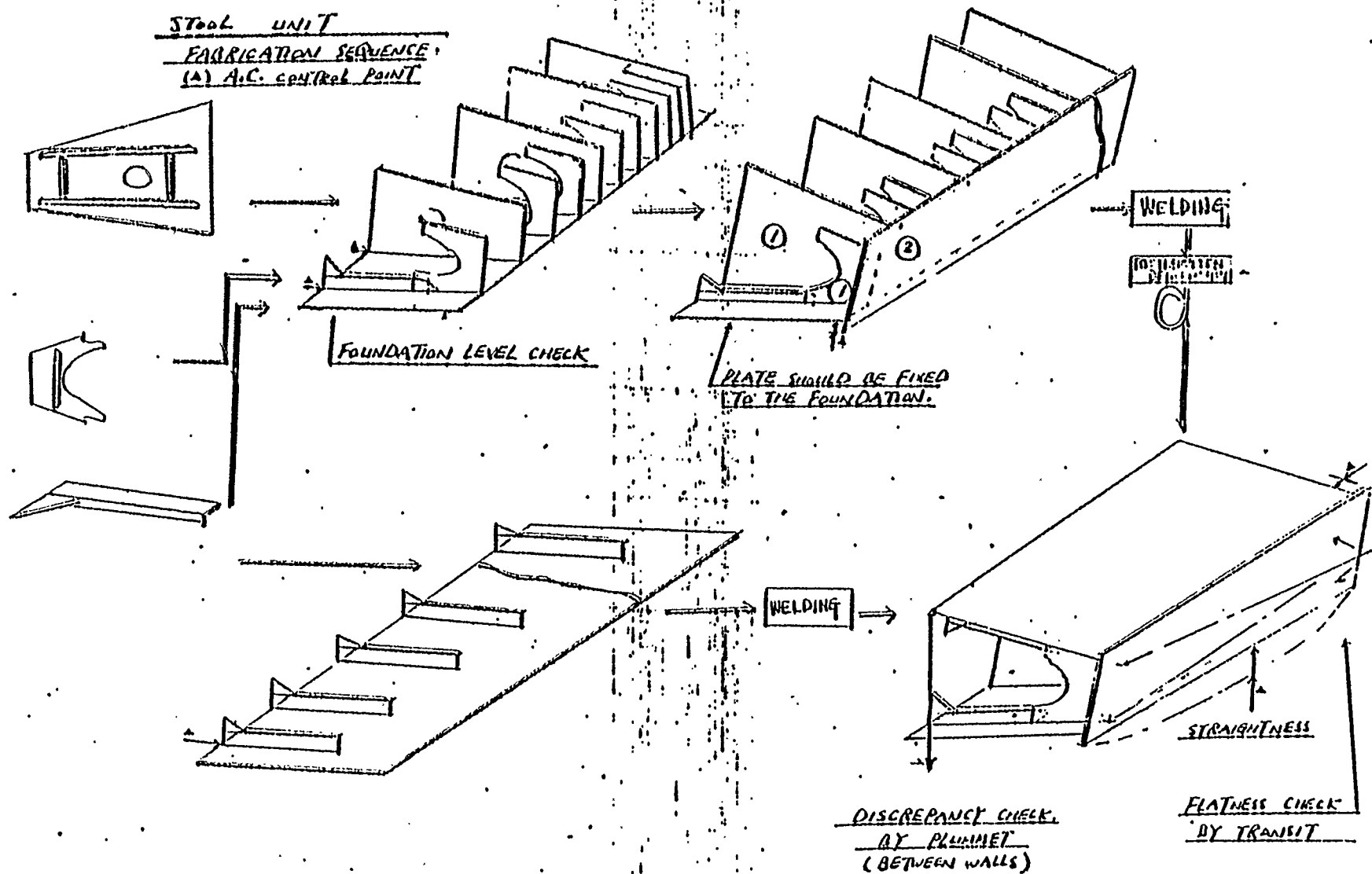


DIMENSION CHECK
AFTER WELDING

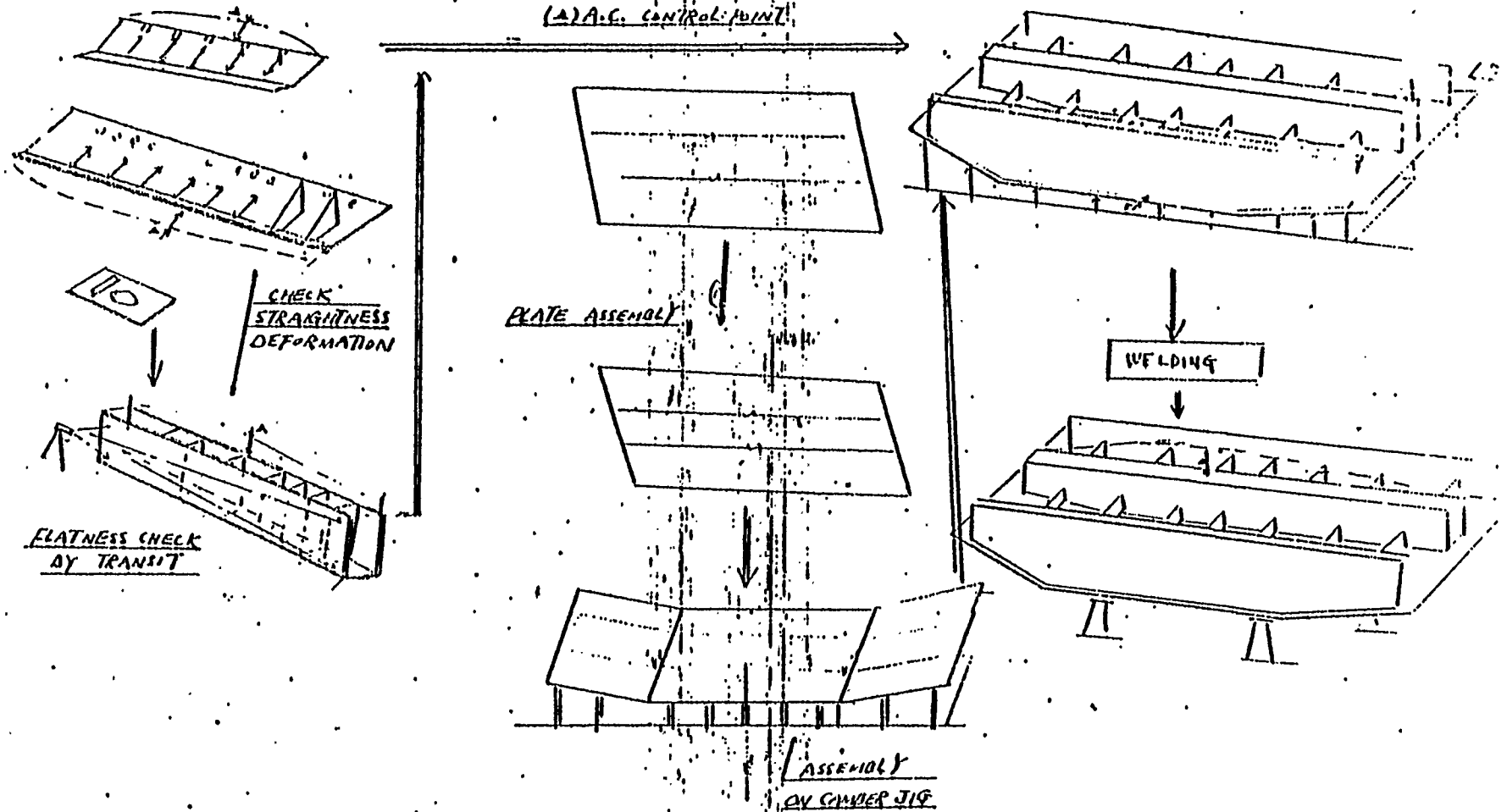
FLATNESS CHECK



STOOL UNIT
FABRICATION SEQUENCE
(A) A.C. CONTROL POINT



UPPER DECK CENTER UNIT
FABRICATION REQ.
(A) A.C. CONTROL POINT



ACCURACY CONTROL

CHECK POINT, CHECKING DIMENSIONS, CHECKING METHOD

AT ERECTION

BASED ON ERECTION SEQUENCE

PREPARED BY IHI

INULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				BOTT, CENTER

MARK	DESCRIPTION	DIMEN- SIONS	TOLER- ANCE	CHARGE	NOTICE
A	Bottom Height			Worker	Measure at C. G. M. by special gauge
D	Level			Worker AC	Measure at 4 corner points by Transit
C	Space Check			Worker	Measure by ruler
D	Space Check from Bld. to Bld.			Worker AC	Measure by ruler
E	Center line check			Worker AC	Adjust at fore and aft by guy wire. Measure by Transit

INULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				BOTT, SIDE

MARK	DESCRIPTION	DIMEN- SIONS	TOLER- ANCE	CHARGE	NOTICE
A	Bottom Height			Worker	Measure at L13 by special gauge
B	Level			Worker AC	Measure at 4 corner points by Transit
C	Space Check			Worker	Measure by ruler
D	Space check from Bld. to Bld.			Worker AC	Measure by ruler
E	Width from C. line to L13			Worker	Measure at fore & aft end by transit

HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				ALIGN BUILT

*Check the alignment at the top seam.
*Finish cut before erection.

MARK	DESCRIPTION	DIMENSIONS	TOLERANCE	CHARGE	NOTICE
A	Width & Perpendicular			Worker AC	Read the gauge at "Q" by transit
B	Alignment & Gap			Worker	Check discrepancy from marked line.
C	Alignment at fore butt			Worker AC	Measure at 3 points (O.P.Q.) by transit.
D	Alignment at the position of Bhd.			Worker	

HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				STOOL

*Check the alignment at the top seam.
*Finish cut before erection.

MARK	DESCRIPTION	DIMENSIONS	TOLERANCE	CHARGE	NOTICE
A	Level & Height			Worker AC	Check of the level at the stool top
B	Center line			Worker	Check discrepancy from marked line.
C	Alignment of frame			" "	Do
D					

The unit is most vital to keep precise level and height of Bhd. and Upper deck.

INCL. NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				CORR. BLD.

MARK	DESCRIPTION	DIMEN- SIONS	TOLER- ANCE	CHARGE	NOTICE
A	Height			Worker	Check at marked line in final assembly.
B	Center line			Worker AG	Measure at center line by transit.
C	Perpendicularity check			Worker AG	Reading gauge by transit.
D	Width			Worker	Measure the dimension between 2 marked lines.

INCL. NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				UPP. WING TANK AND UPP. OK. SIDE

Point:

- 1) Set the unit just a little higher (1")
- 2) Adjust
- 3) Gradually slide and fix

MARK	DESCRIPTION	DIMEN- SIONS	TOLER- ANCE	CHARGE	NOTICE
A	Width			Worker AG	Measure from center line by ruler.
B	Height			Worker AG	Measure from T. Top by ruler.
C	Level			Worker AG	Measure at 4 corner points.
D	Alignment at each frame			Worker	

Inserted Unit: Before inserting, the length between units (inserted space) should be checked and finish cut. Inserted unit should be neat cut at final assembly.

HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT	
UPP. DE. CENTER					
Point: In case of the unit to be inserted; Check "L" and neat cut. (at Assembly)					
MARK	DESCRIPTION	DIMEN- SIONS	TOLER- ANCE	CHANGE	NOTICE
A	Center line			Worker	Check discrepancy
B	Alignment of the join- ing part			AC	by transit
C	Height			Worker	Before erection, check the dimen- sion and neat cut
D					

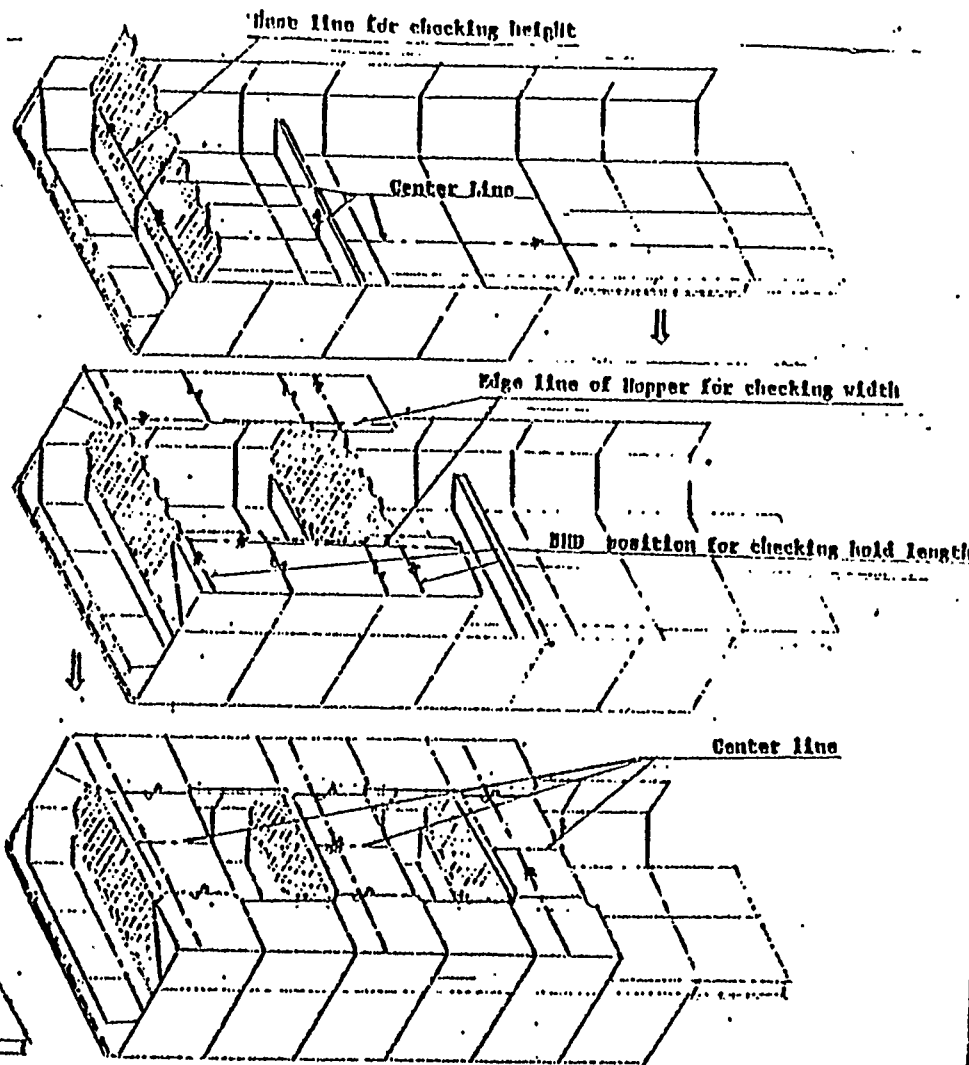
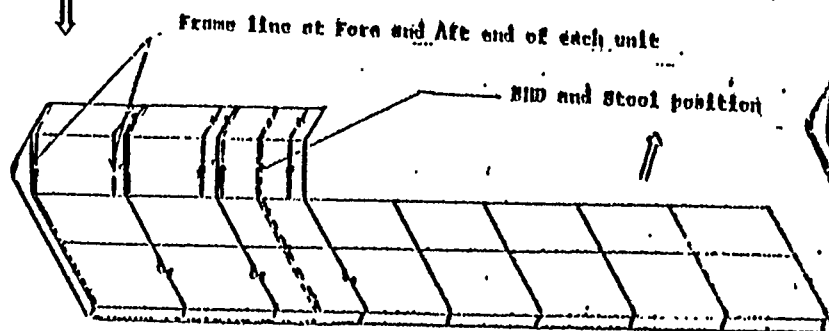
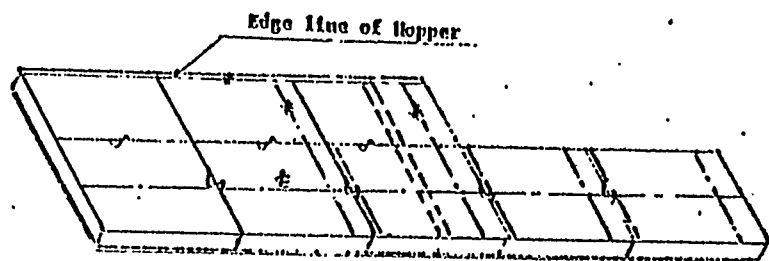
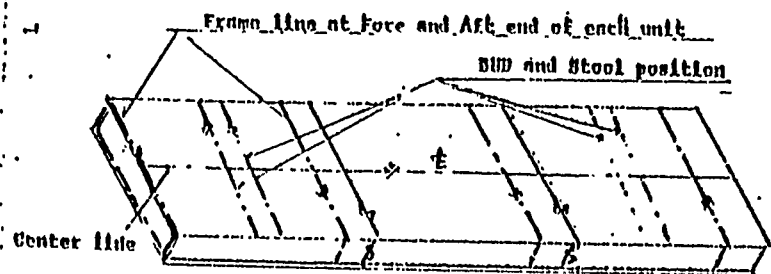
HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT	
MARK	DESCRIPTION	DIMEN- SIONS	TOLER- ANCE	CHANGE	NOTICE
A					
B					
C					
D					

ACCURACY CONTROL

HOW TO DO SHIPWRIGHTING
BASED ON ERECTION SEQUENCE

PREPARED BY IHI

BASE LINES FOR SHIPWRIGHT AT ERECTION
 (These are all marked at final assembly
 symbolized by * mark)



ACCURACY CONTROL

VITAL POINTS AT FABRICATION PHASE

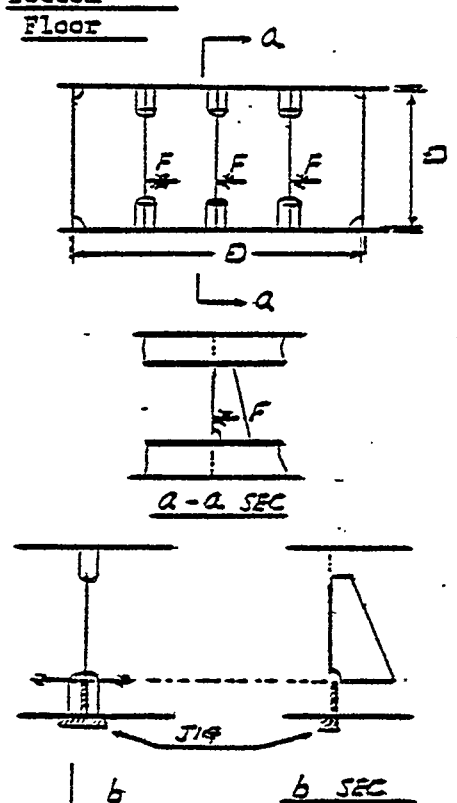
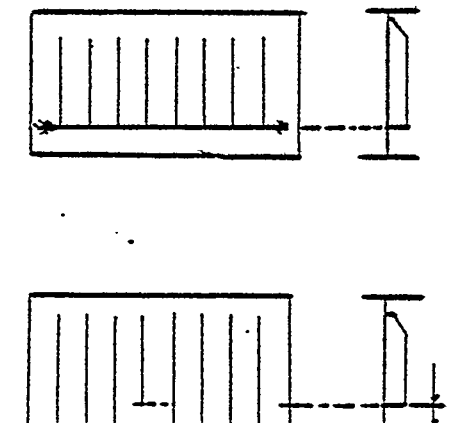
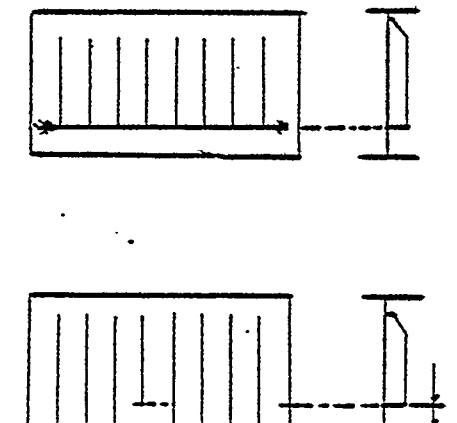
(MARKING, GAS CUTTING, SUB-ASSEMBLY) AND

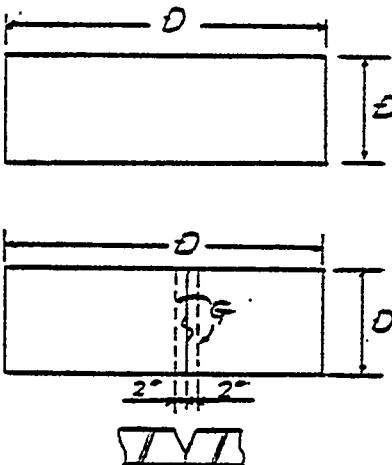
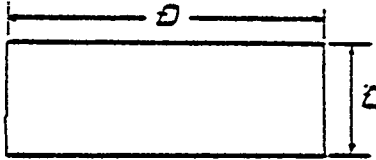
BASE LINES

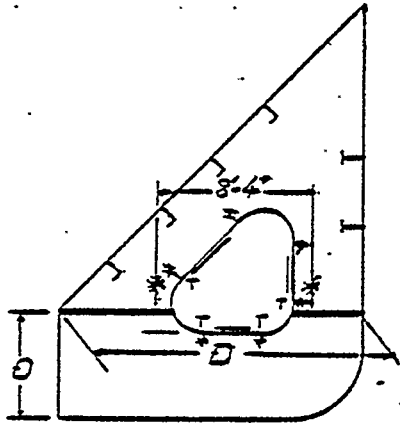
TO BE INVOLVED IN THE OUTPUT FROM

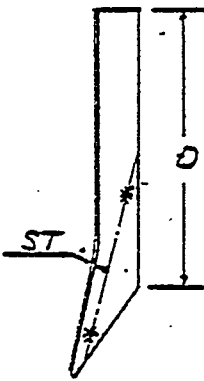
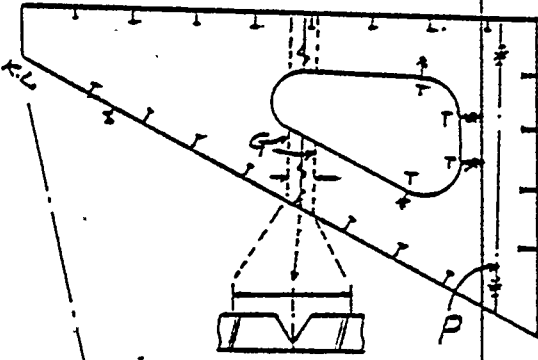
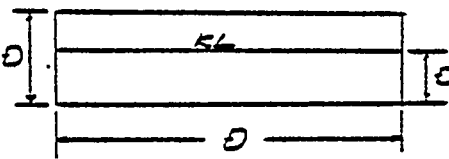
MOLD LOFTING

PREPARED BY IHI

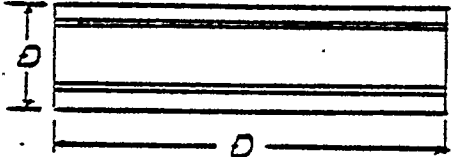
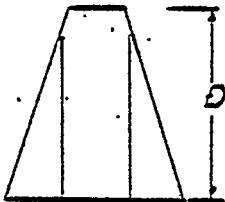
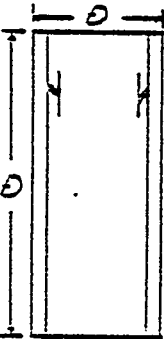
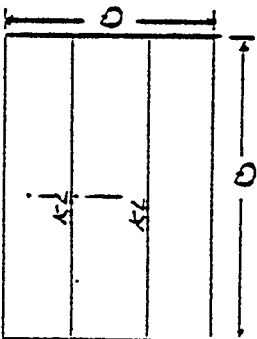
MEMBER & ITEM	MEANING & PURPOSE	NOTES
<u>Bottom Floor</u>  <u>Tight Floor & Wall</u> 	D : Dimension to be checked *The dimension is marked by NC operator and measured after cutting and sub-assembly. F : Guide lines for fitting stiffeners. *To be marked by NC burning machine *To be used for fitting stiffeners at sub-assembly *Two methods to be useful 1) to be marked at the end of stiffeners (Jig to be used) 2) to be marked at the fixed points.	Limited to the case of the neat cut before sub-assembly.
<u>Tight Floor & Wall</u> 	*To be marked at the end of stiffeners. *The dimension should be indicated in case that only one stiffener is different from others.	

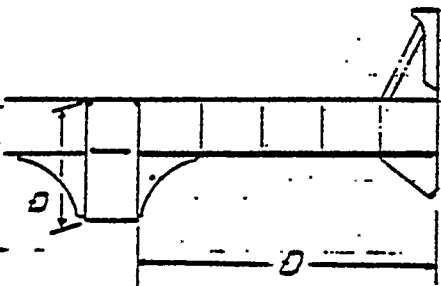
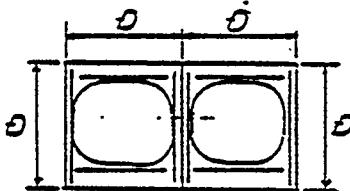
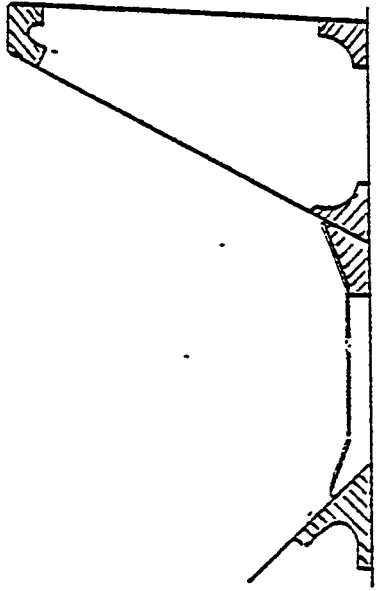
MEMBER & ITEM	MEANING & PURPOSE	NOTES
<u>Girder</u>  <u>Joined at Sub-Assembly</u>	D : Dimension to be checked G : Check lines of gas cutting	
<u>Bottom & T. Top Plate</u> 		

MEMBER & ITEM	MEANING & PURPOSE	NOTES
<u>Bilge Part</u>  The drawing shows a cross-section of a bilge part. It features a vertical base on the left, a horizontal base at the bottom, and a sloped side on the right. A semi-circular bilge is formed by the intersection of these surfaces. Dimension lines indicate a height of '8'-4\"/>	D : Dimension to be checked 8'-4\" : Check lines to be marked by NC machine for checking deformation by heating through gas cutting and welding T : Tangency to be marked by NC machine for fitting of face plate	

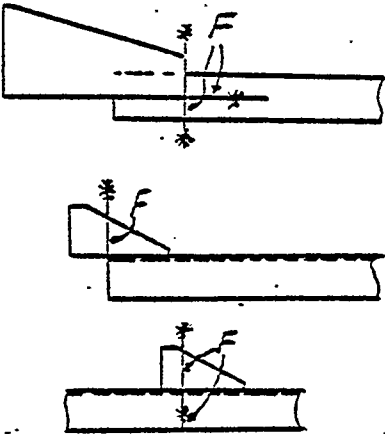
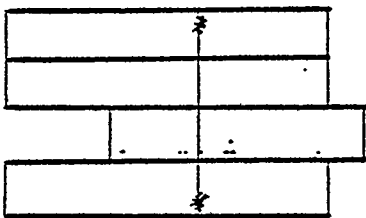
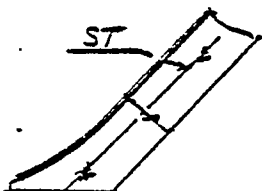
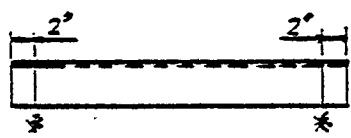
MEMBER & ITEM	MEANING & PURPOSE	NOTES
<u>Side Shell</u> 	D : Dimension to be checked ST: Check line for deformation by heat. To be marked by NC machine or by hand.	
<u>Upper Wing Tank</u>  <u>Knuckled Plate</u> 	G : Check line of gas cutting. P : Check line for perpendicularity to be marked by NC machine. T : Tangency To be marked by NC machine.	

(単位:mm)

MEMBER & ITEM	MEANING & PURPOSE	NOTES
<u>Hopper</u> <u>Top Plate</u> 	D : Dimension to be checked	
<u>Floor</u> 		
<u>Corrugated Bhd.</u> 		
<u>Flat Pl.</u>  <u>Knuckle Pl.</u> 		

MEMBER & ITEM	MEANING & PURPOSE	NOTES
<u>Center Of Upper Deck</u>  <u>Duct Keel (Bottom)</u> 	D : Dimension to be checked	
	Bracket: Shaded brackets are vital to keep the shape of Hull.	

(11 11 11 11 11)

MEMBER & ITEM	MEANING & PURPOSE	NOTES
<u>Sub-Assembly (Angle)</u>    	F : Guide line for fitting to be marked by NC machine or by hand. Guide line for plate joining: In case that some ends of plate are different from others, a base line should be marked for plate arrangement. ST: Check line for deformation by heat. Check line for gas cutting	

IHI MARINE TECHNOLOGY, INC.

ACCURACY CONTROL

CHECK SHEET

FOR FUTURE-32 BULKERS

PREPARED BY IHI

REF. NO. KCT038

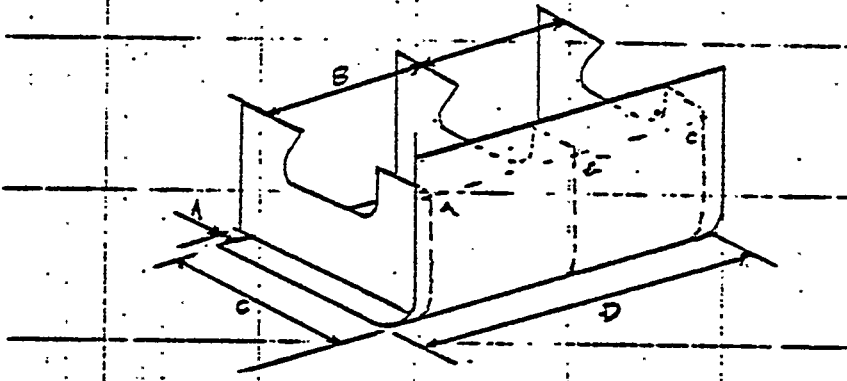
Ship No.	Unit No.	Shop	Condition
		Cut. Sub.As.	

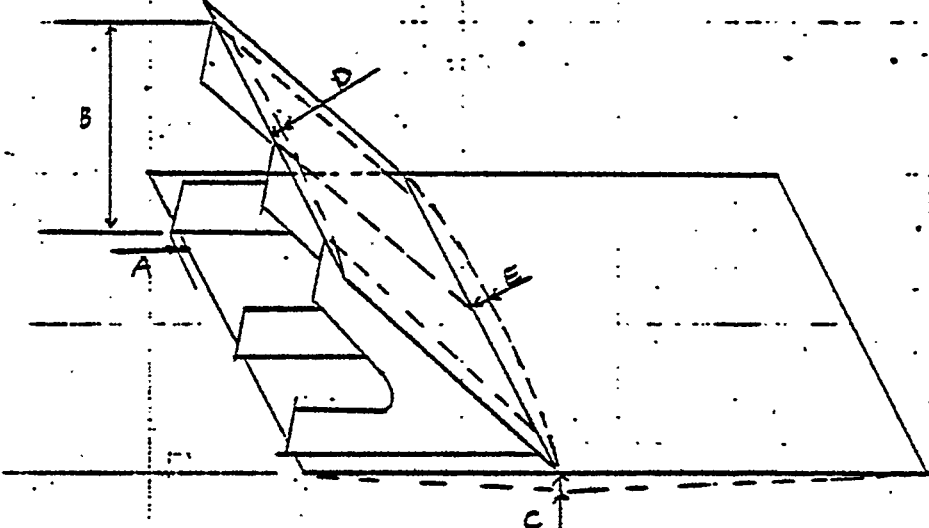
[illegible]

ACCURACY CHECK SHEET

[illegible]

ACCURACY CHECK SHEET										
Ship No.	Unit No.	Shop	Condition							
			Before combined with bottom plate							
Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension		Chg.	Notice			
C			P S			Worker AC	Both side (P.S)			
D	Edge Alignment		F A			"	Every Girder Both Side (F.A.)			
E	Girder Spacing		P S			"	Every Frame			
F	"			FORE	AFT	"	Both side (F.A.)			
G	Straightness					"	Each girder show maximum.			
H	Level			a f	b g	c h	d i	e j	"	9 points a - i
Notice: After fitting, welding										

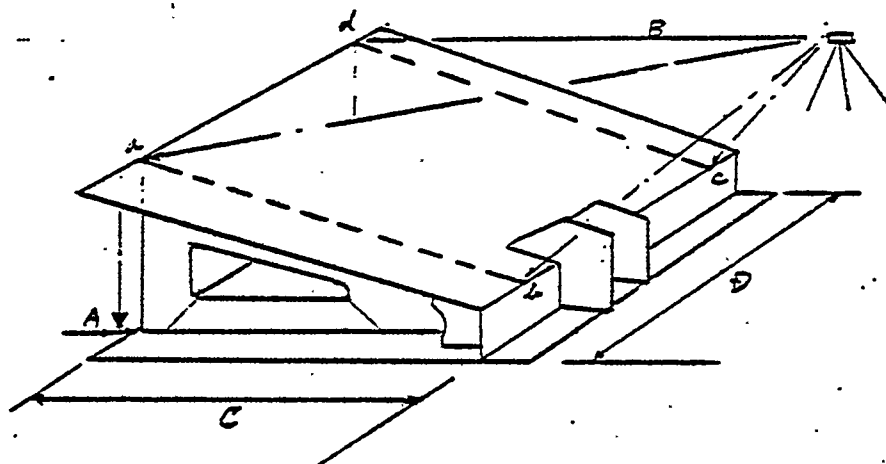
ACCURACY CHECK SHEET									
Ship No.	Unit No.	Shop	Condition						
			Before combined with side shell						
									
Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension			Chg.	Notice	
A	Edge Alignment						Worker AC	Every Trans Web.	
B	Transv. Spacing						"	"	
E	Deformation			a	b	c	"	3 points (a,b,c)	
C	Width						AC		
D	Length						AC		
Notice: After welding, fitting									

ACCURACY CHECK SHEET									
Ship No.	Unit No.	Shop	Condition						
			Before combined with bilge unit						
									
Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension				Chg.	Notice
A	Edge Alignment							Worker AC	Every Transv. web
B	Width at Slant Plate							AC	"
C	Knuckle at Side Shell							AC	"
D	Bending at Slant Plate							"	"
E	Bending at Side Shell							"	"
Notice After fitting welding									

ACCURACY CHECK SHEET									
Ship No.	Unit No.	Shop	Condition						
Unit to Unit									
Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension		Chg.	Notice		
A	Butt Alignment			FORE	AFT	Worker	Both side (A.F.)		
B	Inclination			FORE	AFT	Worker AC	(a,b)		
C	Alignment			C	a	e	j	"	Check by special jig.
1. After fitting and welding 2. Top seam at bilge should be checked and finished up before setting side shell unit.									
Notice									

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Before final unit assembly under the base of the Upper Deck.

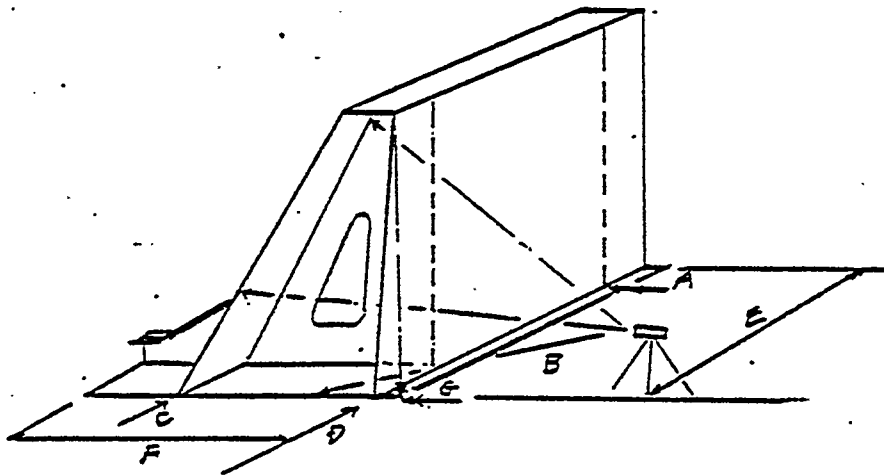


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension				Chg.	Notice
A	Shift between U.Dk. & Top Side							Worker AC	Every Frame
B	Level							"	4 points (a-d)
C	Width							"	
D	Length							"	

Notice: After fitting, welding

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Final Unit Assembly

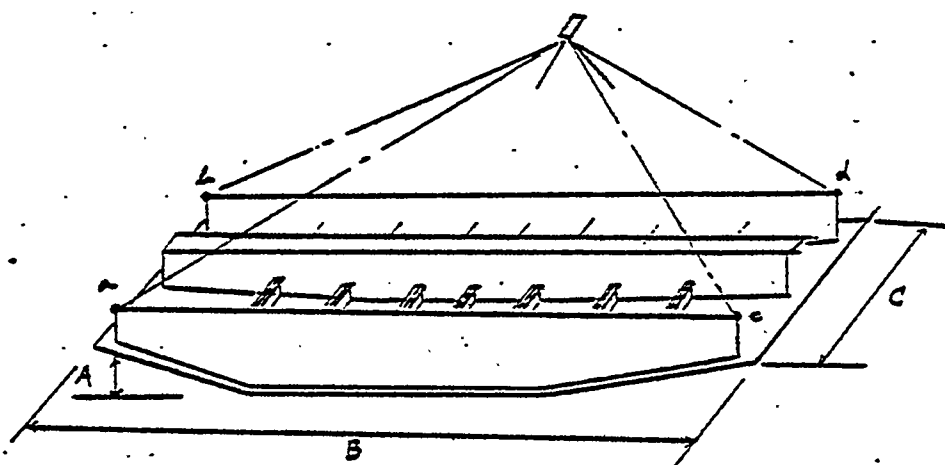


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual.. Dimension			Chg.	Notice
A	Shift						Worker AC	Every Frame
B	Edge Align- ment			AFT		FORE	"	Both end (aft. fore)
C	Straightness						"	
D	Straightness						"	
E	Length						"	
F	Height						"	
G	Inclination			AFT		FORE	"	Both End

Notice: After fitting, welding

ACCURACY CHECK SHEET															
Ship No.	Unit No.	Shop	Condition												
			Final Unit												
Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension		Chg.	Notice								
A	Width					AC									
B	Height					"									
C	Flatness			<table border="1" style="display: inline-table; border-collapse: collapse;"> <tr> <td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> </table>										"	2 points at each frame
Notice: After fitting, welding															

ACCURACY CHECK SHEET						
Ship No.	Unit No.	Shop	Condition			
Final Unit Assembly						
Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Height				Worker	Mark check line for shipwright
B	Level				"	After checking level fix by temp. beam
C	Width					
Notice : After fitting, welding						

ACCURACY CHECK SHEET									
Ship No.		Unit No.		Shop		Condition			
						Final Unit Assembly			
									
Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension				Chg.	Notice
A	Camber Height							Worker AC	4 corners
B	Width							AC	
C	Length							"	
D	Level							Worker AC	4 points
Notice: After fitting, welding									

KCT039

THI MARINE TECHNOLOGY, INC.

ACCURACY CONTROL

THE SCHEME OF THE ADDED MATERIALS

AND

THE PHASE FOR FINISHING UP

FOR

THE FUTURE-32 BULKERS

AT

THI AIOI-SHIPYARD

PREPARED BY THI

REF. NO. KCT039

ACCURACY CONTROL

The scheme of the added Material and the Phase for Finishing Up for the FUTURE-32 Bulkers at IHI AI01-Shipyard.

This paper is to display how the activities of accuracy control at IHI AI01-Shipyard are being performed in the field of planning for the added material and finishing up phase.

The scheme of the subject is usually planned by the A/C Group (Accuracy Control Group which is the nucleus for promoting the A/C activities and is constituted by eight (8) engineers of the Hull Construction Department). This is planned for main structures the ship's hull using preliminary design drawings such as Midship Section, Shell Expansion, Upper Deck Plan, Inner Bottom Plan and the other construction profiles.

It seems to be very significant to notice that the Planning of the subject precedes the beginning of making working drawings, that is, this scheme is a guidance for making working drawings to indicate the actual fabricating method of the ship's hull.

This scheme is designed taking into account of the following fundamental functions to build the actual ship:

- (1) Vital points and vital dimensions to keep high accuracy.
- (2) Fabricating sequence and fabricating method for a unit.
- (3) Erection sequence of units
- (4) Welding method
- (5) Consideration for shrinkage

The main target of the activities of accuracy control at IHI lies in minimizing the work at erection because erection work on board is unsuitable comparing with the work at assembly or work in shop any view point such as safety, quality and efficiency.

This idea shall be easily found in the following drawings. Some remarkable characteristics in it are as follows:

- (1) Finishing up (cutting) at erection is quite a few
Only a few joints (seams and butts) at Bow and Stern are designed to be finished up at erection.

DEI MARINE TECHNOLOGY, INC.

(2) Dimensions of added material and phase where those are finished up are clearly indicated.

-Neat cut Without any added material at cutting stage.

-Finish cut with some added material for the margin shrinkage at cutting stage (marked in 3).

-Finish cut without any added material at assembly (marked in A).

-Finish cut with some added material for the margin shrinkage at assembly (marked in A4).

-Finish cut at final assembly after checking unit dimensions (marked in 30).

-Finish cut on board after checking dimension before erection of the succeeding unit (marked in E).

-Finish cut on board adjusting joint as the time of erection of the succeeding unit. (marked in).

(3) Welding Method

Automatic welding method adopted to the seams and butts are shown.

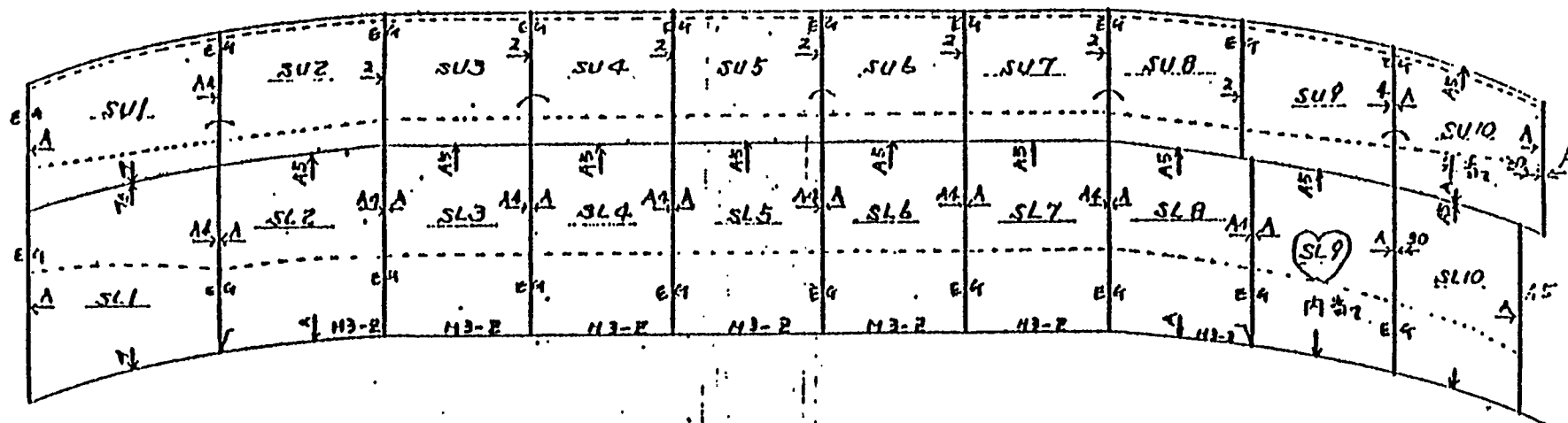
-E.G.
Electro Gas Welding

--CO₂
CO₂ Semi-Automatic Welding

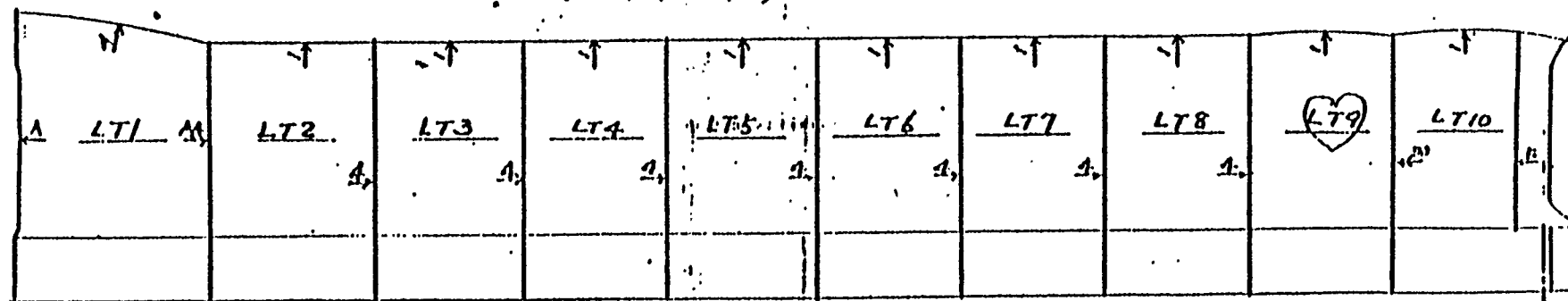
-FAB
Flux Asbestos Backing Welding

[illegible][illegible]

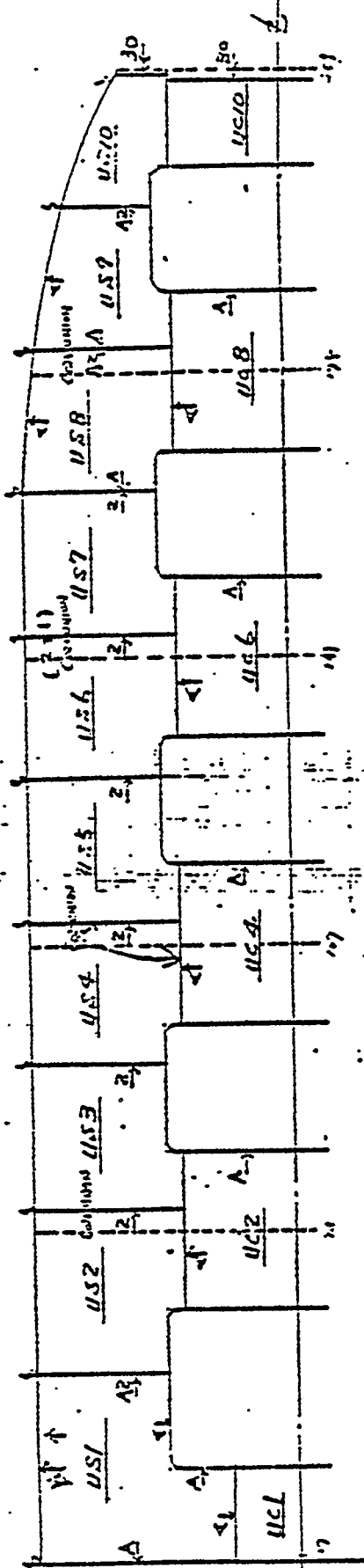
SHELL EXPANSION
(UNIT IN MM)



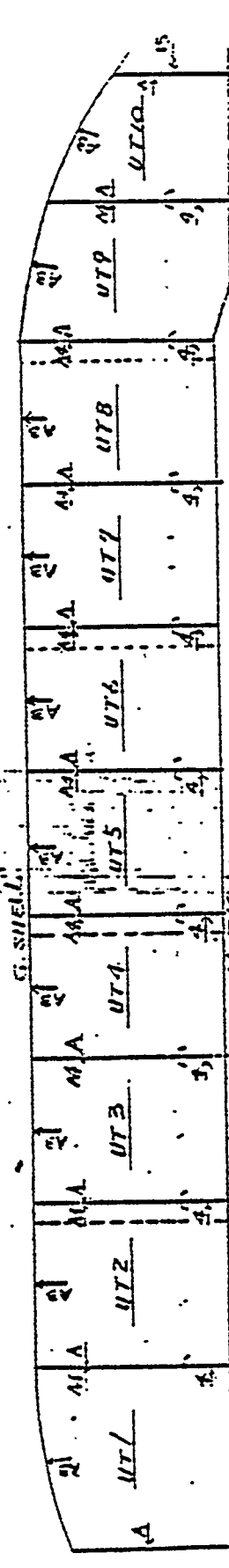
HOPPER TANK TOP
(UNIT IN MM)



UPPER DECK
(UNIT IN 1/4")



TOP SIDE TANKS - BOTTOM
(UNIT IN 1/4")

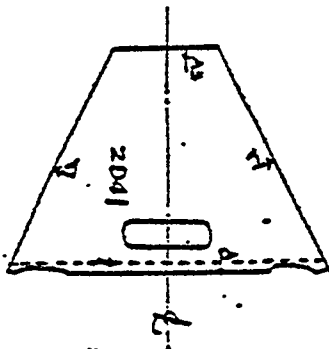


[illegible]

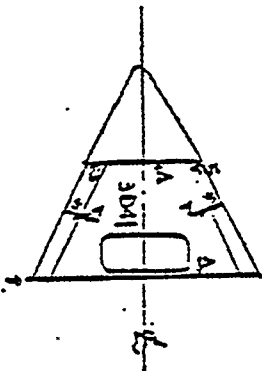
1000

Ly Nail (P)

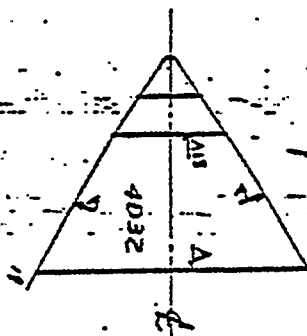
ST. G. FLAT



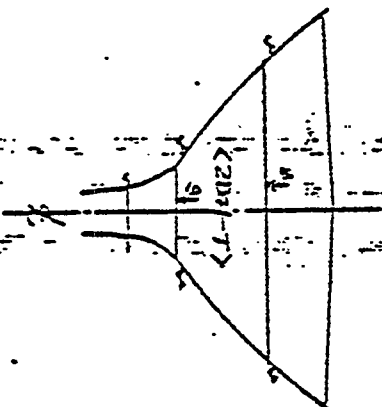
APP. F. FLAT



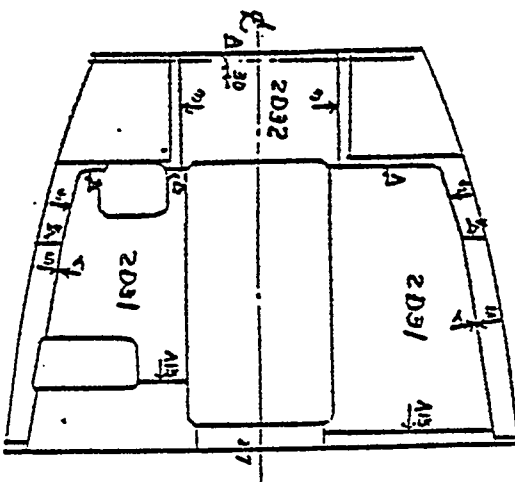
DIESEL GENERATOR FLAT



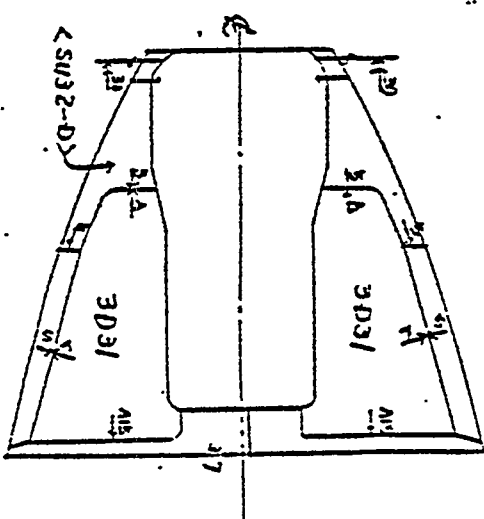
F9. SEC.



UPPER ENGINE FLAT

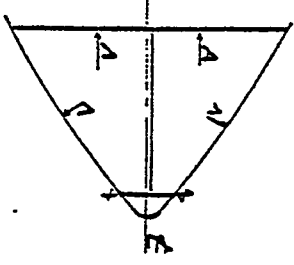


LOWER ENGINE FLAT

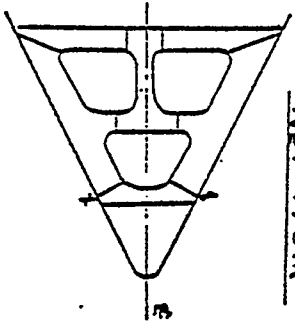


1-1001040

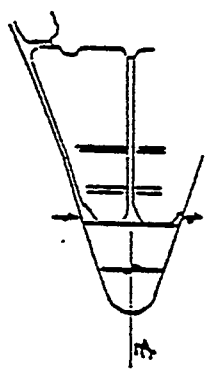
NO. 2 P. STR
C.L. PLAT.



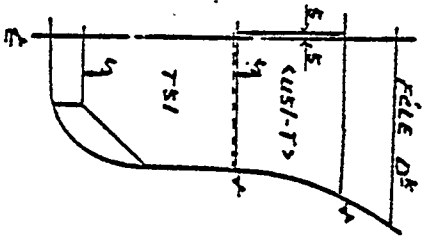
NO. 1 P. STR



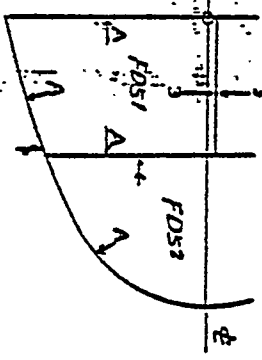
INNER BOTTOM PLAN



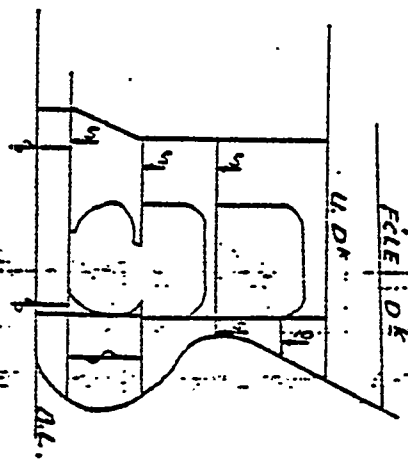
F209 SEC.



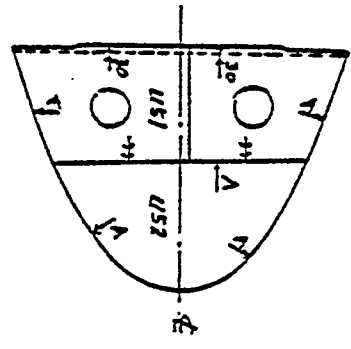
FILE DECK



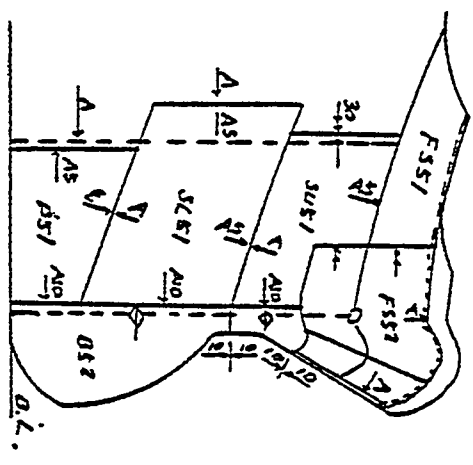
CENTER LINE SEC.

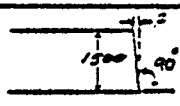
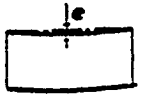
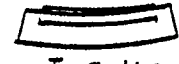
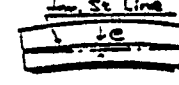
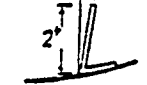


UPPER D5 PLAN



PROFILE



SHOP	ITEMS	ALLOWABLE TOLERANCE	FREQUENCY OF MEASURING	REMARKS
<u>Marking & Gas Cutting</u> (Section) (Fb)	*Check line for gas cutting of angles (after marking)	$e = \pm 1.5/64''$	8 pc/day (piece/day)	
	*Check line for gas cutting of angles (after cutting)	$e = \pm 1/32''$	5 pc/day	
	*Length of angles (after cutting)	$e = \pm 1.5/64''$	5 pc/day	
	(Internal Member)			
	*Normality after gas cutting (Right Angle)	2/1500	5 pc/day	
	*Check line for gas cutting	$e = \pm 1/32''$	Do	
	*Length after gas cutting	$e = \pm 3/64''$	Do	
	*Width after gas cutting	$e = \pm 3/64''$	Do	
	<u>Flame planer</u>			
	(Flat shell plate flat plate)			
<u>Bending</u> (Section) (Plate)	*Length & Width after cutting	$e = \pm 1.5/64''$	5 pc/day	
	*Straightness	$e = \pm 1/64''$	2 pc/week	
	*Bevel Angle	$e = \pm 2.0 \text{ deg.}$	5 pc/day	
	*Normality (Right Angle)	$e = \pm 2/1500$	2 pc/week	
	*Length of frames after bending	$e = \pm 1.5/32''$	5 pc/day	Girth length 
	*Straightness of inverted straight line of frames after bending	$e = \pm 3/32''$	5 pc/day	
	*Round gunwale plate & Bilge plate	$e = \pm 1/8''$	All	
	*Setting degree of template	$e = \pm 1/4''/2''$	All	
	*Discrepancy between template and end of plate	$e = \pm 1/4''$		

STANDARD AND TOLERANCE
FOR KEEPING HIGH ACCURACY
AT IHI AIOI SHIPYARD

*Standard at each shop

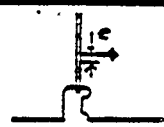
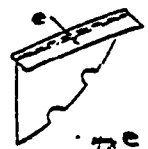
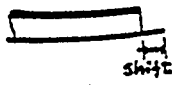
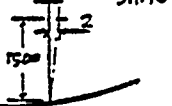
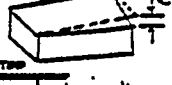
*Standard for maintenance and check
of facilities and instruments

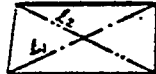
Prepared by
IHI

REF. NO. KCT040

STANDARD AND TOLERANCE FOR A.C. AT IHI AIOI SHIPYARD

2

SHOP	ITEM	ALLOWABLE TOLERANCE	FREQUENCY OF MEASURING	REMARKS
<u>Bending</u>	*Height of sight seeing line	$e = \pm 1.5/16''$	5 pc/day	
	*Discrepancy of sight seeing line between templates and thread	$e = \pm 1/4''$	5 pc/day	 thread position
<u>Sub-Assembly</u>	*Positioning of stiffeners (FB. BKT) on a web plate	$e = \pm 1/32''$	8 pc/day	
	*Positioning of face plate to a web plate (keep shift dimension)	$e = \pm 1/32''$	8 pc/day	
	*Flatness of sub after sub-assembly (LS 31' 14") (L 31' 14")	$e = \pm 1/8''$ $-e = \pm 1/4''$	8 pc/day	
	*Fitting angle of stiffeners to a web plate	$e = \pm 3 \text{ deg.}$		
	*Deformation of sub-unit	$e = \pm 1/4''$	8 pc/day	
<u>Assembly Fitting</u>	*Shift dimension between skin plates and frames/girders	$e = \pm 1.5/32''$	5 pc/day	
	*Shift dimension between skin plates and trans. web/floors	$e = \pm 1.5/32''$	5 pc/day	
	*Fitting angle between trans. web and skin plates	$e = \pm 5/1500$	5 pc/day	
	*Fitting angle between frames and skin plates (at the top)	$e = \pm 1/8''$	5 pc/day	
	*Level	$e = \pm 1/4''$	All	
	*Perpendicularity check by a plummet	$e = \pm 1/16''$ (at the end point)	All	
	*Flatness of a unit	$e = \pm 1/4''/L$	20%	

SHOP	ITEM	ALLOWABLE TOLERANCE	FREQUENCY OF MEASURING	REMARKS
<u>Assembly</u> <u>Marking</u>	*Length of plates	$e = \pm 1/8"$ (curved)	All	 $\Delta L = L_1 - L_2$
	*Width of plates	$e = \pm 1.5/16"$ (plane)	All	
	*Diagonal length of plates (squareness check)	$\Delta L = \pm 1/4"$ (curved) $\Delta L = \pm 1/8"$ (plane)	All	
	*Marking lines by hand	$e = \pm 1/8"$ (curved)	4 units/ 2 days	
	*Straightness of plate edge	$e = 1/16"/L$	20%	
	*Width of corrugate	$e = 1.5/16"$	All	
	Height of corrugate	$e = 1/16"$	All	
	Normality of corrugate	$e = 1.5/16"$	All	
<u>Assembly</u> <u>Gas Cutting</u>	*Check line for gas cutting	$e = \pm 1/32"$	5 pc/day	
	*Depth of bevel	$e = \pm 1/32"$	5 pc/day	
	*Bevel Angle	$e = \pm 2.0 \text{ deg.}$	5 pc/day	
	*Straightness of plate edge	$e = \pm 1.5/32"$	20%	

STANDARD AND TOLERANCE FOR A.C. AT IHI AIOI SHIPYARD

4

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURING	REMARKS
<u>ERECTION</u> Bottom Shell	*Positioning: (Length wise) Measure on the check points on berth	$e = \pm 1/8"$	starting unit only	
	*Positioning: (Height) Measure at the most forward frame (2 points)	$e = \pm 1/4"$	All Units	By gauge
	*Level: (Between left side and right side) Measure on the points at forward edge	$e = \pm 1/4"$	All units	Pay attention to twist
	*Positioning: (Between left side and right side) Measure at the forward butt	$e = \pm 1/8"$	All units	Plum down to the base line on berth
	*Connecting part between units: Check the bevels at seams and butts	$e = \pm 1/8"$	All units	
	*Discrepancy of ship's center	$e = \pm 1/8"$	All units	Measuring by transit

STANDARD AND TOLERANCE FOR A.C. AT THE AIOI SHIPYARD

5

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE- ING	REMARKS
<u>ERECTION</u> Side Shell	*Positioning: (Length wise) Arrangement of butt between bottom shell and side shell	$e = \pm 1/8"$	All units	Check frame space
	*Level: (Lengthwise) Check at the upper block end seam	$e = \pm 1/8"$	All units	Check the be
	*Perpendicularly: Measure at the for- ward butt	$e = \pm 1/4"$	All units	Plum down f the top of asuring by ansit
	*Positioning: (Height) Check the gap between units at side shell	$e = \pm 1/8"$	All units	Check the h ight of T.B.
	*Connecting parts be- tween units: Check the seams and butts (bevels)	$e = \pm 1/8"$	All units	

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURING	REMARKS
<u>ERECTION</u> Grandly Assembled (Stern Part)	*Positioning: (Length wise)	$e = \pm 1/8"$	All units	Measure on the rudder center of upper gudgeon
	Measure at afterend frame			
	*Positioning: (Between left and right)	$e = \pm 1/8"$	All units	Arrange with center girder at stern frame
	Fix on the center line of stern frame			
	*Positioning: (Height)	$e = \pm 1/4"$	All units	Measure the dimension from upper gudgeon to the flat top
	Check the distance between flats			
	*Connecting parts between units: Check the bevels of seams and butts. Check the connecting parts to shell	$e = \pm 1/4"$	All units	

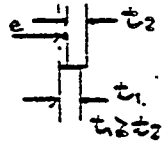
STANDARD AND TOLERANCE FOR A.C. AT THE ATOI SHIPYARD

7

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURING	REMARKS
<u>ERECTION</u> Supper structure	*Position of butts and walls (Lengthwise)	$e = \pm 1/4"$	All units	Check fra space
	*Positioning: (Width wise) Relative position to the ship's center line	$e = \pm 1/4"$	All units	Check bevel deck's seam
	*Positioning: (Height) Measure the dimension between decks	$e = \pm 1/8"$	All units	Pay attention to finish at wall joint
	*Level: (Lengthwise and Widthwise)	$e = \pm 1/4"$		Check the straightness of deck plate
	*Connecting parts between units: Check the feet of walls and bevels at butts and seams of walls	$e = \pm 1/8"$	All units	Check the true and unalign at walls

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURING	REMARKS
<u>ERECTION</u> Curved Shell Unit	*Positioning: (Lengthwise) Alignment between a butt at bottom shell unit and a butt at side shell unit	$e = \pm 1/8"$	All units	Check for space
	*Level: (Lengthwise) Check at the upper block end seam	$e = \pm 1/8"$	All units	Check the level
	*Positioning: (Width) Check the dimension from the ship's center line	$e = \pm 1/4"$	All Units	Plum down the base line (center line etc.) mark on the bearing by transit
	*Positioning: (Height) Check the gap of upper end seams between units	$e = \pm 1/8"$	All units	Check the relationship the height T.BHD
	*Connecting parts between units.	$e = \pm 1/8"$	All units	
	*Discrepancy of ship's center	$e = \pm 1/8"$	All units	Measuring by transit

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURING	REMARKS
<u>ERECTION</u> Super structure (Grandly assembled)	*Positioning: (Length wise) Check the position of front wall	$e = \pm 1/4"$	All units	Check the easy continuity at front wall
	*Positioning: (Width wise) Relative position to the ship's center line	$e = \pm 1/8"$	All units	Check the easy continuity at side walls
	*Positioning: (Height) Measure the dimension between decks	$e = \pm 1/8"$	All units	Pay attention to finish cut at walls
	*Connecting parts between units: Check unalignment at the feet of walls	$e = \pm 1/4"$	All units	Pay attention to alignment width

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURING	REMARKS
<u>ERECTION</u> T. BED	*Positioning: Alignment of plates of T. BED	$e = 1/3 * t_2$	All units	
	*Level: Check at the both end point of upper end seam	$e = \pm 1/4"$	All units	Check the bevel
	*Perpendicularity: Check at the outside stiffener	$e = \pm 1/4"$		Plum down from the top (or by transit)
	*Positioning: (Width) Check the dimension from the center line marked the bottom shell	$e = \pm 1/8"$	All units	
	*Connecting parts between units: Check the bevels at seams and butts	$e = \pm 1/8"$	All units	
	*Positioning: (Height) Check the relationship of upper end seams between units	$e = \pm 1/4"$	All units	Check the alignment at the H.GIR

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURING	REMARKS
<u>ERECTION</u> L. BHD	*Positioning: (Length wise) Shift dimension at the butt between the L. BHD and the bottom shell unit	$e = \pm 1/4"$	All units	Check the same space
	*Level: (Lengthwise) Check at the upper and seam	$e = \pm 1/8"$	All units	Check the level
	*Perpendicularity: Check at the fore-end frame of the unit	$e = \pm 1/4"$	All units	Plum down the top
	*Positioning: (Height) Check the gap at the upper end seam between units	$e = \pm 1/8"$	All units	Check the relationship with the h of T. BHD
	*Connecting parts between units: Check the bevels at seams and butts	$e = \pm 1/8"$	All units	

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE- ING	REMARKS
<u>ERECTION</u> Upper Deck	*Positioning: (Length wise) Check shift di- mension at butts be- tween upper deck and side shell/L. BED	$e = \pm 1/4"$	All units	Check the frame space
	*Positioning: (Width) Check the relationship with the ship's cen- ter line	$e = \pm 1/8 "$	All units	
	*Connecting parts be- tween units: Check the bevels at seams and butts	$e = \pm 1/8"$	All units	

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURING	REMARKS
<u>ERECTION</u> F'cle Deck & Poop Deck	*Positioning: (Lengthwise) Check the shift dimensions and bevels at the butts between the deck and shell plates /L.BHD	$e = \pm 1/4"$	All units	Check the space
	*Positioning: (Width) Check the relationship with the ship's center	$e = \pm 1/4"$	All units	Plum down to the top of upper deck
	*Level: (Transverse) Check the knuckle at the pillars and BHD	$e = \pm 1/4"$	All units	Check the strength both pillars and BHD
	*Positioning: (Height) Check the height at the pillars and BHD	$e = \pm 3/8"$	All units	Check the connection to other pieces.
	*Connecting parts between units: Check the bevels at seams and butts	$e = \pm 1/8"$		

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURING	REMARKS
<u>ERECTION</u> Grand Assembly With Stern Frame	*Positioning: (Length wise) Check the dimension from the after end of Main Engine to the after end of the Boss	$e = \pm 3/8"$		Shaft length
	*Positioning: (Transverse) Check the center line of the ship from upper gudgeon, lower gudgeon to the center line on the berth	$e = \pm 1/8"$		*Plum down from upper gudgeon to lower gudgeon * Plum down from lower gudgeon to the berth
	*Sight seeing of the shaft center: Marking the center at the 3 points on T. Top	e: (Transverse) $\pm 1.5/16$ Height $\pm 1.5/64"$		Measuring by transit
	*Connecting parts between units: -Check the bevels at seams and butts -Fitting to the radius part of the keel plate	$e = \pm 1/8"$		

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURING	REMARKS
<u>ERECTION</u> Grand Assembly At Cant. Frame	*Positioning: (Lengthwise) Check the dimension and bevels at the butt	$e = \pm 1/4"$		Check the same space
	*Positioning: (Transverse) Check the relationship with the ship's center	$e = \pm 1/8"$		Check the continuity with the forward unit
	*Rudder center: Check the dimensions, transverse, and lengthwise with the upper gudgeon	$e = \pm 1.5/16"$		Check the relationship rudder center at upper gudgeon
	*Rudder center: (Height) Check the dimensions between the flat top and the upper gudgeon	$0 \sim 1/4"$		Dimension the steering gear flat to upper gudgeon top
	*Level: (Lengthwise) Check at the top on the center line	$e = \pm 1/8"$		

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE- ING	REMARKS
<u>ERECTION</u> Grand Assembly At the Bow Construction	*Positioning: (Length wise) Check at the after and frame with plating	$e = \pm 1/4"$		Plum down
	*Positioning: (Trans- verse) Check the relation- ship with the center line on the berth	$e = \pm 1/8"$		Measuring by transit
	*Positioning: (Height) Check the gap at the seams between the unit and afterward unit	$e = \pm 1/4"$		Check with the height of the longitudinals
	*Connecting parts be- tween units: -Check the bevels at seams and butt -Check the connection to the shell plates	$e = \pm 1/8"$		

SHOP	ITEM	ALLOWABLE TOLERANCE	FREQUENCY OF MEASURING	REMARKS
NC Burning Machine	*Check accuracy		5 times/day	
	*Accuracy Check: After marking a square, measuring diagonals		1 time/week	
	*Check gas kerf compensation			
	*Check the discrepancy of positions between the marking equipment and the cutting torch			
	*Check the roughness of the cut surface			
Flame Planer	*Width after gas cutting	$e = \pm 1/64"$	5 times/day	
	*Roughness of cut surface		5 times/day	
	*Bevel angle		5 times/day	

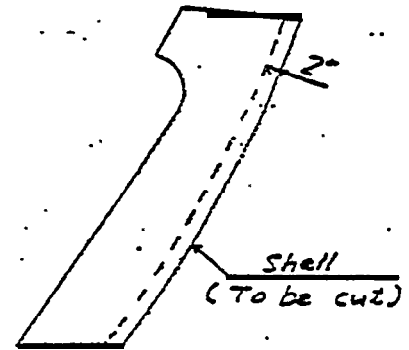
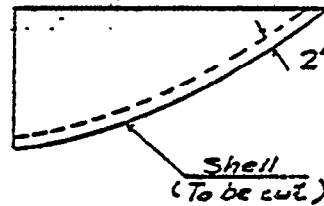
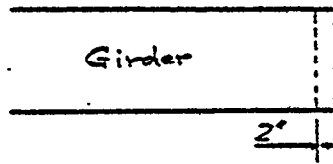
BASE LINE TO BE EFFECTIVE FOR KEEPING HIGH ACCURACY
INCLUDED IN TEE OUTPUT THROUGH ENGINEERING AND LOFTING

(1) Checking line for gas cutting.

A previously marked parallel line to a cutting line is useful to check how precisely gas cutting has been done. The distance between said two lines are fixed, 2 inches for example, so precision of gas cutting can be easily checked by *measuring the distance* after cutting.

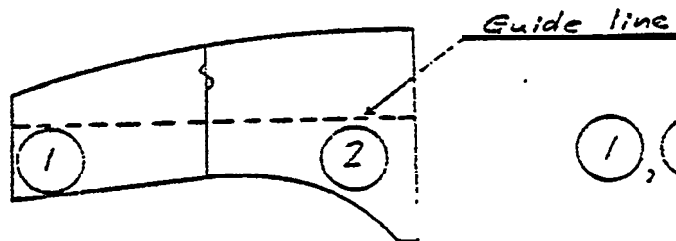
This line is particularly useful for the following parts:

- * Joint part of the girders
- * Edge line to curved shell



(2) Guide line for plate joining at sub-assembly

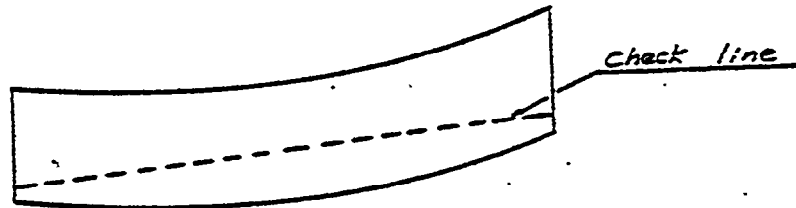
In case of joining two pieces which have no long straight surface at sub-assembly a previously marked *straight line passing through both pieces* these pieces on the correct position.



①, ② : Pieces to be

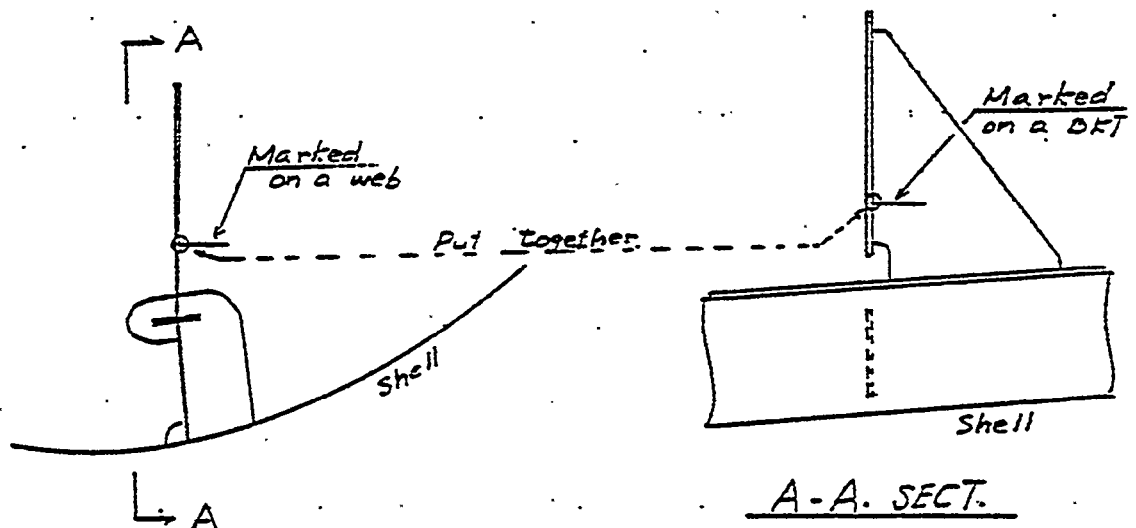
(3) Check line for torsion by heat

In case of a long and narrow piece without any appropriate straight line, a previously marked straight line is useful to check how much distorsion has been caused by heat during gas cutting and also useful as a guide line to reform; reforming is continued until the marked line becomes straight.



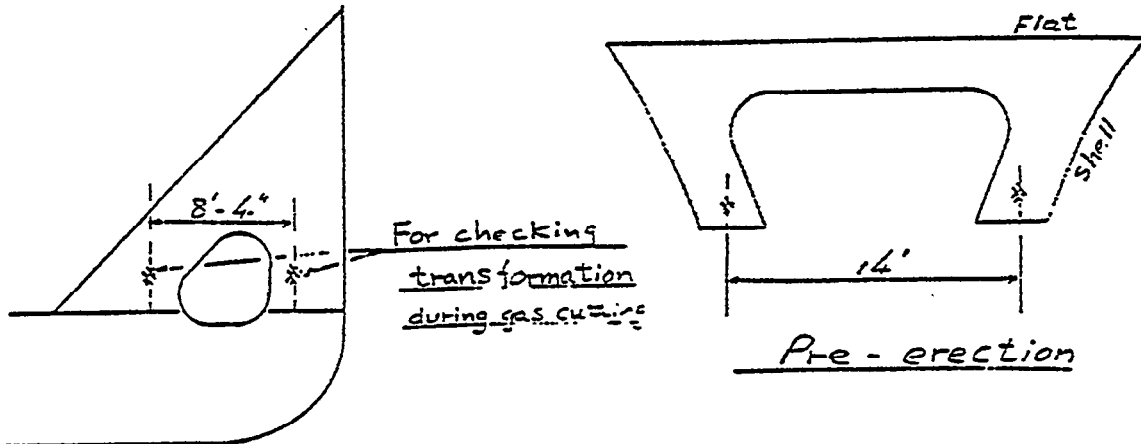
(4) Guide line for fitting stiffeners (BKT, FB) on a web.

In case that the end point of a stiffener is not clear; a stiffener stops at a longitudinal frame and a "cutout" is opened there, for example; both marked lines on a web plate and on a stiffener itself are very useful to fit a stiffener on a web by putting one line on another.



(5) Check line for keeping a certain dimension.

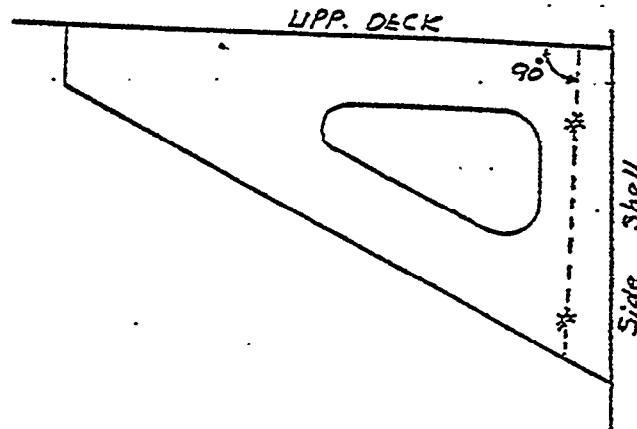
In case of the following drawings, two parallel lines apart a certain distance each other are useful to check transformation of a piece and/or a unit and to reform it. (Marked *).



6) Check line for shipwright

In case of the following drawing, a previously marked normal line to upper deck is useful to check shipwright of top side unit at assembly. Shipwright is easily checked by some methods such as a plummet.

(Marked ✱)



STUDY REPORT ON SHIPBUILDING
FOR
NATIONAL STEEL AND SHIPBUILDING CO.

Volume II
- Accuracy Control of Hull Construction -
Addendum

October, 1979



Ishikawajima-Harima Heavy Industries Co., Ltd.

TOKYO, JAPAN

ACCURACY CONTROL

ADDENDUM FOR IHI'S FIRST SURVEY REPORT

AND FIRST RECOMMENDATION

TO NASSCO



October, 1979

Ishikawajima-Harima

Heavy Industries Co., Ltd.
TOKYO JAPAN

REF. No.

CONTENTS

Summary	1
1. Design Unit Assembling Method	5
2. Design Data Sheet	7
3. Analysis	8
4. Exercise 1	9
5. Exercise 2	12
6. Epilog	15
Recommendations prepared by NASSCO	16
Appendix - 1	18
Appendix - 2	36

Summary

This document was prepared by IHI as the addendum for the first survey report and the first recommendation which were already furnished to NASSCO.

After the first survey on the present Accuracy Control System at NASSCO lasted from May 7, 1979 through May 18, 1979 NASSCO was visited again by two (2) IHI engineers to clarify their findings with some effective recommendations and to assist implementing the advanced Accuracy Control System at NASSCO. The implementation was done from August 6, 1979 through August 31, 1979 in the following schedule:

C 1) The actual implementing schedule

* August 6 - 8

IHI briefly explained IHI's first survey report and the first recommendation to the managements and the nominated experts of NASSCO to confirm that description and to review the present status at NASSCO.

* August 8 - 14 (5 days)

Detailed explanation of the all documents, prepared by IHI to the experts group of NASSCO.

* August 15 - 16

Brief explanation of the said report and recommendation to the group of formen of NASSCO.

• August 17

IHI conducted to design the unit assembling method and data sheet for a flat unit under assembly.

• August 20 - 21

IHI conducted to gather necessary data and designed dimensions to compare with the actual dimensions. Then measured the actual dimensions along the data sheet.

• August 21 - 22

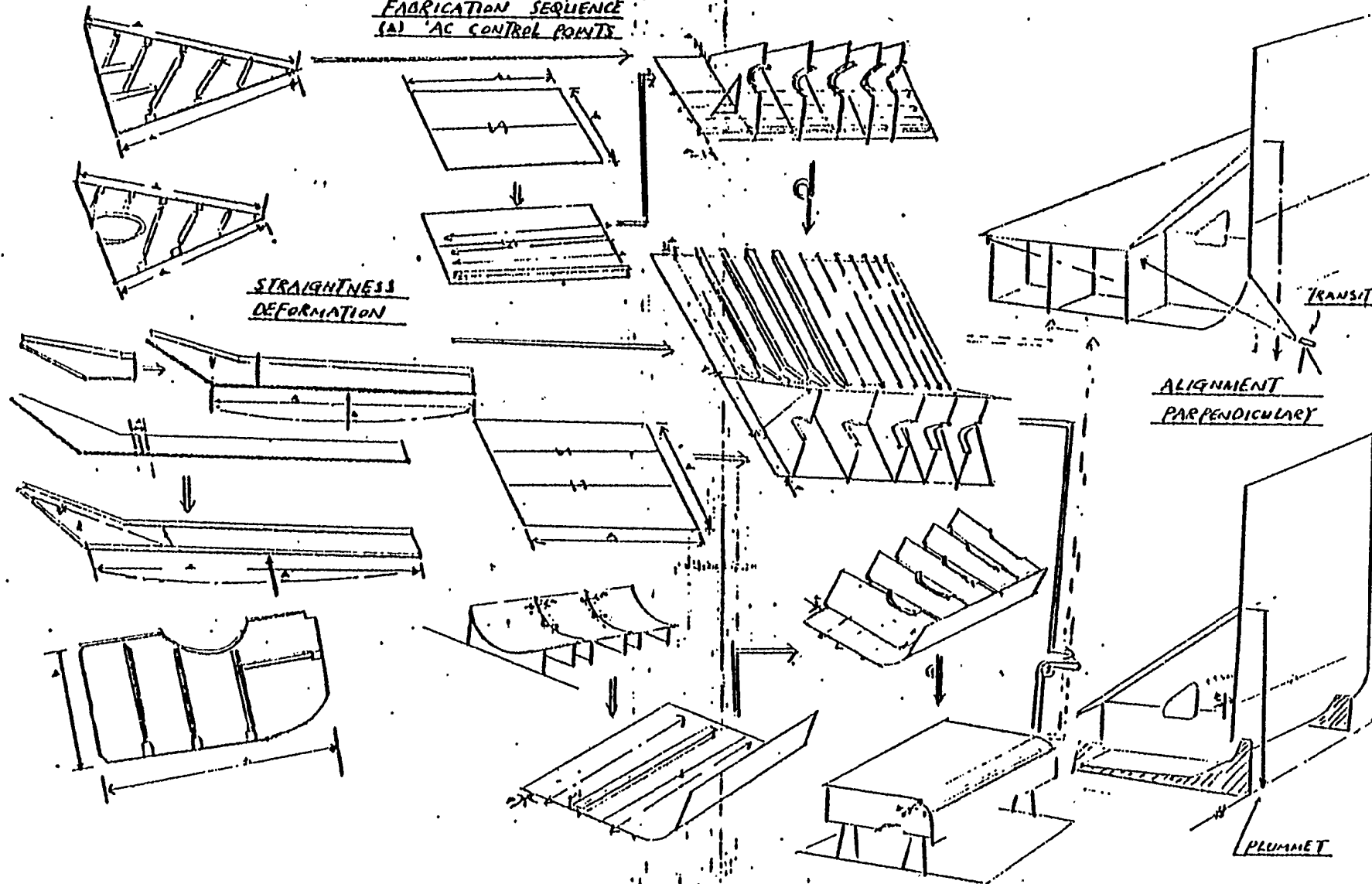
IHI conducted to analyze the measured dimensions referring to the IHI's method described in the report.

• August 23 - 31 (7 days)

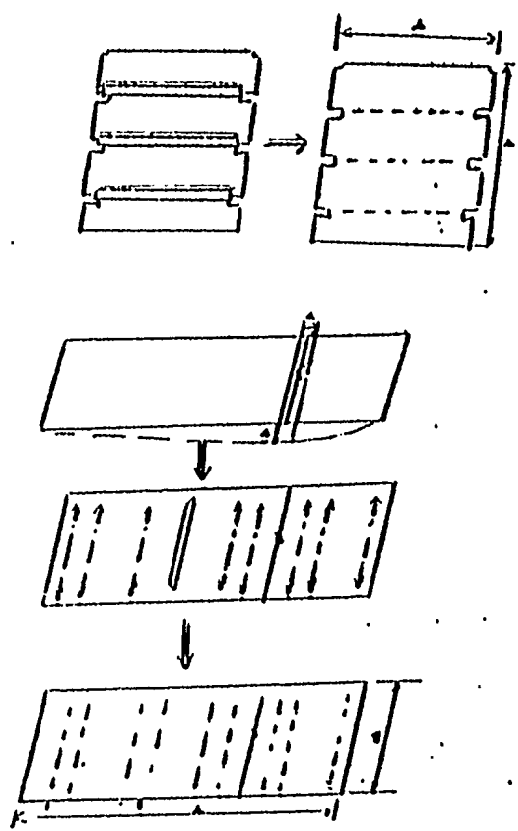
IHI conducted to apply to a curved shell unit under assembly in the same manner as the flat unit. And IHI assisted the experts group of NASSCO to prepare the recommendation to the top management on this subject.

Thus, after explanation of IHI's first survey report and the first recommendation, a typical method was applied to a few real units under assembly to test the A/C techniques written in that report. This method along with further recommendations for accuracy control implementation at NASSCO is presented hereafter. Since there is not a written standard at NASSCO, recommendations and discussion of the standard itself are excluded.

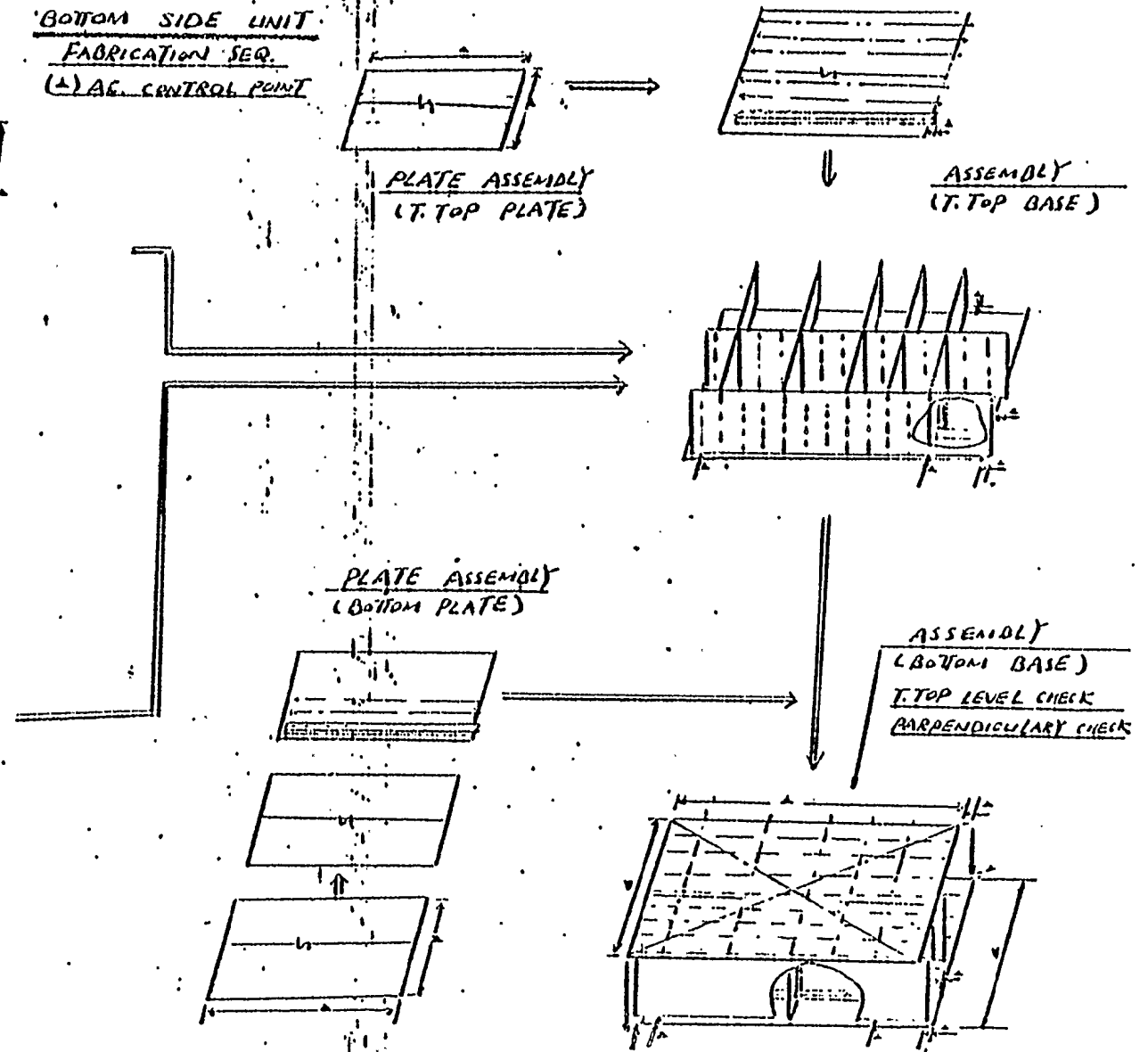
BILGE SHELL UNIT
FABRICATION SEQUENCE
(A) 'AC' CONTROL POINTS



SLIP-ASSEMBLY



BOTTOM SIDE UNIT
FABRICATION SEQ.
(Δ) AG. CONTROL POINT



One of the ways in which this scope can be reduced is by "Grouping." For example, the installation of fuel oil piping in the Engine Room can be broken down as follows:

Marking pipe line

Installing piping

Fastening pipe flanges

Welding pipe supports

Installing valves

Fastening pipe supports

Also, this sequence can be described simply as:

Installing firemain piping

The former is referred to as "description of elemental jobs" or "elemental jobs" and the latter as "description of grouped jobs" or "grouped job." Six elemental jobs become one grouped job.

In this particular case, the "grouping" means "grouping jobs." On the other hand, looking at materials included in the elemental jobs, we can find that a description of material can represent a job description relating to that material. In this report, "grouping" is mainly grouping materials, and "palletizing" means "grouping of materials."

Note: Sometimes the word "pallet" is used for "grouped materials" or for the physical container, which is usually made of steel, and by which the grouped materials are transported.

3. Resources of Palletizing

In the outfitting production process, there are many resources to be controlled. They can be JOB, MATERIAL, PERSONNEL, TIME, MONEY, etc. Since time and money are the results of control, we can omit them from our discussion.

Material is always closely related to job. For example, "MATERIAL," a main engine, produces "JOBS" such as loading onboard, installation, fuel oil piping, electric wiring for automation, operation, testing and painting.

At the same time, "MATERIAL" has a relationship to "PERSONNEL" through "JOBS." That is, "MATERIAL," a main engine, requires a number of riggers for loading onboard, machinists for installation, pipefitters for fuel oil piping, electricians for electric wiring for automation, and so on.

In addition to the above, "MATERIAL" is always definite and concrete throughout all the production phases - design, material procurement, planning, scheduling, manufacturing, assembling, installing, testing, operation, etc. "MATERIAL" is always visible, therefore everybody can easily tell if something is wrong. For example, the pipe is not strong enough for the test pressure, shipping of the fresh water pump is delayed, installation of the condenser has to be started, etc.

The above facts suggest that if we can control the flow of materials, the other entities can automatically be controlled. So we finally decide that "MATERIAL" is the major resource of grouping.

4. Planning Palletizing

4.1 Introduction

What will be the best method of palletization? We have already discussed that material is the best among the possible resources for outfitting job control. But how are we to palletize (group) material — system-by-system, zone-by-zone, trade-by-trade, stage-by-stage, or a combination of the above?

The three dimensional illustration of the concept of palletization — conventional and improved — show the differences between the two ideas for three axes of function, zone and time, as shown in Fig. 1-7.

Note: Function relates to trade.

Time relates to stage.

The size of pallet is also important in planning. Size must be determined by the following considerations, as shown in Fig. 1-8:

- 1) Large number of pallets makes a network and control complex.
- 2) Large yard facility allows **large** size pallet.
- 3) Large size of ship requires large number of pallets.
- 4) A Ship which has complex outfitting requires larger number of pallets. In other words, an LNG tanker requires more pallets than does an oil tanker.
- 5) Pallet segregation relates to hull block segregation.

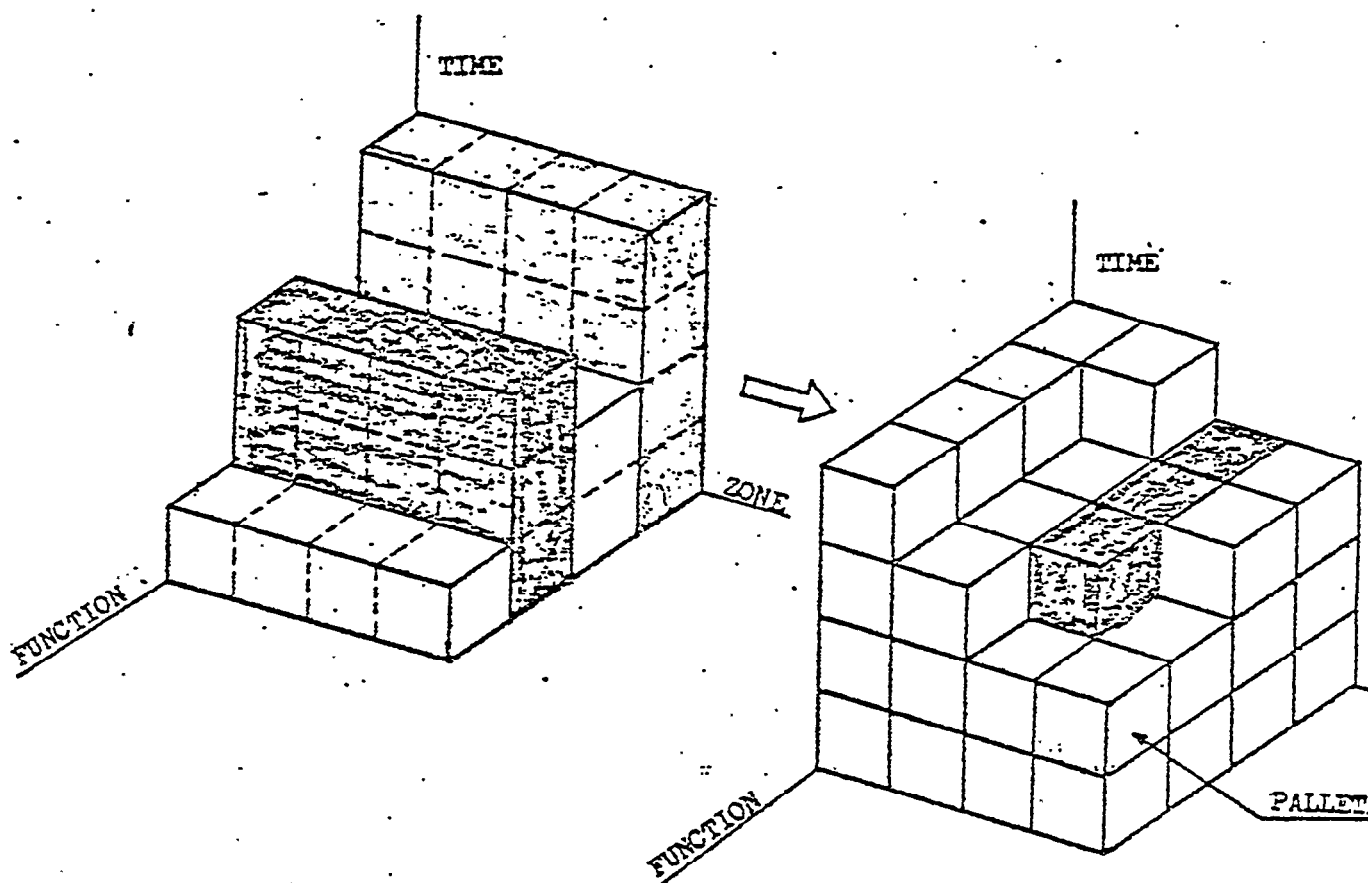
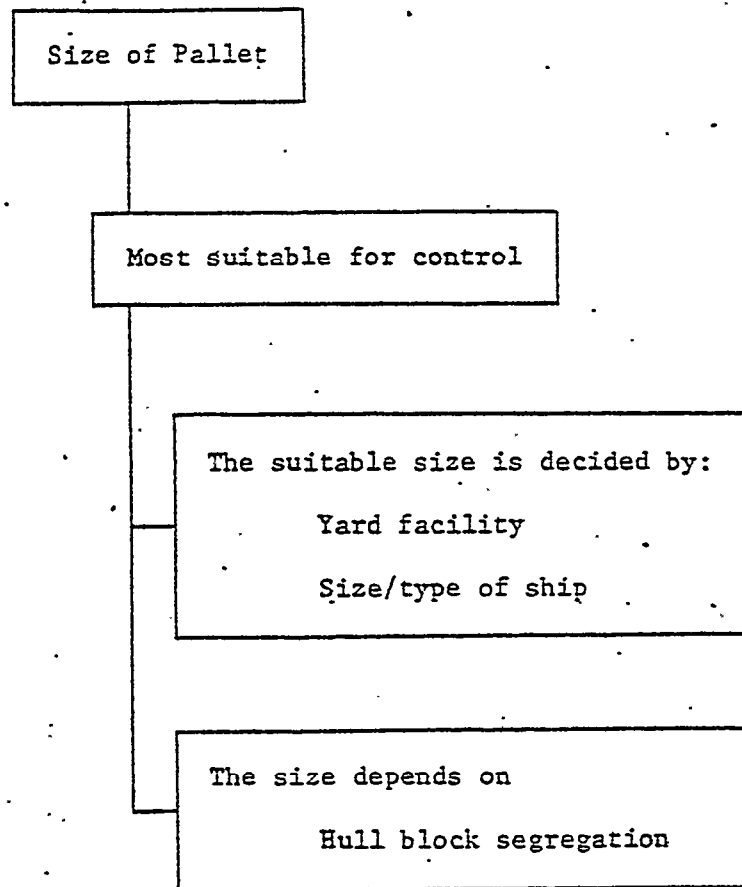
CONCEPT OF PALLET

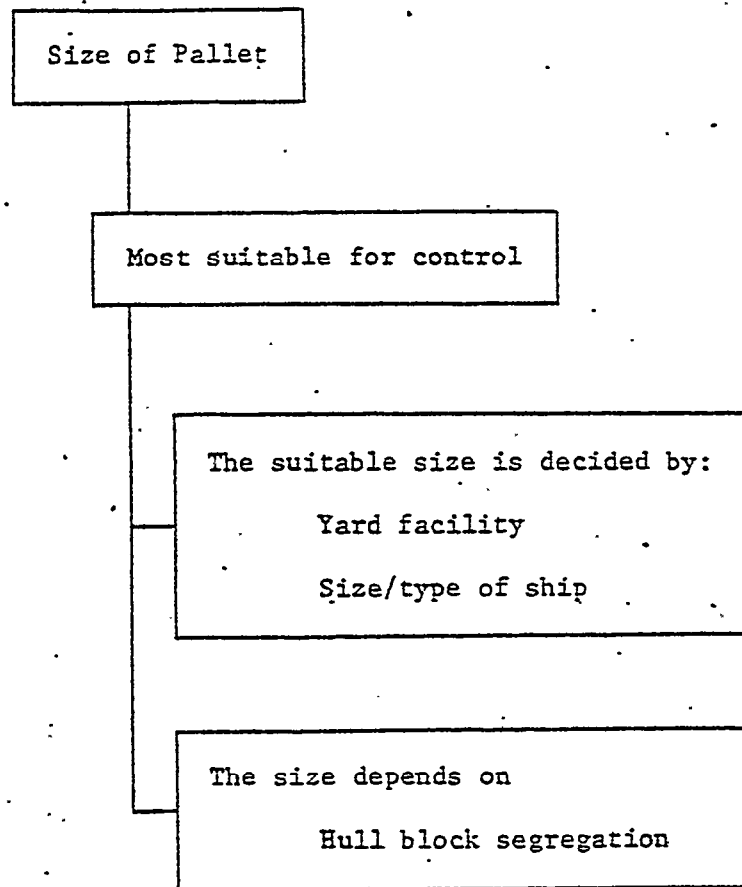
Fig. 1-7



Average No. & Size of Pallet/Unit at IHI Kure Shipyard

Number			Size
	Freedom	250 Tanker	Max. Unit Size
Accom.	450	400	30 L x 20 B x 10 H
Dk & Hold	300	800	(hull block size)
Machinery	250	400	Max. Weight
Electricity	200	300	275 Ton
Total	1200	1900	(hull block weight)

Fig. 1-8



Average No. & Size of Pallet/Unit at IHI Kure Shipyard

Number		Size	
	Freedom	250 Tanker	Max. Unit Size
Accom.	450	400	30 L x 20 B x 10 H
Dk & Hold	300	800	(hull block size)
Machinery	250	400	Max. Weight
Electricity	200	300	275 Ton
Total	1200	1900	(hull block weight)

Fig. 1-8

- The number of managing activities becomes great. They have various durations and create complicated networks.
- The complicated network causes poor control and poor feed back due to its great number of objectives.
- The system oriented network causes idle time due to the difficulty of synchronizing work order releases for various activities. (See Note 1.)
- Installation jobs have a tendency to be scattered over a ship.
- Schedule is dependent on hull schedule.

Note 1: See Chapter I, 5.

"Efficiency of Outfitting Jobs"

4.3 Palletization by Zone

If we can forget that all materials belong to certain systems and establish that they only belong to some zones where they are to be installed or that they are only parts composing a ship but equally divided into zones, and if we have a drawing that ^{indicates} the procedures for installation of a particular system, it is not necessary to take special care for particular system installation.

Fig. 1-9



Zone Outfitting on-block (F'cle Bosum Store)

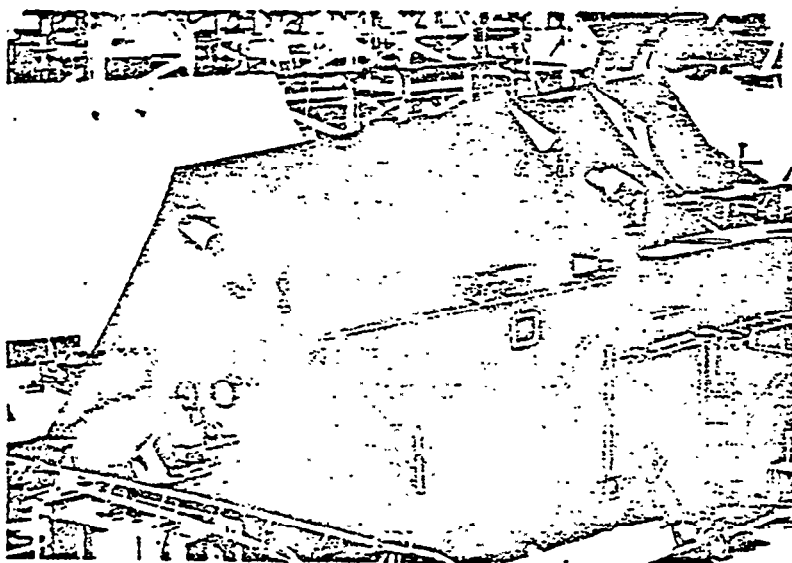


Fig. 1-10

Zone Outfitting on-block (Engine Room Side Shell)

Fig. 1-9



Zone Outfitting on-block (F'cle Bosum Store)

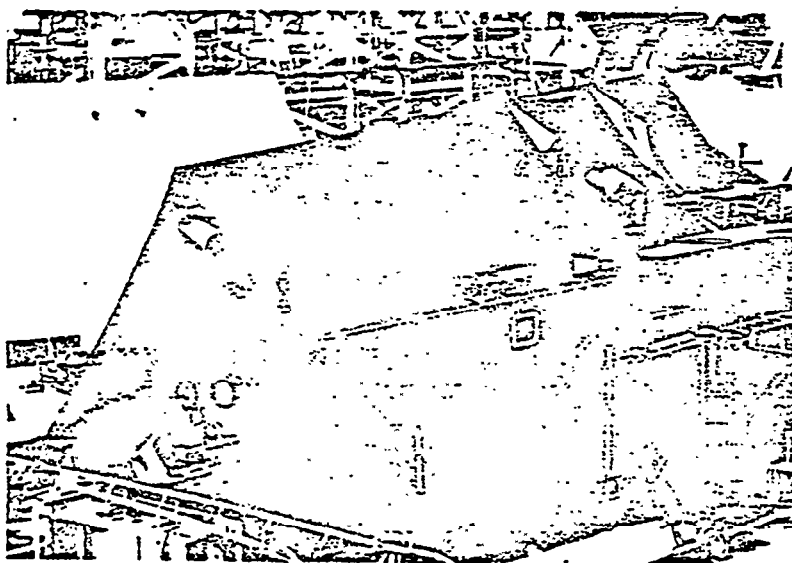


Fig. 1-10

Zone Outfitting on-block (Engine Room Side Shell)

Fig. 1-11



Erection of Outfitted Superstructure
(Grand Block of Accommodation with Engine Casing,
Looking Forward)

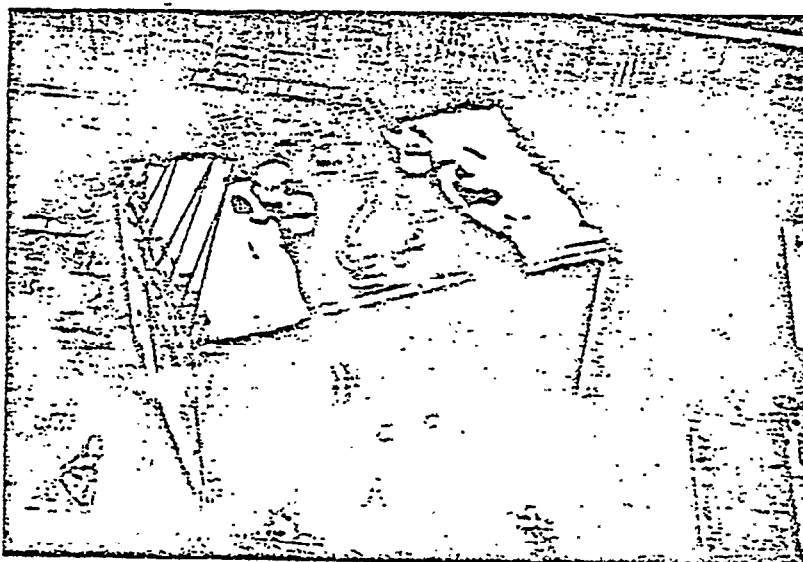


Fig. 1-12

Erection of Outfitted Superstructure
(Grand Block of Accommodation with Engine Casing,
Looking Aftward)

4.4 Grouping by Trade

Materials palletized by zone can further be grouped by trade.

They belong to various functional systems which require particular knowledge and skill for installation. But if the knowledge and skill are completely instructed in drawings, outfitting jobs become simply installation of material. IT requires a worker to have simple abilities such as reading drawings, installing materials as shown in drawings, fastening bolts and nuts, welding, etc. This means that every worker has an opportunity to perform all kinds of outfitting jobs. If this opportunity is realized, both system and activity loss could be reduced.

Actually, however, we still need some specialties for installation of different ~~system~~ Subdividing materials by specialties is still providing us good productivity. Although, too many subdivisions results in too many activities, which would **cause low system efficiency** ^(*) Therefore, subdivision has to be optimum.

(* 1 See Chapter I, 5 "Efficiency of Outfitting Jobs".

Possible breakdowns for palletizing by trade are:

Pipefitter
Steelworker
Machinist
Carpenter

Electrician

Automation installation group

Operation & adjusting group.

Each group has to have the ability to perform welding.

Pipefitters have to be able to install-not only. pipes but also pipe supports and materials which are closely related to piping.

Steelworkers have to be able to install ducting, gratings, handrails, cranes, ladders, doors, buits,- bollards, racks, foundations for machinery, etc.

Machinists have to be able to install and adjust machinery.

Carpenters have to be able to ~~install steel and~~ wood furniture but also lines, ceiling, furring, joiner doors, racks, almost everything relating to accommodations.

Electricians have to be able to install not only electrical equipment and wiring but also supports for wiring and everything relating to electricity.

Automation installation groups have to be able to install tubing, wiring, equipment and *other* things relating to automation.

Operation and adjusting groups have to be able to perform everything relating to the operation of machinery.

Fewer trades means *fewer* activities. Fewer activities in a network makes the loss less.

4.5 Grouping by Stages

Materials in one zone can be further divided into several groups which can be installed at different times. Some of these can be installed while they are being assembled in the shop. Some others can be installed after the ship is launched.

The former, installation in shop, provides better productivity than the latter because a shop provides adequate facilities, tools, safety and convenience in material handling and transportation, protection from the weather and ease of supervision. Even if pipe pieces have to be installed on both sides of a deck structure, both can be installed so that piping is not on the underside of the deck plate but on the upperside. We can avoid difficulties such as lifting heavy things overhead and welding in overhead positions. Such installations can be performed each time the deck structure is turned over.

Stages combined with hull and outfitting can be divided into several steps as illustrated in Fig. 1-13.

Manufacturing

This means manufacturing process in the shop of pieces which are listed in the "Material List of Pallet." But since the procedure for piece manufacturing is quite different from that for outfitting, it has to be controlled independently. Therefore, a necessary aspect is timing, to meet both completion of pieces and starting of palletization.

Unit Assembly (Fig. 1-4, 1-14, 1-15)

This means the assembling process of a unit, which consists of machinery, foundations, piping, valves, and any other materials closely located, that are assembled firmly, sometimes reinforced, to allow transportation and installation as one piece. An advantage of this process is that it can be done in the shop, which provides superior conditions to the outside shop .

On-block Outfitting (Figs. 1-9 and 1-10)

This means a process of installation for pieces and units on hull block, in the shop or on land. It is usually carried out while hull blocks are being stored, but also can be done while they are being assembled. Its advantage is the same as *that of* unit assembly.

Onboard Outfitting

This is a process of installation for pieces and units onboard the ship. Installation of pieces and units which are already installed on-block is carried out at the same time *that* the block goes to erection onboard. Combinations of these processes" results in 4 procedures for outfitting are illustrated on Fig. 1-13.

WORK FLOW OF PALLETED MATERIALS

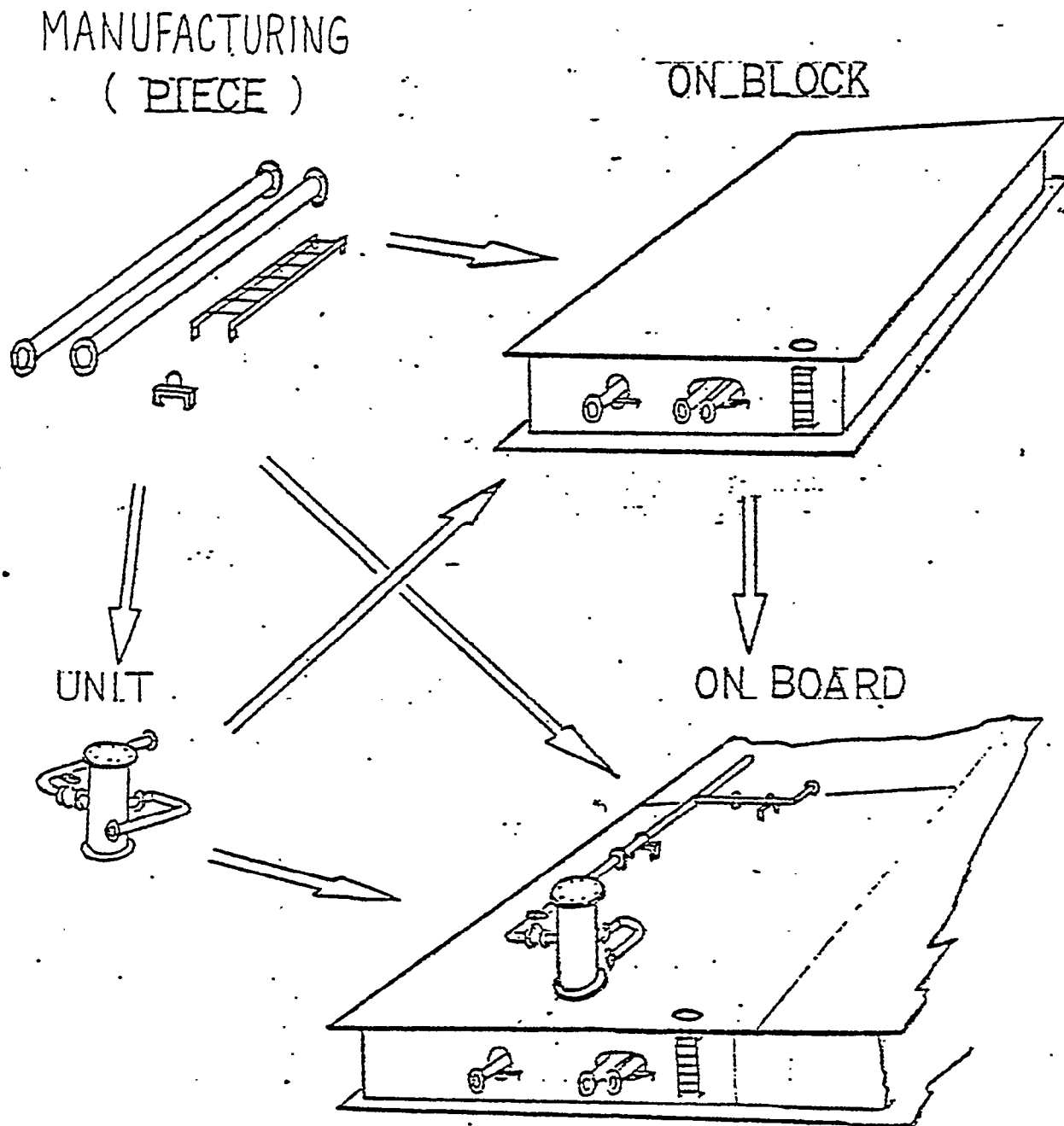


Fig. 1-13

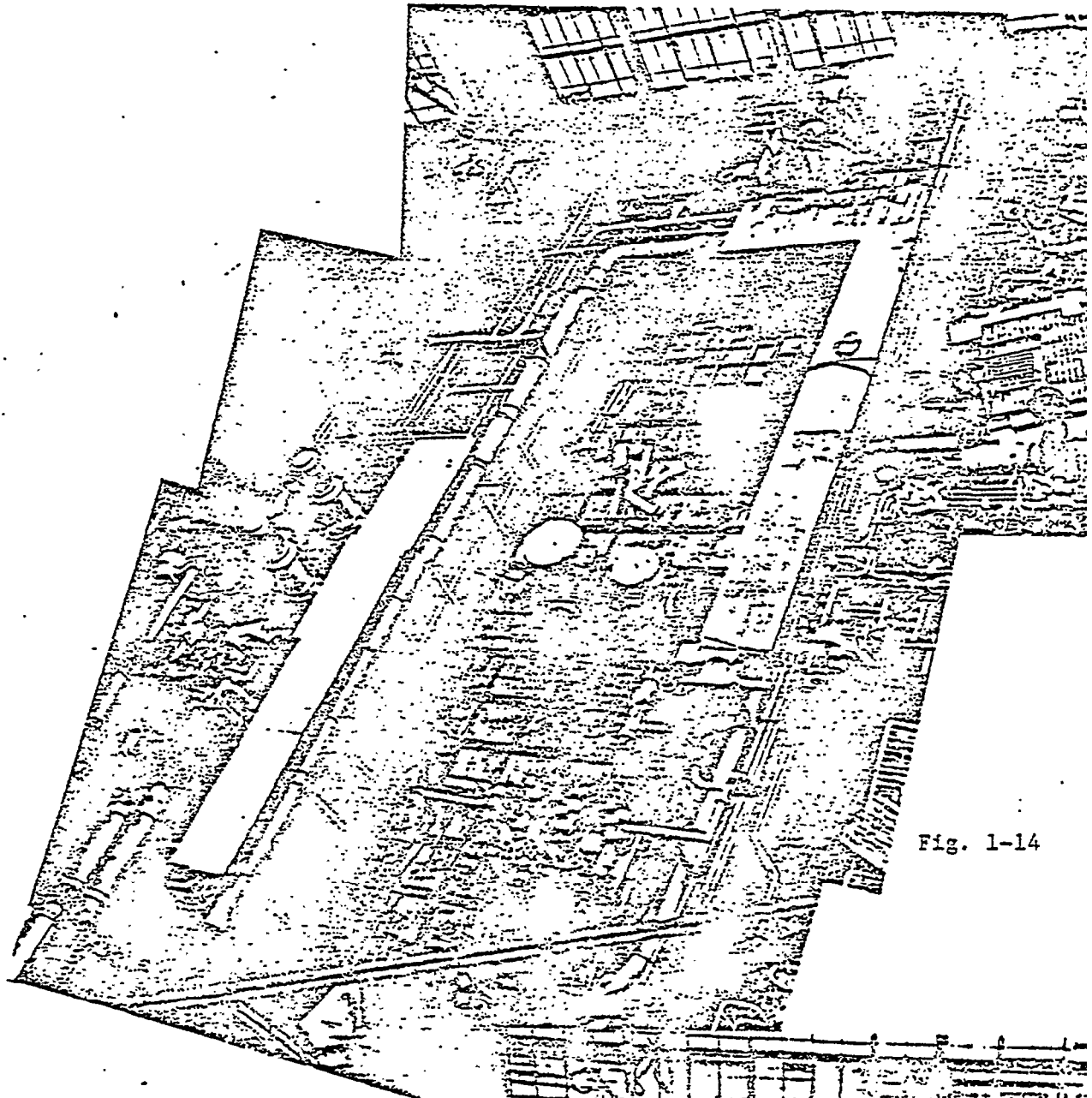


Fig. 1-14



Fig. 1-15

4.6 Manufacturing of Pallet

1) Required *quantity* of Pallets

The fact or for determination:

Daily products of pipe shop	A pcs/day
Average contents of one pallet	B pcs
Average stay period in shop	c days

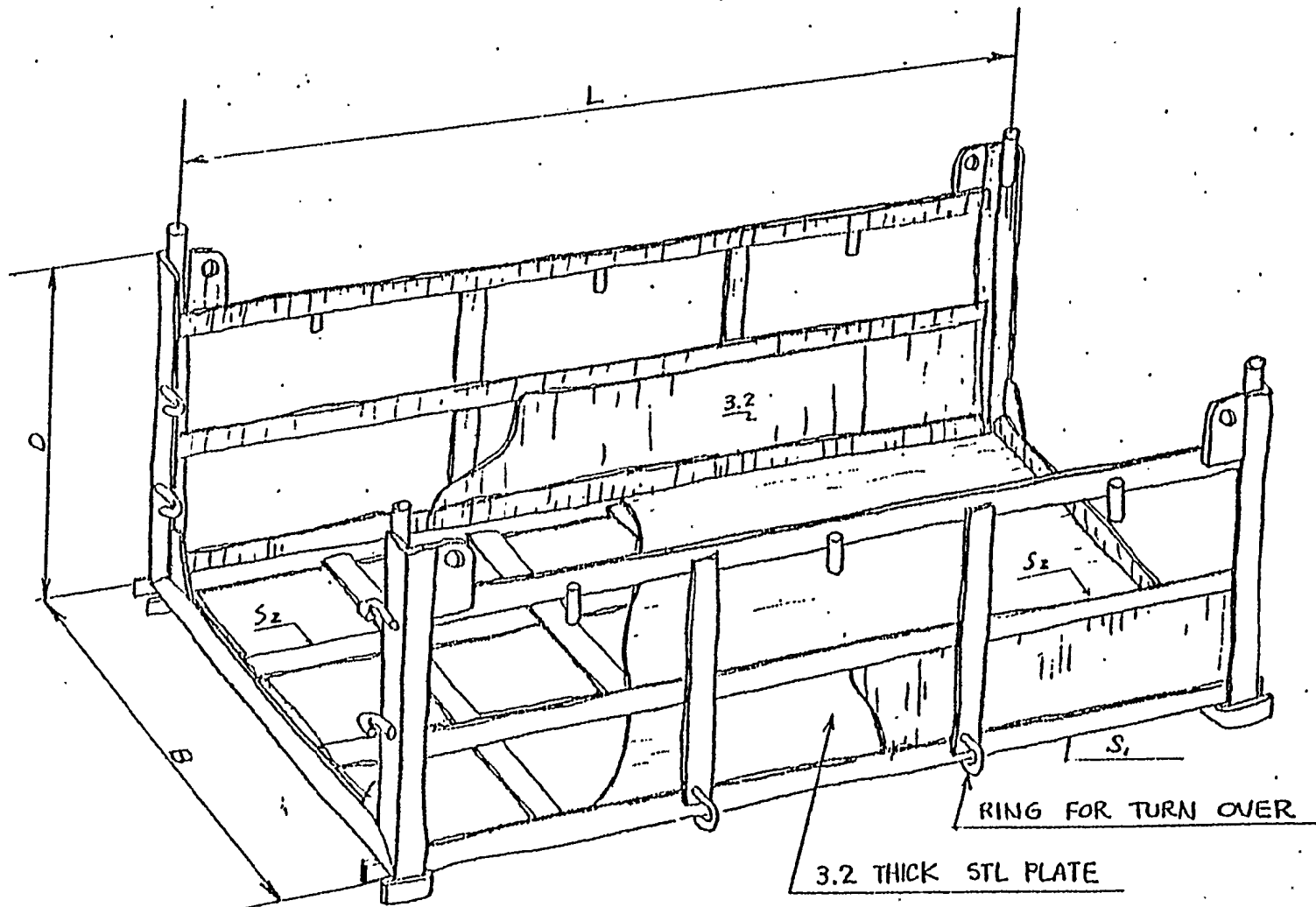
Required quantity of pallets = $(2A/B)C$
(including materials other than piping)

2) Pallet Design

Presented IHI case. (Fig. 1-16)

- Size of pallet; As shown-in Fig. 1-16
(provided the quantity of pipes is 50 pcs in maximum
average quantity can be assumed about 30 pcs.)
- Material for pallet; angle bar 3" x 3" X 3/8", steel net,
lifting eye plate, rib, etc.

	L	B	D	S1	S2	unit: mm
Large Pallet	1,922	900	805	75 x 75 x 9	75 x 9	
Small Pallet	3,400	1,800	1,800	100 x 100 x 10	90 x 60 x 9	



5. Efficiency of Outfitting Jobs

Efficiency of outfitting jobs can be divided into two categories. One is called "system efficiency" and the other "activity efficiency". When whole outfitting jobs are figured out as a network, the former is an efficiency caused by idle time between different activities and the latter-within an activity. Both efficiencies are shown in Figs. 1-17 and 1-18.

5.1 System Efficiency

On the network shown in Fig. 1-17, at the point that activities 1, 3 and 4 are connected we sometimes have idle time after completion of activity 1 due to delay of activity 3. This idle time W_{tb} is indicated by a dotted line in Fig. 1-17.

For example, when activity 3 is installation of a bilge pump and activity 1 is pipe fitting for the pump, the pipefitting have to delay starting their job until the bilge pump installation is completed. But as we have experienced many times, coordination of different activities is difficult.

It is inevitably interrupted. Receipt of the bilge pump in the warehouse could be delayed by accident or damage in transportation, or by delay of vendor's delivery. Piping installation would be delayed by problems such as illness of the workers or bad weather etc.

Sometimes, same type of delay occurs before *starting* jobs. (Workers might be awaiting delayed materials or preparation of tools which should have been prepared in time by another group . This kind of time loss is comparatively larger than time loss caused within an activity. This is not a loss caused by workers, but by a network and its control. We can improve this by *improving* the network and improving *control*. We call this "system loss" and efficiency caused by system loss is called "system efficiency."

5.2 Activity Efficiency

Activity efficiency can be divided into two parts. One relates *to* actual work efficiency and the other to personal efficiency.

Actual work efficiency relates to, for example: welding speed, gas cutting speed, grinding speed, fastening speed, etc. It can be improved by technical development for tools, facilities equipment, etc.

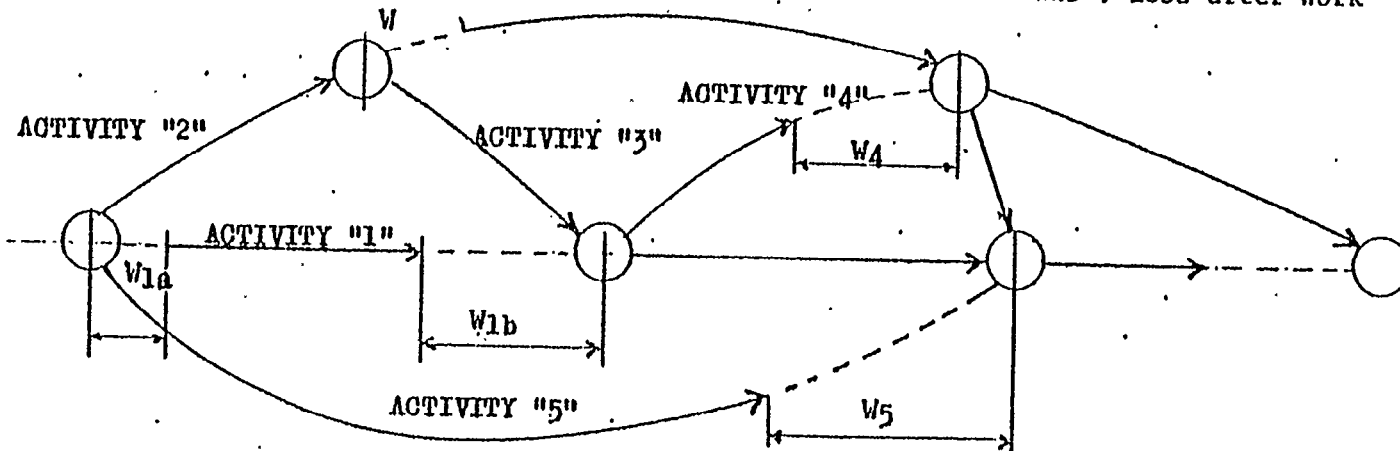
Personal work efficiency *relates* to workers' irregular rests during duty that are necessary to continue the *work* physically, such as going to the restroom, etc. It can be improved by providing education, motivation, promotion, supervision, etc.

5.3 Palletizing and Efficiency

As discussed, there are many activities in a network. Each activity has the possibility of causing the system problems.

But, if we can reduce the number of activities we could reduce system losses at once. If we can reduce the number by one-teeth could reduce system losses by more than one tenth. See Chapter 1; 2.1.

Fig. 1-17



$$\eta_s = \frac{MH - W_n}{MH} \times 100(\%)$$

η_s : System Efficiency

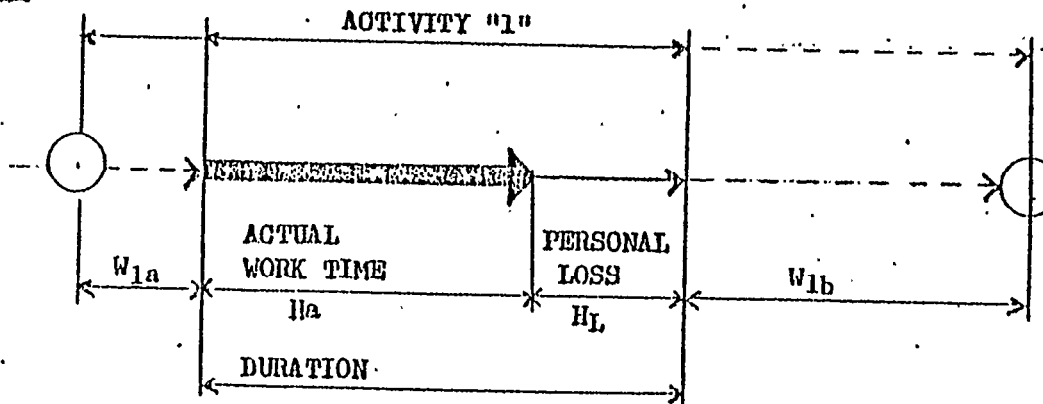
MH : Total Manhour required for System

$W_n = W_{na} + W_{nb}$

W_{na} : Loss before Starting of Work

W_{nb} : Loss after Work

Fig. 1-18



$$\eta_a = \frac{H_a}{H_a + H_L} \times 100(\%)$$

η_a : Activity Efficiency

CHAPTER II - PROCESS OF PALLETIZATION

1. Outline of Process for Palletization (Fig. 2-1)

There are two important functions involved in establishing a successful palletizing system: composite drawing and cross-communication between design engineers and production planning scheduling and controlling engineers (PP'S engineers.). . See Fig. 2-2.

After completion, functional drawings (general arrangement, machinery arrangement, piping diagram, ducting diagram, mooring arrangement, access plan, handrail and grating, accommodations, ceiling and living, insulation, etc.) are sent to PPS engineers. And then, follow the following procedures.

1.1 Planning of Outfitting Method.

PPS engineers study these drawings and decide how to outfit the ship based on their experience on previous ships. They also refer to the hull construction method and hull block segregation. Master schedule (annual schedule) and slip. ways or docks to be used are also referred to.

Finally, the PPS engineers decide outlines of how to outfit the ship and a list of pallets which will be used in that particular ship. They also devise a pallet schedule which shows the required date of each pallet. (See detail e-xplana-

tion in Chapter II, 4.2.) This information is then sent to design engineers.

1.2 Preliminary Composite Drawing

Design engineers *study* the above information and develop preliminary composite drawings, which are very *rough* arrangements of piping, ducting and other major equipment on the general and machinery arrangements. Piping is indicated by only one line, as in a diagram. But the drawing has to be developed so that PPS engineers *can* understand how many and what kinds of pipes will be run in a particular section, and then they can decide palletizing segregation for almost all materials, relating to zones, trades, stages and units. See Fig. 2-3.

Preliminary composite drawings are sent to PPS engineers for their review.

1.3 Scheduling of Material Procurement

The pallet list and *its schedule are sent to m e n g i n e* ~~They~~ decide the material purchasing and issuing schedules, referring to the lead-time of materials. See Figs. 2-4 and 2-5.

1.4 Review on Preliminary Composite Drawing

Preliminary composite drawings are reviewed by PPS engineers, together with design engineers. They plan palletizing. They decide what materials are to be installed at the assembly stage, onboard the ship, or assembled into units.

This information is sent back to the design engineers.

1.5 Developing Composite Drawing

Design engineers develop composite drawings, referring to functional drawings and information from PPS engineers. Composite drawings are drawn zone-by-zone. *All materials* that are to be installed in a zone have to be indicated after checking that they have no interferences with each other. Besides *necessary* information for installation being indicated in these drawings, they are also satisfied by functional requirements.

After completion, composite drawings are sent to PPS engineers.

1.6 Review of Working Drawing

Composite drawings are reviewed by PPS engineers to see if the drawings reflect the intended installation. IF they have any comments on these drawings, they discuss their comments with design engineers until both PPS and design engineers reach mutual agreement.

Then, approval for further development is then given on those drawings.

1.7 Development of Working Drawings

Working drawings are drawings by which installation of material in one zone can be completed. A drawing is issued with segregation corresponding to one activity, that is, *issued by zone*, by trade and by stage. Sometimes it is issued with more than one segregation for convenience in installation *or* manhour saving. Contents are almost the same as those of *a composite* drawing, therefore, it can be developed from the composite drawing by means of a photographic technique.

A material list of pallet is made from the working drawing. Both working drawings and material **lists** are sent to PPS engineers for planning, scheduling and actual jobs. Material lists are sent to *material* control for updating the material ledger and palletizing.

Note: A working drawing is issued only when outfitting in a *certain* zone is congested as not to be covered by the composite drawing. Normally the composite drawing can be used as working drawings.

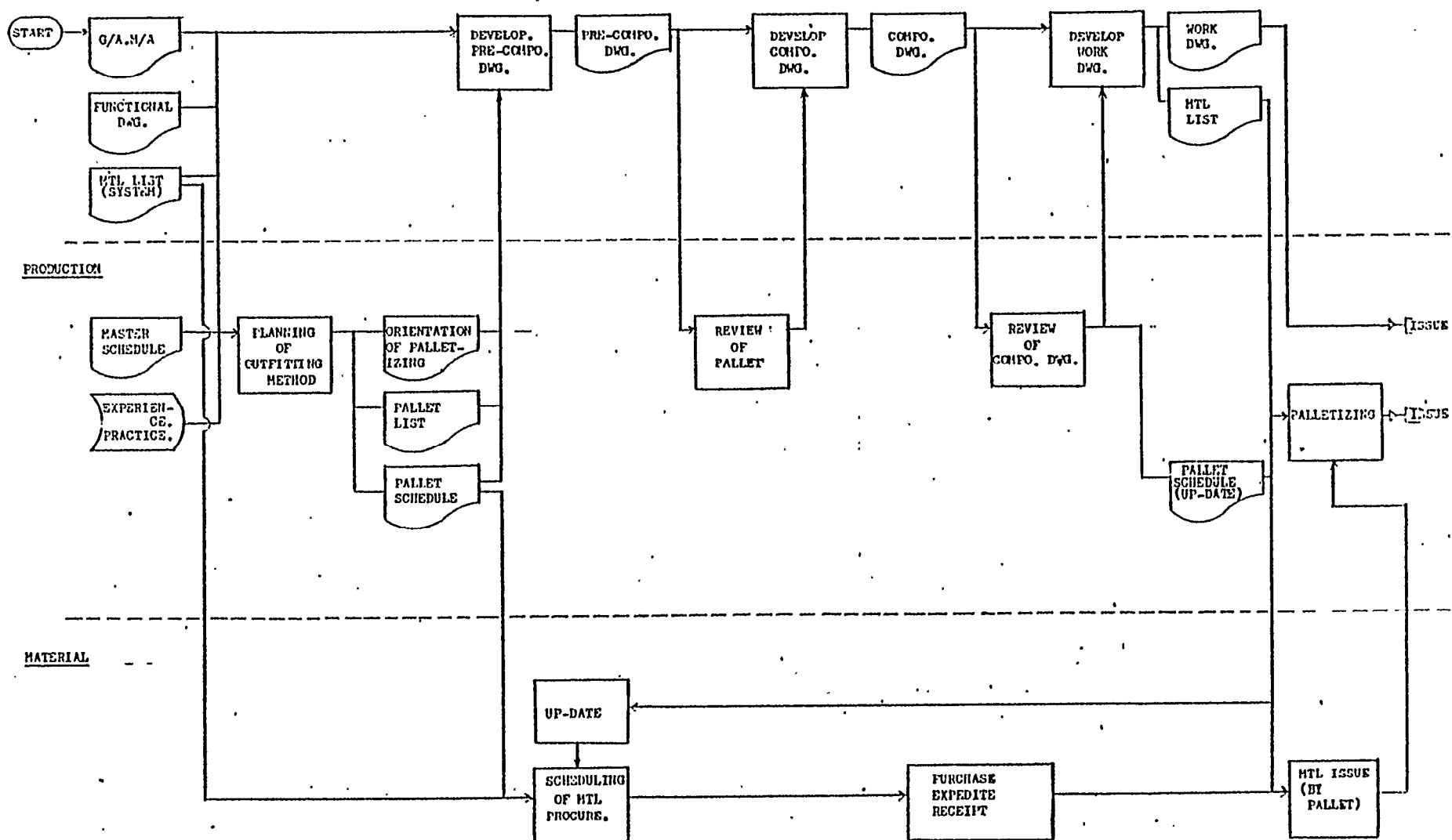


FIG. 2-1

FIG. 2-1 PROCESS OF PALLETIZATION

A-B-Q-D meeting

A-B-C-D meetings are held for cross communication between Sales, Initial Design, Yard Design and Production.

Contract

Delivery

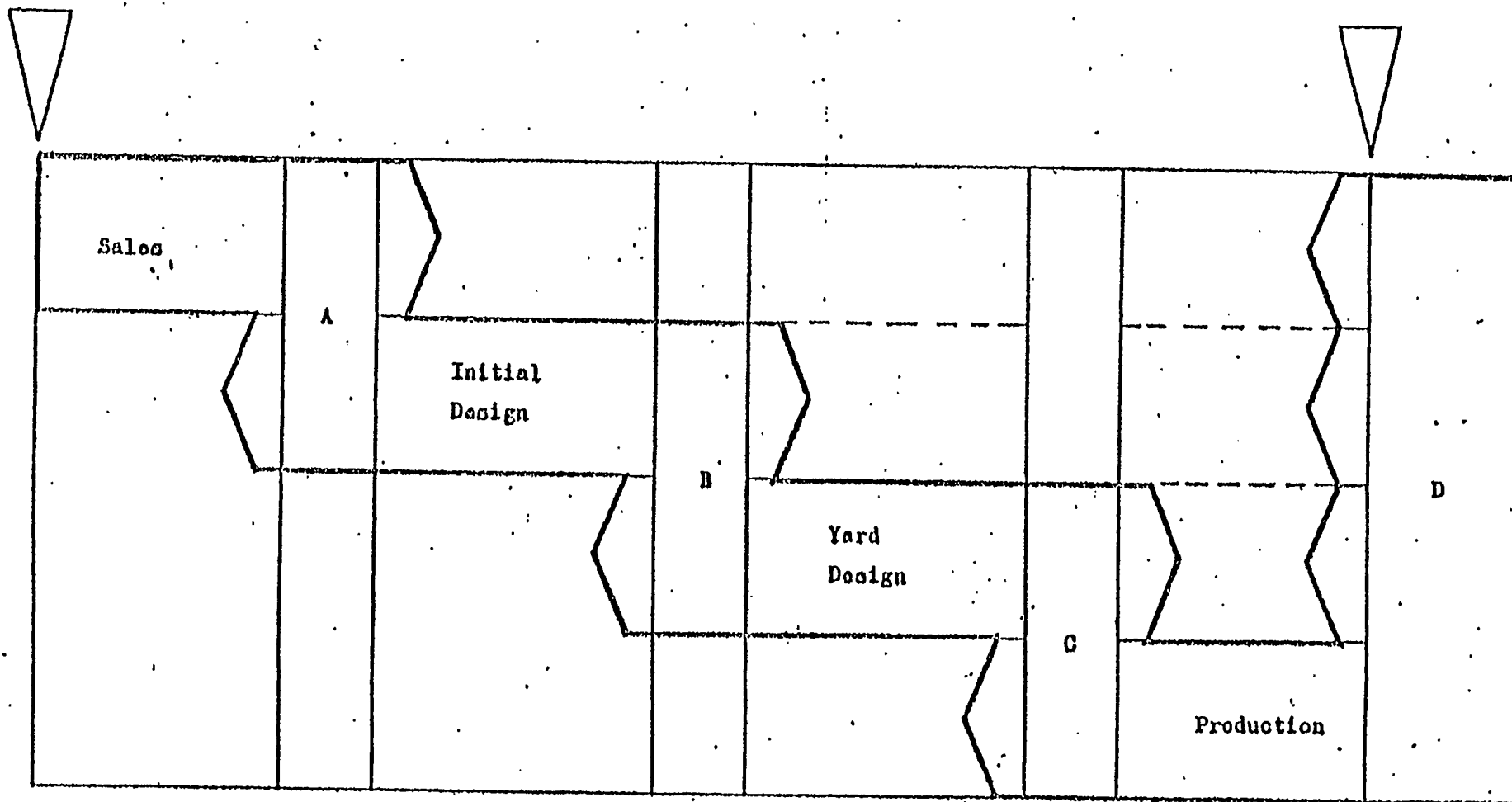


Fig. 2-2

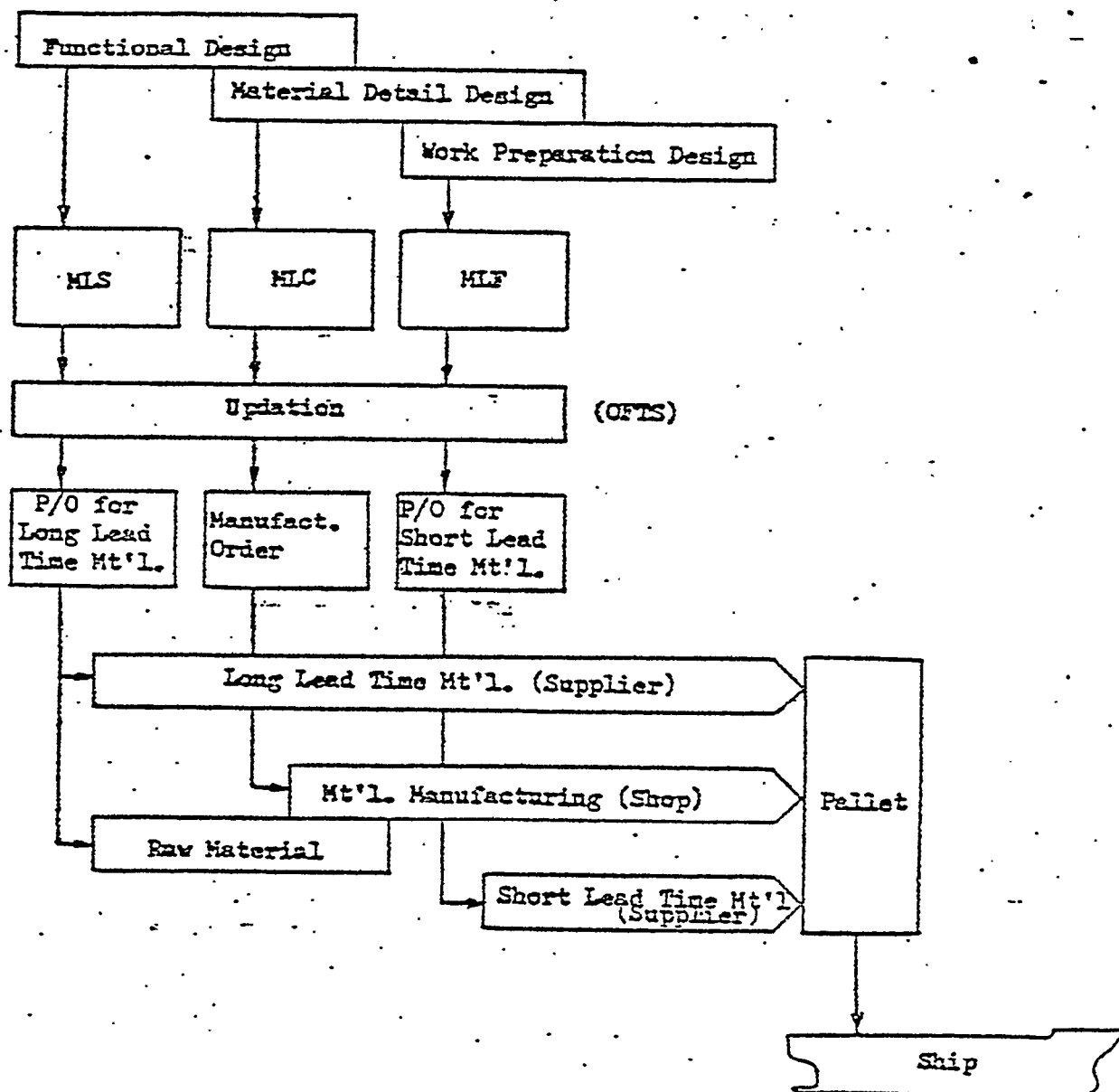
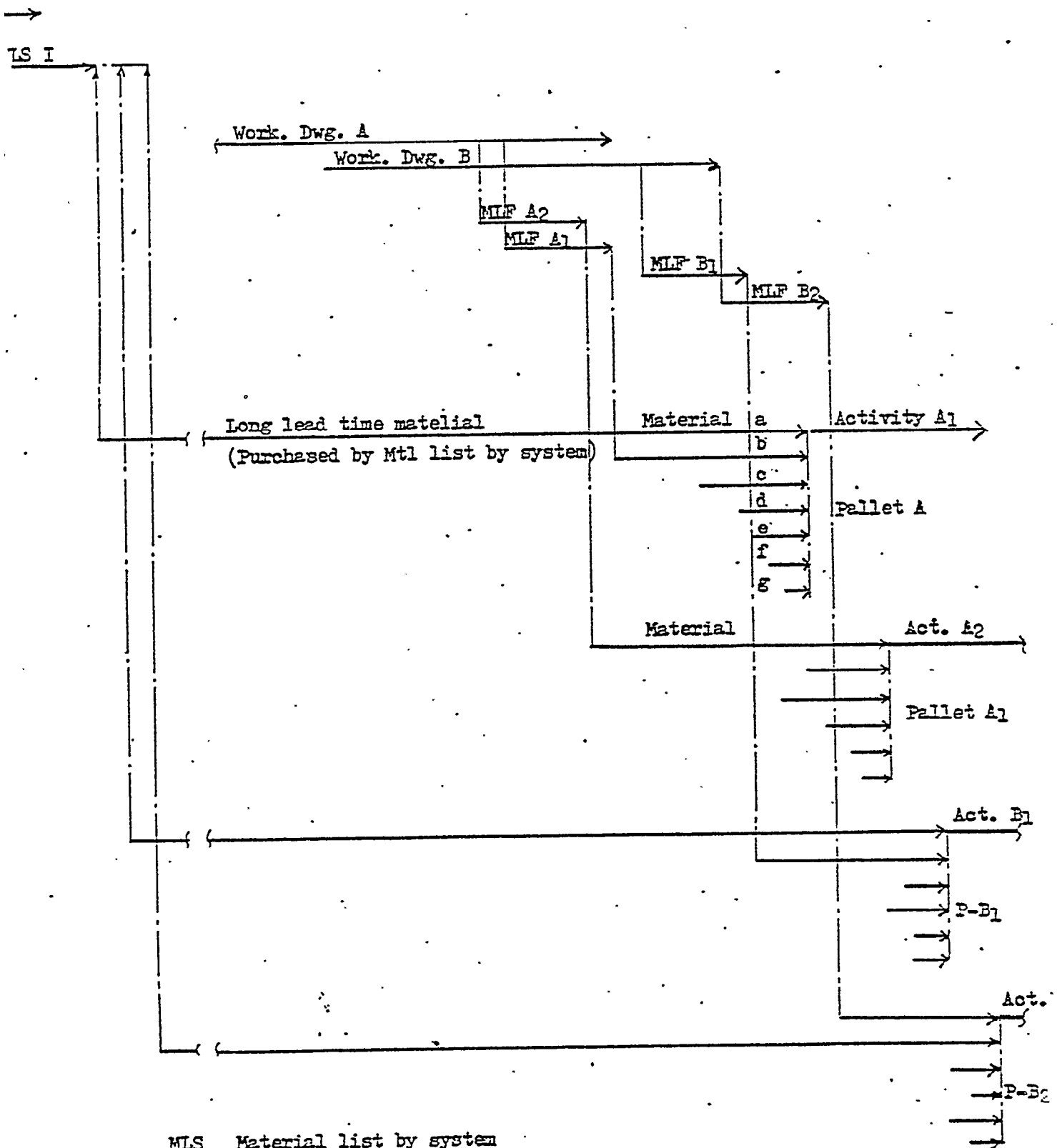


Fig. 2-4



MLS Material list by system

MLF Material list for pallet

MLF-A₁, A₂ are material lists of work.Dwg. A but divided for stage A₁, A₂.

Fig. 2-5

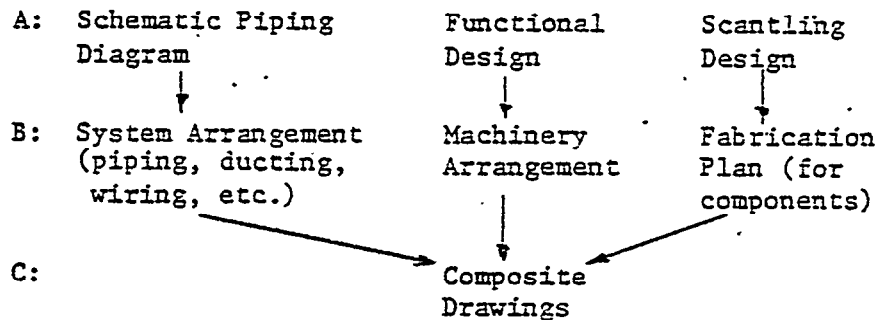
2. Design Phase

2.1 Requirement for Design or Production Planning

It is an organizational option as to whether the conditions discussed shall be required for the Design Department and/or the Production Planning Department. Provided below are the options of the Design Department:

1) Composite Drawing

The method developing the design is as follows:



Let A, B and C represent the levels of the design developing stage. A level drawing is a segment of the functional design without any specification of position. B level drawing specifies the rough position or dimension for the actual system, machinery or components. C level drawing specifies position, with an interrelationship of all materials and hull construction. This is the composite drawing.

This C level composite drawing is very important for palletizing. The area of the drawing includes the region

of job units and accordingly, all the jobs accompanied with all the materials in that region. If the composite drawing cannot include all the materials in that area (i.e., composite drawing of-piping only), palletizing may be incomplete.

As the method above simply shows, the Composite drawing is based on the hull structure. But the revision of the hull structure may be required from the outfitting standpoint, and the hull structure will be revised at the desk, not at the construction site. It goes without saying that this will also increase the efficiency of outfitting.

2) List of Material for Outfitting

The unit of material flow or the unit of a job can be brought to view by the list of materials for outfitting (referred to as MLS). It is the list of materials contained in the unit of a job referred to in 1) above.

There are three aims of the MLF:

- (1) To present MLF as a process, a schedule unit, used for considering when the job is contained in the MLF and when to end them.
- (2) To present HLF as a delivery date unit, used for considering the time allowed up to the delivery date of each piece of material contained.

(3) Loading of each material in the pallet according to the MLF.

The MLF is made from the composite drawing and the list of materials for requisition. The time allowed for the MLF to be made depends on the necessary date of the pallet and the lead time of each piece of material in the MLF. "Who should make the MLF depends on the organization and circumstances.

Therefore, the requirement for design as to the MLF is only to figure all the necessary information in the composite drawing. The MLF is related to the list of materials for requisition in the following (the list of materials for requisition corresponds to design levels A and B):

Requisition: Each material delivery date is estimated from the Milestone Schedule.

MLF : Each pallet delivery date is determined by detail planning for palletizing, namely monthly and weekly schedules.

The above relationship shows, that it is possible to revise each material delivery date when the MLF and its schedule are made. But the careful planning of palletizing and the information from that planning can minimize such a revision.

2.2 Drawing Issue Schedule

Drawings that are necessary for palletizing are:

- 1) Composite Drawing
- 2) Working Drawing
- 3) Material List for Pallet (MLF)

These drawings must be issued in advance of the date for purchasing, manufacturing and palletizing of materials so that the palletized materials are delivered in time to meet production engineer's requests.

The issue date of MLF (A) is decided by:

- 1) The delivery date of each pallet to a production site
(B) .
- 2) *The longest lead time among various materials of short lead time* contained in a pallet (C), as shown in Fig. 2-5.

$$(A) = (B) - (C)$$

Actually, however, since various materials have various lead times, they are divided into several groups of pallets which have similar lead times, rounded to a whole number, as a criterion of the scheduling for drawings in order to make the scheduling simple; for example, a group of pallets has lead time of one month, another has two months, and so on.

This scheduling is performed referring to the lead time of only the material which has short lead times. Material with

long lead times can be ignored for this scheduling because preparation of these materials must have been completed in the early stage by functional drawings and their material lists (MLS = Material List by System). See Fig. 2-4.

Starting date for making the "Material-List of Pallet" is decided, adding its duration to the issue date of drawings. Also, the starting date of the composite drawing is principally decided, adding its duration to the issue date of the "Material List of Pallet." It should be noted that the "Material List of Pallet" can be started and completed before completion of the composite drawing and "Material List of Pallet" should be carefully controlled because the earlier the issue of the list and the more accurate the list, the more efficient the production preparation.

2.3 Composite Drawing (Figs. 2-3 & 2-6)

The composite drawing can be divided into two kinds of drawings. One is the composite *drawing* itself and the other is the working drawing. The former is used for studying all the installations for machinery, equipments, piping and all *other* outfitting materials, and for checking interferences between them and with *steel* structures. The latter is used for installations in the yard, therefore, it is usually issued **s e g r e g a t e d**, by ~~zone~~ *zone*, ~~by~~ *by* stage. The latter can be developed from the *former* by means of the photographic technique.

After taking a copy of one zone from a composite drawing, the lines which have to be worked out by that activity (trade and stage) are emphasized by the photographic technique. And particular information for workers, such as sizes and clearances necessary for installation, installation sequence, loose flange, weight for loading, etc.; are added. The most *important* aspect of the working drawing is that all work included in one work job order can be completed from one working drawing without the help of other drawings.

We also have preliminary composite drawings, but these drawings are only developed in the process of developing the composite drawing for convenience, if necessary. (See Chapter II, 1.2.)

The-composite drawing requires much more information than any other drawings that are to be issued. Therefore, the draftsman for the composite drawing has to be a person who has a comprehensive faculty for understanding not only functional matters but also production matters. Sometimes, he has to go on board to see actual situation of outfitting and to discuss matters in problem, if any, with PPS engineers and foremen.

The composite drawing has to have the following information:

- 1) Information on hull structure such as location, shapes and sizes of web frames, face plates, stiffeners, brackets, chocks, block joints, seams, butts, lightning holes, drain holes, air holes and all other information which affects the installation of outfitting materials.
- 2) Location, shapes and sizes of all machinery, equipment, instruments, facilities, electric cableways, ducts, racks, shelves, etc.
- 3) All details-have to fulfill functional requirements.
- 4) All machinery and equipment are arranged to have adequate spaces for operation, overhauling and maintenance.
- 5) Machinery, equipment, and hull structures do not interfere with each other.
- 6) Dimensions and sizes indicating locations, shapes, distances, clearances and tolerances necessary for installation are to be indicated.
- 7) Piece numbers for machinery, equipment and pieces necessary for installation are to be indicated.
- 8) Installation sequence of machinery and equipment are to be indicated.
- 9) Loose pipe and make-up pipe are to be indicated. The indications are also used for pipe installation sequence.

- 20) Particular notices for installation, if any, are to be indicated:

2.4 Material List for Pallet (MLF, See Fig. 2-7)

Material List for Pallet must list all *materials* that are necessary to complete jobs in one work order, for example, pipe pieces, flanges, bolts, nuts, gaskets, nameplates, etc as well as major materials. Jobs in one work order mean jobs in one activity or jobs in one zone, but divided by trade and stages, if any.

1) Major Information to be included in Material List for Pallet

Material List for Pallet must include information necessary for installations, such as:

- (1) Pallet number
- (2) Name of material
- (3) Identification for installation (piece number)
- (4) Specification
- (5) Quantity
- (6) Weight
- (7) Sketches, if necessary
- (8) Information for assembly
- (9) Working drawing number corresponding to this list
- (10) Information for manhour calculation for jobs included in this list

(Item No. corresponds to the Column No. of MLF in the circle)

Details of above items are as follows:

- (1) Pallet Number is used for identification in order to know

When we have to start this palletizing

When we have to deliver this pallet

Where we have to deliver this pallet

Where we have jobs of this pallet

When we have to *do* jobs of this pallet

To whom we have to deliver this pallet

- (2) Name of Material is indicated for each item of material listed so that anyone can understand it.

Some kind of code can be used for identification in a computer system in addition *to the* above.

- - - - -

- (3) Identification for Installation (piece number) is used for identification of each listed piece (see Note) *which* has to be indicated on the working drawing for convenience of installation.

Note: Piece is not material., therefore, piece number is not material code, e.g., one piece of pipe is composed of two flanges and one pipe.

- (4) Specification is diameter of pipe and valve, plate thickness, classification of material, etc.; dia-

meter of pipe and valve is especially important but it may be indicated in Name of Material Column instead this column .

(5) Quantity - No explanation is necessary.

(5': Unit of quantity)

(6) Weight is used for planning of jobs, such as lifting weight, total weight of assemblies, or index for checking job progression such as total loading weight per month.

(7) Sketches is convenient for identifying materials such as pipe pieces, especially for "unskilled workers.

(8) Information for Assembly is used for indicating sequence of jobs, units to be pre-assembled, or notation for special installation.

(9) Working Drawing Number is the drawing to be referred to accomplish jobs relating to this pallet.

(10) Information for Manhour Calculation (Control Weight) is used for manhour calculation for jobs included in this pallet. Manhour Calculation is used for control.

Material List for Pallet is also used for palletizing materials in the warehouse, and for checking received materials by foreman in the yard. Sometimes, comments on

installation or material itself is fed back to the design engineer. Therefore, Material List for Pallet has to be a list that people in design, *material procurement plan*, scheduling, and the foreman and worker can chase material easily by referring to this list.

2) Other Information included in MLF of IHI

(See Fig. 2-7; ItemNo..*corresponds* to the column MLF in the circle)
.

(5') Unit of Quantity, 1: piece, set, sheet, etc.

2: g (gram) l.

3: kg (kilogram)

4: ' m

5: m^2

6: m^3

7: $1/1000 m^3$

8: l .

(10 ') Identificatim of Weight for manhour calculation,

Blank: Weight of material not proportional to
outfitting manhour

(ex. Main engine, diesel generator, etc.)

1 Weight of material proportional. to outfitting
manhour. (= Control Weight)

(11) Ship Number

- (12) Required Date for Pallet
- 13) Next Stage (MLF-NO.)
- (14) Responsible Outfitting Shop (Code No. of each shop)
- (15) Responsible Design Section (Code No. of each section)
- (16) Page Number means the page of each MLF sheet in the all MLF sheets printed out in a day. It is serial number and used for identification between different shops or design sections.
- (17) Length of Electric Cable if any
- (18) Weight of Pallet; The upper figure shows sub-total weight in the sheet and the lower figure accumulated weight of the pallet. Weight of temporarily located material which is to be outfitted by other MLF after loading onboard is not included.
- (19) Erection (Loading) Weight includes the weight of temporarily located material.
- (20) Page of MLF within a pallet
- (21) Fabrication Sign indicates information of fabrication process to be applied to the pipe piece before final., installation. such as for make-up pipes or a pipe pieces which need to be finish painting in the pipe shop. after decision of the dimension.
- (22) Temporary Location sign
- 1 :To be finally installed at the next stage..

- 2: To be finally installed at this stage, i.e., the material is temporarily located at the preceeding stage.
- (23) Painting Schedule code of which is given by IHI standard SOT-A280201.
- (24) MLF No. for Temporarily Located Material
- 1: MLF No. of the next stage.
 - 2: MLF No. of the preceding stage.
- (25) Reference Drawing No. for example, drawing number of the fabrication drawing or purchase order specification for the material.
- (26) Material Resources identifies resource of the material such as allocated material purchased for a specific ship or stock material etc.
- (27) Material Code is IHI standard code given for the material and used commonly for various ships.
- (28) Classification of the Material is classification standard for the material such as IS (IHI Standard), JIS (Japanese Industrial Standard), ABS etc. This classification may be given by (4) Specification as practically.
- (29) Remarks; Any special remarks other than (1) - (28).

M L F

※第一品目は 0.加工費 1.金型費 (注16) (注17) : 金型費 (注16) (注17)
 3.全型費 4.特型費 (注16) (注17) 5.特型費 (注16) (注17) (21)
 6.現場加工費 0.ノルプ

1.式図面本数 2. 3. 4. 5. 6. 7. 1000^{mm} 8. 9.
 取込サイン 1.次のステージのM.L.F. No
 取込サイン 2.前ステージの M.L.F. No (24)

※付録24
 A.B.C...S.D
 1.2.3...

※本製品
 1.取込品 (次のステージで本付されるもの) (22)
 2.取込品 (前のステージで取込されたもの)

(23) SOT-A200201参照
 各取込品
 1.管理番号 (10)

1. 引当品 2. 外注品
 3. 加工品 4. 引当品
 5. 材料品 (25) (26)

作成日
 79.06.06

② 品 名		部品符号 ③	① 引当指示項目 (コメント)	数 量 ⑤	重 量 ⑥	仕 装	引当図番	引当図番	取込品コード ②①	備 考 ②②
材質・型式・規格・寸法							ステージ移行	引当図番		
		AS200-5	FF50 3.2M 40A 12	10	183.80g		27			+
		AS260-0	FF30 2.0M 40A 15	10	109.16g		27			+
		AS202-3	FF70 3.2M 200B	10	174.78g		44			+
		AS200-9	FF20 2.2M 200B	10	117.08g		44			+
		AS210-2	FF70 3.3M 200B	10	154.38g		44			+
		FO220-1	FF30 3.3M 250B	10	218.08g		44			+
		SH404-4	FF20 1.2M 300A	10	50.59g		61			+
		SH404-5	FF20 0.6M 300A	10	53.59g		61			+
		SH404-0	FF20 0.4M 300A	10	43.59g		61			+
		SH429-2	FF20 1.0M 125A	10	22.59g		61			+
		SH429-3	FF20 0.0M 125A	10	16.59g		61			+
		SH429-4	FF20 0.7M 125A	10	17.59g		61			+
		SH429-5	FF20 0.4M 125A	10	13.69g		61			+
		SH429-0	FF20 0.5M 125A	10	15.59g		61			+
		SH451-7	FF21 2.6M 400A	10	26.59g		61			+

PAGE 62

⑪	M.L.F. - No ①	作業開始日 ⑫	次のステージ ⑬	⑭	⑮	⑯	⑰	⑱	⑲
							1257	1257	1257

MLF

※第一品目は、品名・仕様・数量（注記あり）を記入（注記あり）

1. 品名 2. 仕様（注記あり） 3. 数量（注記あり）

4. 単位 5. 備考

※本行品

1. 取付品（次のステージで本付されたもの）

2. 取付品（別のステージで取付されたもの）

1. 式鋼線本尺 2. g 3. kg 4. m 5. m² 6. m³ 7. mm² 8. t

取付サイン 1. 次のステージのMLF No

取付サイン 2. 前ステージの MLF No

SOT-A200201 参照

※部品重量

1. 管理重量

※1. 引当品 2. 外品 3. 外品

※3. 加工品 4. 引当品

※5. 一般部品

79,06,00

品名	部品符号	引当指示項目（コメント）	数量	重量	引当箇所	取付サイン	取付サイン	備考
材質・型式・規格・寸法					ステージ移行			
	SH452-1	FF11 7M 300A	10	107.5	61			+
	SH420-1	FF21 9M 250A	10	66.3	61			+
	SH420-2	FF20 9M 250A	10	63.0	61			+
	SH400-1	FF10 7M 250A	10	48.0	61			+
BC GLOBE VALVE DL FGT 16025	SH-411V	?	10	57.0			5403221005	+
BC SCREW/BITE GLOBE V. BC M-SCR, FGT 20010SUL	SH-412V		10	10.0			4403245C02	+
SC/BC SHELL V. LINING SC/BC SHELL V. LINING	SV-439V	10K-250	10	259.0	N4041000A		440419C000	+
BUTTERFLY VALVE (MANUAL) BUTTERFLY VALVE (MANUAL)	SH-456V	FL25 SC513 5K + 250	10	30.0	N4044000		440445CCGL	+
BUTTERFLY VALVE (MANUAL) BUTTERFLY VALVE (MANUAL)	SH-458V	FL25 SC513 5K + 300	10	40.0	N4044000		440445CCCC	+
BUTTERFLY VALVE (MANUAL) BUTTERFLY VALVE (MANUAL)	SH-460V	FL25 SC513 5K + 300	10	40.0	N4044000		440445CC00	+
BLIND FLANGE (H/HANDLE) SS41 GALV-FD 5K 300SS1			10	270.0			440651C1071A	+
WATER FILTER WATER FILTER	SH-402S	5K-250C BALLAST PP	10	246.0	N4062400		440625C5CC	+
GASKET ASBESTOS PA 5K 12500			50	0.0			540640111310	+
GASKET ASBESTOS PA 5K 20000			50	0.0			540640111510	+
GASKET ASBESTOS PA 5K 25000			70	1.0			540640111610	+

品名	MLF - No	作業開始日	次のステージ	重量	パレット重量	管理重量	搭載重量	凡
2726	14Y024---	174.01.20	14m05.11.20	7	42.0	221.3	221.3	

MLF

Fig. 2-7 (3/6)

品名		部品符号		引当指示項目 (コメント)		数量		重量		引当図番		製品コード		備考	
材質・型式・規格・寸法										ステージ移行					
GASKET															
ASBESTOS PA 5K 3000U						60		12				54064011671		+	
GASKET															
ASBESTOS PA 5K 3500U						12		04				54064011681		+	
GASKET															
ASBESTOS PA 5K 4000U						12		05				54064011691		+	
GASKET															
ASBESTOS PA 10K 400J						24		00				54064121071		+	
GASKET, RUBBER SHEET															
GASKET, RUBBER SHEET		Ln/QUIP		5K-500 FOR LINING		12		1000		N4064900A		1408493000		+	
HEXAGON HEAD BOLT/NUT															
SS GALV. BN 10S 5050						52		5200				54052175131		+	
HEXAGON HEAD BOLT/NUT															
SS GALV. BN 20S 6050						24		7200				54052176151		+	
HEXAGON HEAD BOLT/NUT															
SS GALV. BN 20S 6550						60		18000				54052176161		+	
HEXAGON HEAD BOLT/NUT															
SS GALV. BN 20S 7050						54		16200				54052176171		+	
HEXAGON HEAD BOLT/NUT															
SS GALV. BN 22S 7050						60		24000				54052177171		+	
HEXAGON HEAD BOLT/NUT															
SS GALV. BN 22S 7550						22		86000				54052177181		+	
BALLAST PUMP															
BALLAST PUMP		MA-059AA		VLC 500MS/H * 25M		10		5900		N4451060A		1445106000		+	
MOTOR (BALLAST PUMP)															
MOTOR (BALLAST PUMP)		P/BTP-M		25KW 1800RPM IE V B		10		5400		N4451070		1445107000		+	
PIPE BAND SUPPORT															
PIPE BAND SUPPORT										F4634002		2463400000		+	
VERTICAL LADDER															
VERTICAL LADDER		VLC-102V		VFS-5 L/100		10		37633		F4030214		2403021400		+	

PAGE 64

Fig. 2-7 (4/6)

PAGE 63

ABC...又は
1.2.3...

3. 全封密 4. 排型密 (按图打不型) 5. 排型密 (按图打型)

① 仮返品(次のステージで本付されるもの)
② 仮返品(前のステージで仮返されたもの)

1. 3x4 4x4 5x5 6x6 7x7 8x8 9x9 10x10 11x11 12x12 13x13 14x14 15x15 16x16 17x17 18x18 19x19 20x20 21x21 22x22 23x23 24x24 25x25 26x26 27x27 28x28 29x29 30x30 31x31 32x32 33x33 34x34 35x35 36x36 37x37 38x38 39x39 40x40 41x41 42x42 43x43 44x44 45x45 46x46 47x47 48x48 49x49 50x50 51x51 52x52 53x53 54x54 55x55 56x56 57x57 58x58 59x59 60x60 61x61 62x62 63x63 64x64 65x65 66x66 67x67 68x68 69x69 70x70 71x71 72x72 73x73 74x74 75x75 76x76 77x77 78x78 79x79 80x80 81x81 82x82 83x83 84x84 85x85 86x86 87x87 88x88 89x89 90x90 91x91 92x92 93x93 94x94 95x95 96x96 97x97 98x98 99x99 100x100 101x101 102x102 103x103 104x104 105x105 106x106 107x107 108x108 109x109 110x110 111x111 112x112 113x113 114x114 115x115 116x116 117x117 118x118 119x119 120x120 121x121 122x122 123x123 124x124 125x125 126x126 127x127 128x128 129x129 130x130 131x131 132x132 133x133 134x134 135x135 136x136 137x137 138x138 139x139 140x140 141x141 142x142 143x143 144x144 145x145 146x146 147x147 148x148 149x149 150x150 151x151 152x152 153x153 154x154 155x155 156x156 157x157 158x158 159x159 160x160 161x161 162x162 163x163 164x164 165x165 166x166 167x167 168x168 169x169 170x170 171x171 172x172 173x173 174x174 175x175 176x176 177x177 178x178 179x179 180x180 181x181 182x182 183x183 184x184 185x185 186x186 187x187 188x188 189x189 190x190 191x191 192x192 193x193 194x194 195x195 196x196 197x197 198x198 199x199 200x200 201x201 202x202 203x203 204x204 205x205 206x206 207x207 208x208 209x209 210x210 211x211 212x212 213x213 214x214 215x215 216x216 217x217 218x218 219x219 220x220 221x221 222x222 223x223 224x224 225x225 226x226 227x227 228x228 229x229 230x230 231x231 232x232 233x233 234x234 235x235 236x236 237x237 238x238 239x239 240x240 241x241 242x242 243x243 244x244 245x245 246x246 247x247 248x248 249x249 250x250 251x251 252x252 253x253 254x254 255x255 256x256 257x257 258x258 259x259 260x260 261x261 262x262 263x263 264x264 265x265 266x266 267x267 268x268 269x269 270x270 271x271 272x272 273x273 274x274 275x275 276x276 277x277 278x278 279x279 280x280 281x281 282x282 283x283 284x284 285x285 286x286 287x287 288x288 289x289 290x290 291x291 292x292 293x293 294x294 295x295 296x296 297x297 298x298 299x299 300x300 301x301 302x302 303x303 304x304 305x305 306x306 307x307 308x308 309x309 310x310 311x311 312x312 313x313 314x314 315x315 316x316 317x317 318x318 319x319 320x320 321x321 322x322 323x323 324x324 325x325 326x326 327x327 328x328 329x329 330x330 331x331 332x332 333x333 334x334 335x335 336x336 337x337 338x338 339x339 340x340 341x341 342x342 343x343 344x344 345x345 346x346 347x347 348x348 349x349 350x350 351x351 352x352 353x353 354x354 355x355 356x356 357x357 358x358 359x359 360x360 361x361 362x362 363x363 364x364 365x365 366x366 367x367 368x368 369x369 370x370 371x371 372x372 373x373 374x374 375x375 376x376 377x377 378x378 379x379 380x380 381x381 382x382 383x383 384x384 385x385 386x386 387x387 388x388 389x389 390x390 391x391 392x392 393x393 394x394 395x395 396x396 397x397 398x398 399x399 400x400 401x401 402x402 403x403 404x404 405x405 406x406 407x407 408x408 409x409 410x410 411x411 412x412 413x413 414x414 415x415 416x416 417x417 418x418 419x419 420x420 421x421 422x422 423x423 424x424 425x425 426x426 427x427 428x428 429x429 430x430 431x431 432x432 433x433 434x434 435x435 436x436 437x437 438x438 439x439 440x440 441x441 442x442 443x443 444x444 445x445 446x446 447x447 448x448 449x449 450x450 451x451 452x452 453x453 454x454 455x455 456x456 457x457 458x458 459x459 460x460 461x461 462x462 463x463 464x464 465x465 466x466 467x467 468x468 469x469 470x470 471x471 472x472 473x473 474x474 475x475 476x476 477x477 478x478 479x479 480x480 481x481 482x482 483x483 484x484 485x485 486x486 487x487 488x488 489x489 490x490 491x491 492x492 493x493 494x494 495x495 496x496 497x497 498x498 499x499 500x500 501x501 502x502 503x503 504x504 505x505 506x506 507x507 508x508 509x509 510x510 511x511 512x512 513x513 514x514 515x515 516x516 517x517 518x518 519x519 520x520 521x521 522x522 523x523 524x524 525x525 526x526 527x527 528x528 529x529 530x530 531x531 532x532 533x533 534x534 535x535 536x536 537x537 538x538 539x539 540

仮正サイン 2. 前ステージの MLE H₀

8DT-A28020: 1411

市部品產經

→ 1. 引出输入品 2. 外售输入品
3. 加工外售品 4. 引出输出品
5. 一般输出品

79.07.1

[illegible]

Page 66 of 70

 M/E

電機長	パレット通員	管理通員	搭載通員	凡

3. Material Control

3.1 Scheduling for Material Procurement

The most important point for palletization is to prepare a pallet without missing material in a timely manner. To satisfy the above requirement, materials have to be purchased, stocked, expedited, received and issued by a material procurement schedule which is prepared on the basis of the required date of each pallet. An example of material procurement scheduling is indicated in Fig. 2-8. Explanation of words used in Fig. 2-8 is as follows:

Material Delivery Date is the date that the pallet is requested to be delivered to yard; this date is decided by an outgoing control engineer daily or weekly, reflecting current situation of jobs.

Required Date for Pallet is the scheduled date by which a pallet should be ready to be delivered from the warehouse with a few days advance of the Material Delivery Date. This advance is necessary for preparation of issuing the pallet.

Material Issue Request is request for delivery of pallet, to pallet number. Issue of Materials is ordered by Material Issue Order. (Figs. 2-9, 2-10)

List of Missing Material (Fig. 2-11) lists missing material in a pallet which is going to be delivered by Material Issue Request. The outfitting control engineer, foreman and his workers can know that they will have missing material in their next job by this list.

List of Delayed Material (Fig. 2-12) lists materials which are delayed from contracted date. The material expeditor has to expedite these listed materials in order to obtain them by the material distribution date. When he is unable to obtain the delayed material in time, he has to list that material in the List of Missing Materials.

Vendor Delivery Date is the delivery date of an item of material on a contract between vendor and shipyard.

Starting Date of Palletizing is the same date as the vendor Delivery Date, taking into account of few days' duration for palletizing.

When the Material Delivery Date arrives, the outfitting control engineer prepares a Material Issue Request for particular pallets for which he wishes to start corresponding jobs. By request, the warehouseman delivers the requested pallets; the status of outfitting jobs changes daily, although palletization occurs on the basis of the outfitting schedule.

In IHI, time spans A, B, C, and D in Fig. 2-8, are 60, 7, 15 and 10 days, respectively, but they vary on a case-by-case basis.

Many kinds of materials which have different lead times, from more than one year to less than one week. Materials which have long lead times must be purchased early in the design phase; materials such as machinery, motors, starters, anchors, bollards, special valves, large valves, castings, furniture, etc., must be purchased by material list by system (MLS), which is prepared when a functional drawing is completed.

Fortunately, these major materials, with their quantities can be listed in the early stage and the date for purchasing these materials can be easily determined on the basis of the required date of the pallet. Because the locations of these materials are clear on the functional drawing, then we can easily determine the need date from the master schedule.

Information for Expediting lists the materials that are scheduled for delivery within a few months. The expeditor can pay attention to particular materials in order to begin expediting, if necessary, by this list.

Date for Placing Purchase Order is a date on which the purchaser must place an order for material for a manufacturer. This date can be determined by taking account lead time and Vendor Delivery Date.

Thus, we can determine the date for placing an order for each item of material and put it together to form the material purchasing schedule. But actually, we have to place an order taking into consideration not only the above schedule but also the market condition, purchase lot, etc.

3.2 Expediting and Palletizing

After placing an order, we have to prepare Information for Expediting in order to obtain material of a pallet in time. When the Vendor Delivery Date passes, we have probably received almost all of the material for one pallet, because the purchasing schedule is determined on the basis of Required Date of Pallet. Even so, we may experience a delay in material receipt. If material is delayed; it must be listed in the List of Delayed Material within a few days after Vendor Delivery Date in order to expedite that material. Then, we have to start palletizing materials.

If we find that *getting* material in time is impossible, the materials must be listed in the List of Missing Material.

The outfitting control engineer or foreman must decide whether he should start a job now or wait in order to minimize loss which might be caused by missing materials until the missing material is supplied with Supply List of Missing Material (Fig... 2-13).

Materials which have short lead time are troublesome. We can not definitely list these minor material especially with their quantities, in an early stage when only functional drawings are available. Besides, we have to hold listing them with their definite quantities, because we cannot determine quantities and locations of these minor materials such as drain valves, small pipe, flanges, elbows, reducers, plugs, pipe supports, electric cable trays, wire nets, rings, eyes, etc., by functional drawings only. We have to hold purchasing until after working drawings are completed. Fortunately, they have short lead times. Therefore, if we can schedule the working drawing and/or material list of pallet to meet the material purchasing schedule, we can complete these drawings in a comparatively late period without impacting the pallet schedule. Fig. 2-4 shows this aspect.

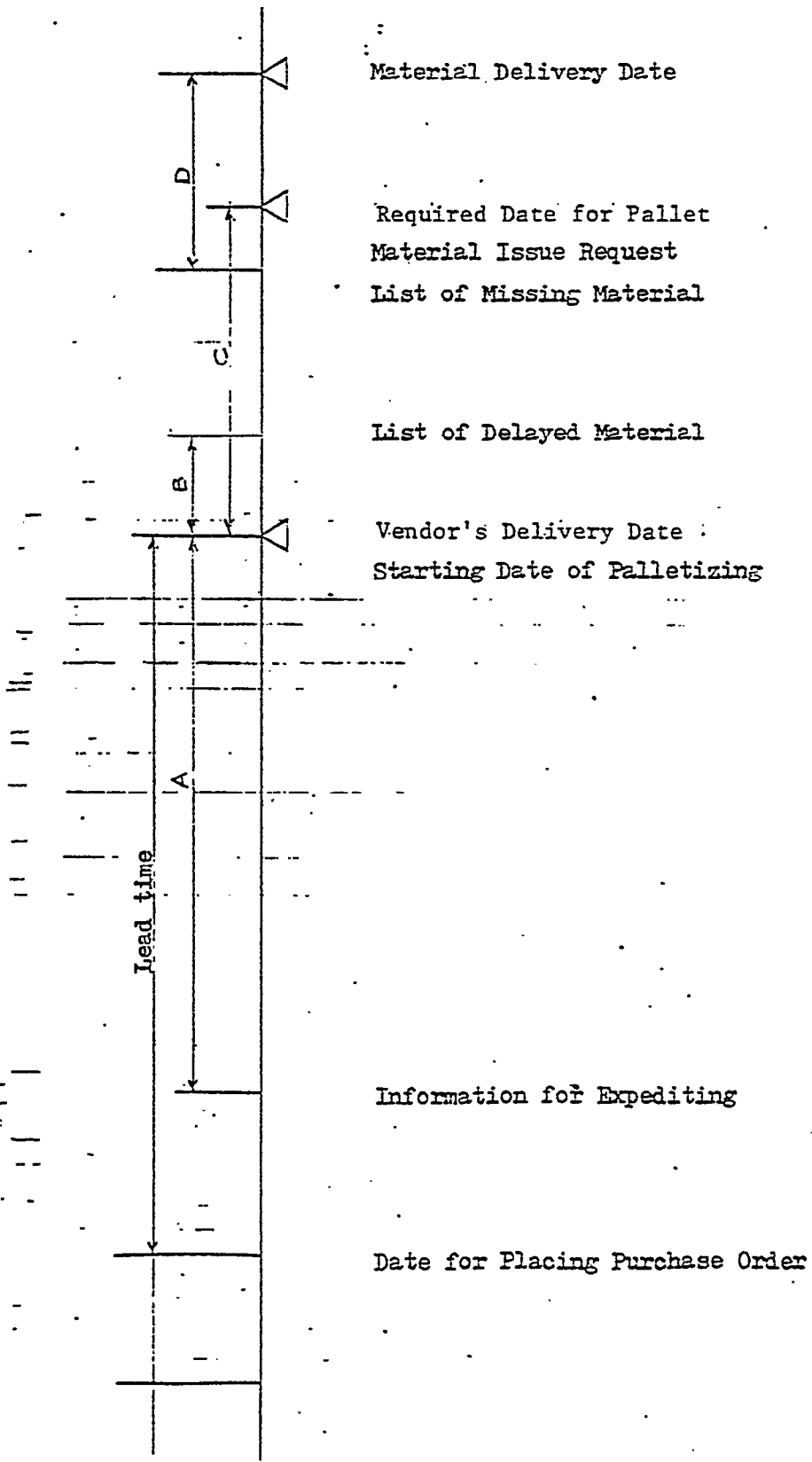


Fig. 2-8

M L 出庫指示表()

(79 4 06 11 5 11) ☐ ☐ 1979 4 5

PAGE 192

[illegible]

PAGE 75

790629

[illegible]

次品票

Destination

材区 航 装 品 コ ー ド												規 改																		
1	1	4	8	0	5	2	1	0	U	A																				
工 事 番 号								分 番				M L - N O.		分 割	読 取															
	2	1	1	2	6	8	8	4	8	0	5	1	4	0	3	0	3	1	P	-	0									
部 品 符 号								配 給 日				入 庫 予 定 日				倉 庫														
N	L	-	U	U	U	P						1	5	0	0	2	9						5	3						
注 文 番 号								同 配 給 先		管 材 数 量		車 数 量																		
2	5	1	4	3	J	U	U	3	4													1								2

倉庫課
担当

٢٠٤

PNV= 202

出版先一各埠理

欠品票

材 区 船 装 品 コ ー ド										規 改		品名 EYE PLATE																	
1	1	4	0	0	2	1	0	0	A			寸法 EYE PLATE																	
工 事 番 号										M L - N O.										分 冊	簡 要								
2	1	1	2	0	6	3	4	0	5	1	4	0	3	D	3	1	S	-	0										
部 品 符 号										配 給 目										入 庫 子 定 目		貯 担							
N	L	-	U	8	U	P				7	9	0	6	2	9						5	3							
課 注 文 番 号										同 在 給 先 策 材 数 計										庫 庫 庫									
																				出 当									
2	5	1	4	3	8	0	0	3	4											2									

٥٠٤

PHO= 203

Fig. 2-11 List of Missing Material

100000 (02) ** KA **

未入庫調査表

(75年6月18日) P.0002



発注先	注文番号	品名	数量	単位	納入予定日	納入場所	納入数量	納入単位	納入予定日	納入場所	納入数量	納入単位
3500	25051750	0000501101F 500005500	1	1	750	000000	1	1	750	000000	1	1
3500	25052310	00005111C2 500005510	1	1	750	000000	1	1	750	000000	1	1
3767	25751150	27320000A P.ROOM LADDER UNIT	1	1	750	000000	1	1	750	000000	1	1
3767	25751160	27320000A P.ROOM LADDER UNIT	1	1	750	000000	1	1	750	000000	1	1
4156	25747330	20700100A GASKET FOR H.D.H.COVER	1	1	750	000000	1	1	750	000000	1	1
6357	25143800	48052100A EYE PLATE	1	1	750	000000	1	1	750	000000	1	1

Fig. 2-12 List of Delayed Material

Description
Material Control
Material Control Classification
P.O. No.

Q'ty
Warehouse Q'ty
Unit
Warehouse to be Delivered
User's Request Date
Final Delivery Date
Requisitioned Date



部 品 票

材 区										積 費 品 コ ー ド										規 改		品 名 AIR PIPE HEAD																					
1 2 2 0 4 3 1 0 9 0 7																						A.P-HEAD 5K-125 (H=450)																					
工 事 流 号										分 番										M L - N O.										分 冊		概要											
4 1 1 2 7 4 7 2 0 9 2 1 2 4 0 4 P P H - U																																											
部 品 符 号										配 給 日										入 庫 予 定 日										倉 庫		担当											
										7 9 0 6 2 5																				4													
課										注 文 番 号										同 配 給 先										管 材 数 量										單		数 量	
2 5 2 5 7 3 6 0 3 4																														1										1			

(3666)F2003011

V03

PNO= 578

0 Format is same as Fig. 2-11

Fig. 2-13 Supply List of Missing Material

4. Outfitting Production

4.1 Functions of Organization

For the operation of palletized outfitting, the zone-oriented organization is superior to the craftsmanship oriented organization. An example of the zone-oriented organization is shown in Fig. 2-14.

As indicated in Fig. 2-15, the functions of each sub-divided organization are as follows:

- Engine room section performs all jobs in engine room except electrical jobs.
- Accommodation section performs all jobs in accommodation space except electrical jobs.
- Deck and hold section performs all jobs in spaces other than engine room and accommodation space except electrical jobs.
- Electrical section performs all electrical jobs in entire ship/area.
- Each section has sub-sections, such as unit assembly, on-block outfitting and onboard outfitting.

(Alternative 1) Unit assembly and on-block outfitting be merged into one in each section if estimated total workload of these sub-sections is not great.

(Alternative 2) If estimated total workload of unit assembly and on-block outfitting-in each section is not sufficient to continue these jobs with a reasonable quantity every day, part of the sub-section may be omitted.

(Alternative 3) If estimated total workload of unit assembly and on-block outfitting of all sections is sufficient to continue these jobs with a reasonable quantity every day, a common and merged unit assembly and on-block outfitting section may be advisable.

- Material preparation section performs material gathering marshalling, palletizing and delivery. Details are described in CHAPTER II, 4.3, "Material Marshalling and Palletizing."
- Material preparation section consists of palletizing group and transportation group.
Palletizing group performs material gathering from warehouse or manufacturing shops, marshalling and palletizing materials.
Transportation group performs delivery of pallets to destinations requested by production control engineer.
- Manufacturing shop, manufacturing pipes, ducts, doors, hatches, machinery, equipment, etc., has to be operated independently. from the others, because manufacturing shop operation and procedure are quite different.

We merely make a synchronized interface between the end of manufacturing and the start of outfitting, that is, completion of materials and palletizing.

Job territory of each section in a ship must be determined as clearly and simply as possible. For example, the boundary between the territories of engine section and deck section has to be set at one plane on or in parallel with the engine room front BHD as much as possible. In other words, organization should be zone-oriented.

By this organizations jobs in some zones can be completed by a minimum number of workers who belong to only one section, while the same must be accomplished by a larger number of workers who belong to more than two sections of a craftsmanship oriented organization. If a zone is not large and jobs in a pallet are not complicated, the job's might be completed by only one able worker.

Today, it seems that well educated workers are requesting more educational opportunity and knowledge about their jobs. We called them "multi-job workers" who can do various kinds of jobs such as installation of piping, steel work, equipment, welding, gas cutting etc.

If we can successfully train a multi-job worker, we will be able to locate workers at certain zones and gain control with

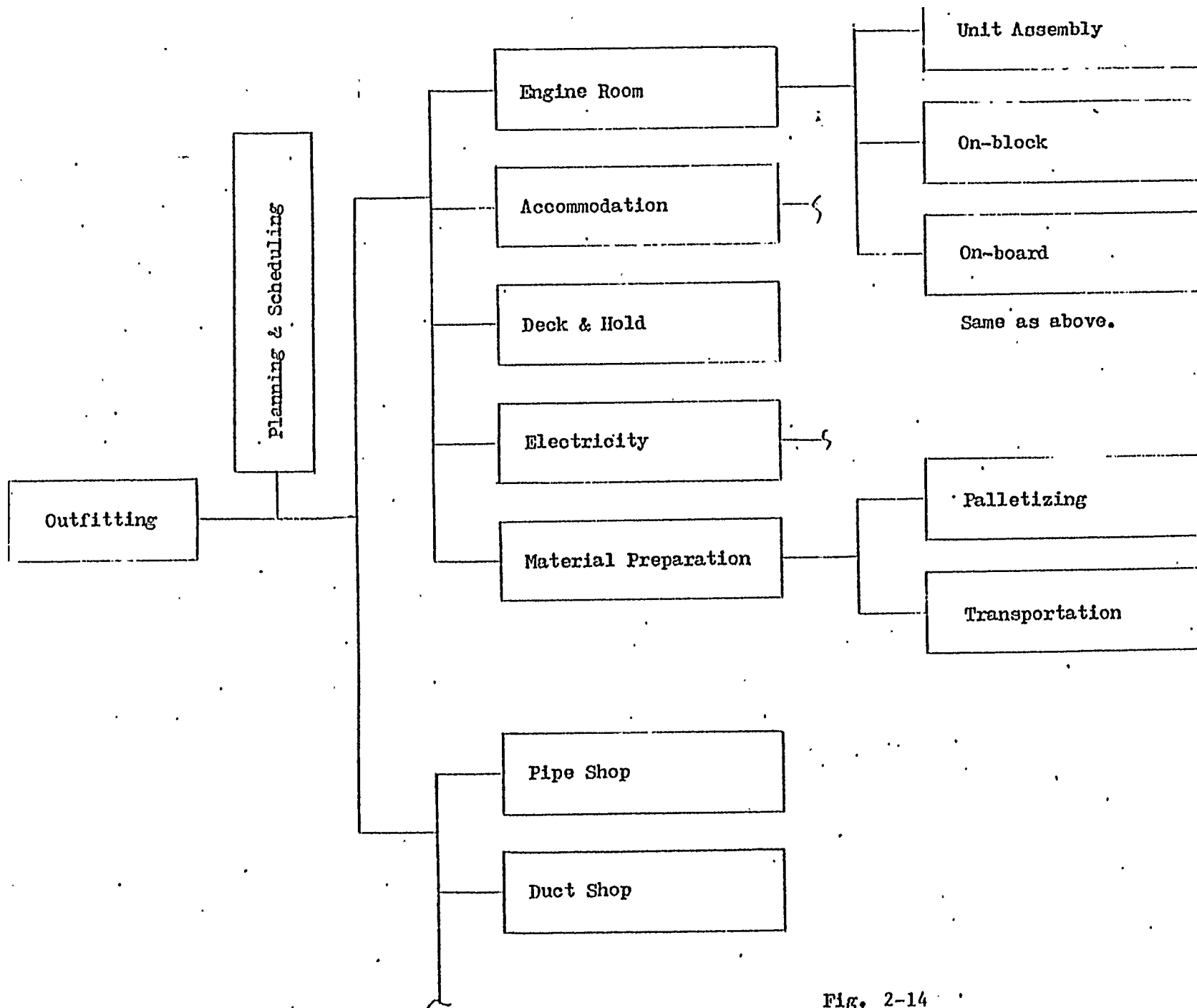
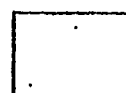
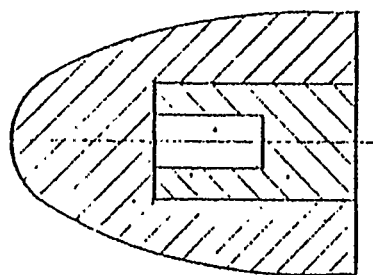
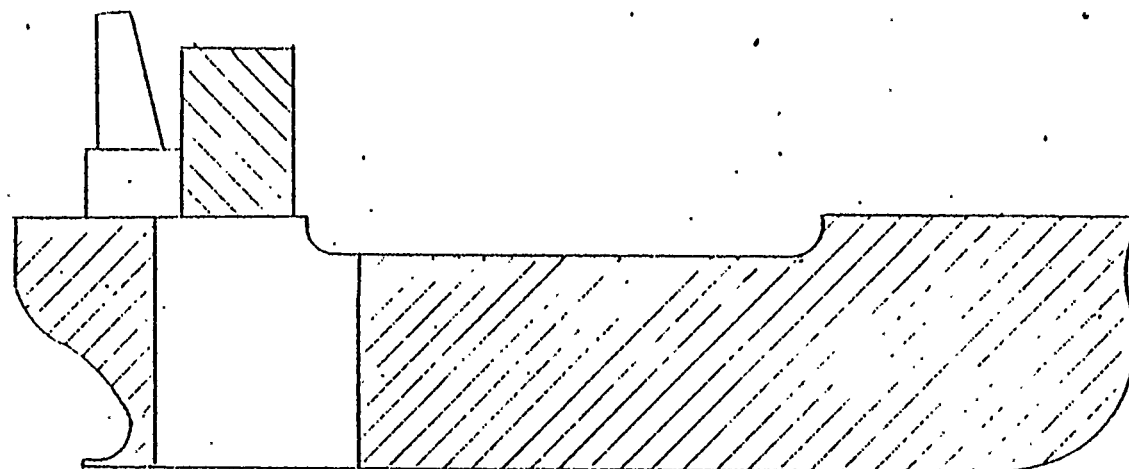
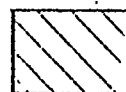


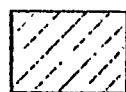
Fig. 2-14



Engine Room



Accommodation Space



Deck and Hold

Fig. 2-15

high productivity. We call this idea "Fixed Place, Fixed Person" or "Multi-job System, " which is one of the ideal organizations in the future.

4.2 Major Activity of Palletizing Planning (See 'Fig. 2-1)

1) Planning of Outfitting Method and Palletization

PPS engineers plan "how. to outfit" and make a primary guide for palletization, utilizing the following drawings and information.

- General Arrangement
- Machinery Arrangement
- Functional Drawings
- Hull Construction Drawings
- Practice and Experience of Palletizing
- Ship Construction Method"
- Hull Block Segregation
- Master Schedule etc.

First they match the segregation of outfitting zones and pallet zones with the hull block. assemblies taking into account the following:

- Scope of units - size and number of unit, machine and adjacent piping to be assembled, etc.
- Sequence of jobs (materials) for each on-unit, on-block, onboard outfitting

- "Miscellaneous details

Following is an example of an engine room lower flat:

- How does the engine room segregate into zones?
- Is the large unit outfitting method applied?
- How is the main engine installed?
- How are the auxiliary machines assembled into the units together with adjacent piping and other materials?
- In what sequence are they installed?
- By what stage are they installed?
- How are the other materials palletized?

After the above study, they prepare "Orientation of Palletizing," "Pallet List" and "Pallet Schedule."

"Orientation of Palletizing" indicates "how to outfit." Namely, it contains detailed zoning of the ship (Fig. 2-16), pallet definition for each stage (Figs. 2-17, 2-18) and guidance for materials to be preferably outfitted at each stage with some sketches, if necessary, etc.

"Pallet List" lists all pallets which are to be used in the ship. See Fig. 2-19. "Pallet Schedule" shows the required date for each pallet, which is used for drawing issue schedule and material procurement. See Fig. 2-20. These information are sent to the design engineers who develop the preliminary composite drawings. Since this planning is performed at a very early stage, "Pallet List" and "Pallet Schedule" may be updated in subsequent stages.

Fig. 2-16 Zoning of Machinery Part
(For the detail, refer to Chapter V)

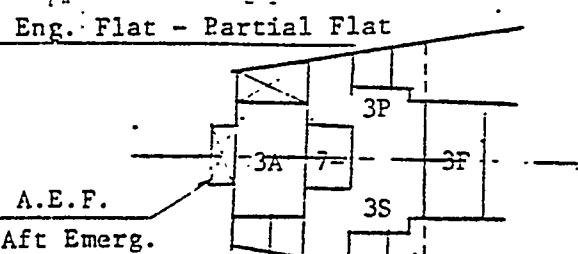
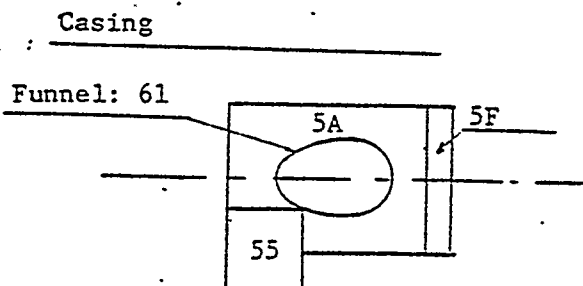
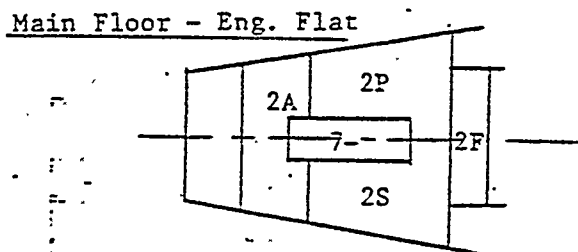
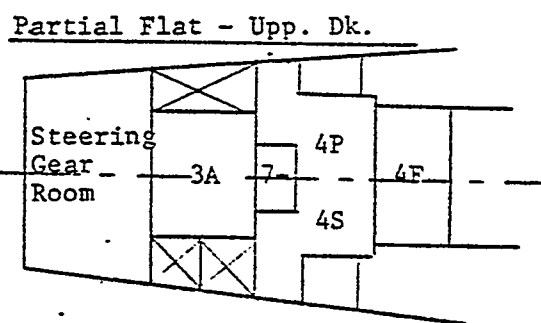
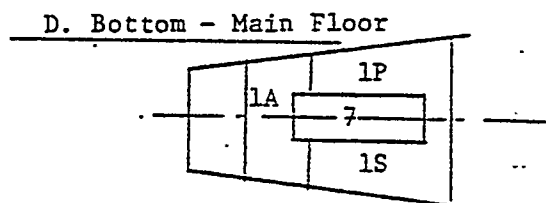
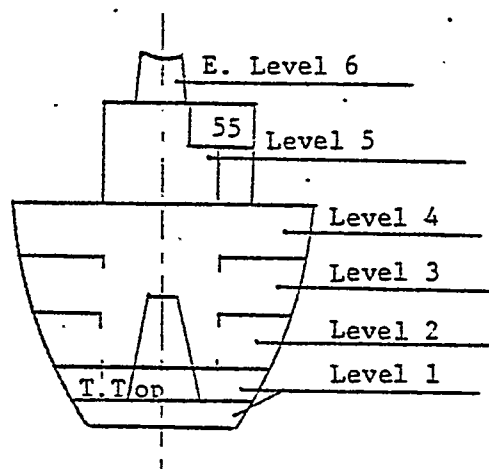
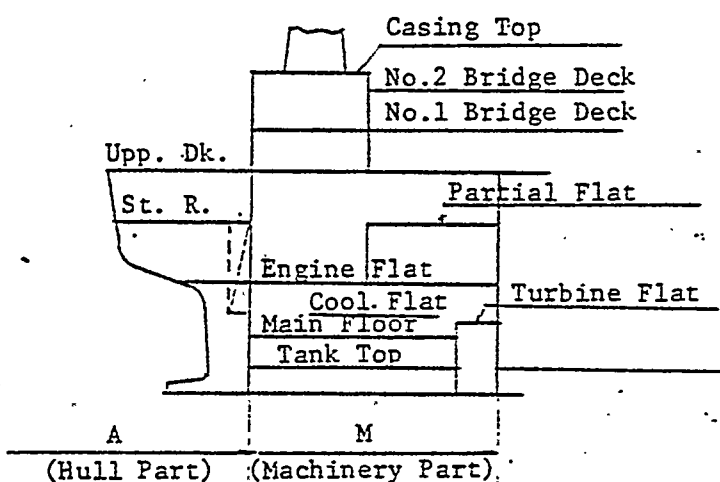
A B C ... Zone Level (See Chapter V)



F: Fore, A: Aft, P: Portside, S: Starboard side, C: Center

Elevation Level No, or Initial Letter of Compartment

M: Machinery Space, A: Aft Part (Hull Part)



Central Control Room: CR
Work Shop : WS
Inert Gas Fan Room. : 55

TANK TOP PLAN (1995 ABOVE P.L.)

Q. T. ELDER 14 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1

H.N.T. FLOOR - H.N.T. GLR 13 (1111. SPEC. 407E13)

E. T. G. R. i. 16

STIFF OF N.W. FLOOR: 1.20 + 17.5 FR (11.5)

STILL OF O. T. FLOCK : 250.90, $\frac{1}{2}$ (1.15-2) (44.37, 570)

(T.TÖPF) T4AD33---0

(T. TOPF) T48P33---0

TANK TOP PLAN
3295 ABOVE D.L.

(A) SEC.

(T.TOP F) T4AD32---0

(T.TOP) T4RD32---0

五、

PAC



Fig. 2-19 (1/4)
PALLET LIST

PART: MACHINERY

STAGE: ON-BLOCK (PIE

MLF. No.										DESCRIPTION	NEXT STAGE (MLF. No.)					
1	2	3	4	5	6	7	8	9	10		1	2	3	4	5	6
T	4	A	D	3	2	-	-	-	0		T	4	Z	M	1	S
T	4	A	D	3	2	-	-	-	0		T	4	Z	M	1	A
T	4	B	D	3	2	-	-	-	0		T	4	Z	M	1	S
T	4	B	D	3	3	-	-	-	0		T	4	Z	M	1	A
T	4	A	3	C	3	1	-	-	0		T	4	Z	M	2	S
T	4	A	3	C	3	2	-	-	0		T	4	Z	M	2	S
T	4	A	3	D	3	2	S	-	0		T	4	Z	M	2	S
T	4	A	3	D	3	3	S	-	0		T	4	Z	M	2	A
T	4	A	3	D	3	2	P	-	0		T	4	Z	M	2	S
T	4	A	3	D	3	3	P	-	0		T	4	Z	M	2	A
T	4	B	M	S	1	-	-	-	0		T	4	Z	M	1	S
T	4	B	D	G	1	-	-	-	0		T	4	Z	M	1	A
T	4	G	3	D	3	2	S	-	0		T	4	Z	M	2	S
T	4	G	3	D	3	3	S	-	0		T	4	Z	M	2	A
T	4	G	3	D	3	2	P	-	0		T	4	Z	M	2	S
T	4	G	3	D	3	3	P	-	0		T	4	Z	M	2	A
T	4	A	S	L	3	2	S	-	0		T	4	Z	M	2	S
T	4	A	S	L	3	3	S	-	0		T	4	Z	M	2	A
T	4	A	S	L	3	2	P	-	0		T	4	Z	M	2	S
T	4	A	S	L	3	3	P	-	0		T	4	Z	M	2	A

REMARKS: (CONTINUED)

STAGE: ON-BLOCK (PIPING UNIT)

[illegible]

REMARKS:

STAGE: ON-BOARD (MACH. UNIT)

[illegible]

Fig. 2-20. (2/2) Itemized Description of Pallet Schedule

1. MLF No:
2. Following Stage (MLF No., Used for a unit)
3. Temporary Location Zone
4. CIII, Sign for alteration; 1:, Partial Revision, 3: Deletion .
5. Responsible Outfitting Shop
6. Zone for Material Procurement
7. Installation Date
8. Working Drawing No.
9. 9-1: Number of pipes or electric cables
9-2: Weight of pipes or electric cables
10. Installation Weight, 10-1: Control weight which is in proportion to outfitting manhour
10-2: Other weight than control weight
11. Starting Date of Installation .
12. Revision No. of Pallet Schedule
13. Revision No. of Design
14. Schedule, A: Drawing Issue Date, B: Material Issue Date, C: Installation Date,
D: Input Date of MLF Data (to Computer)
15. Ship No.
16. Responsible Design Section
17. Authorization
18. Distribution

2) Review of palletizing

After receiving the pre-composite (= preliminary) drawings from design engineers, PPS engineers review them to determine whether the pre-composite drawings are developed as previously indicated by "Orientation of Palletizing."

Furthermore, they check the drawings with regard to several points with which PPS engineers must be more familiar than are design engineers. Checking safety of installation is especially important to PPS engineers.

- Is the design (arrangement) workable at operation and maintenance? e.g., arrangement of handle, space for operation, height of handle, etc.
- Are lifting eyes located at a position so that lifting wires on them will not cause damage to outfitting materials when they are lifted and turned over?
- Do hull blocks have space for rests for storing after all materials are installed?
- Are all jobs accomplished safely?
- Can scaffolding be prepared firmly and safely?

After review of pre-composite drawings, PPS engineers send them back to the design engineers for development of composite drawings.

3) Review of Composite Drawing

After receiving the composite drawings from design engineers, PPS engineers review them to determine whether the composite drawings have been developed as requested. They then check all machinery units, piping units, other units, pipe spools, grating, and all other materials, piece-by-piece.. They carefully check pieces which are located on or near segregation between pallets, because these pipes will sometimes affect onboard outfitting productivity. For example:

On Fig. 2-21, when planning of the pump unit, we usually want to put the valve manifold together with the pump, because it is a part of the pump unit. If we do so, boundary between the pump unit and the pipe and grating unit (pallet) becomes B. Then 6 pieces of pipe spools ①, ②, ③, ④, ⑤ and ⑥ go to an onboard unit, which requires connection of pipes and the manifold onboard. But if we put it into the pipe and grating unit (pallet), the-boundary becomes A. Then pieces ① to ⑥ go to an onboard unit, i.e., connection of pipes and the manifold can be done in the unit assembly shop. Besides, installation of piece ⑦ is much easier than under grating pipe pieces ①, ②, ③, ④, ⑤ and ⑥ if carried out onboard. On Fig. 2-22, the hull block B is loaded after A, as their joints indicate.

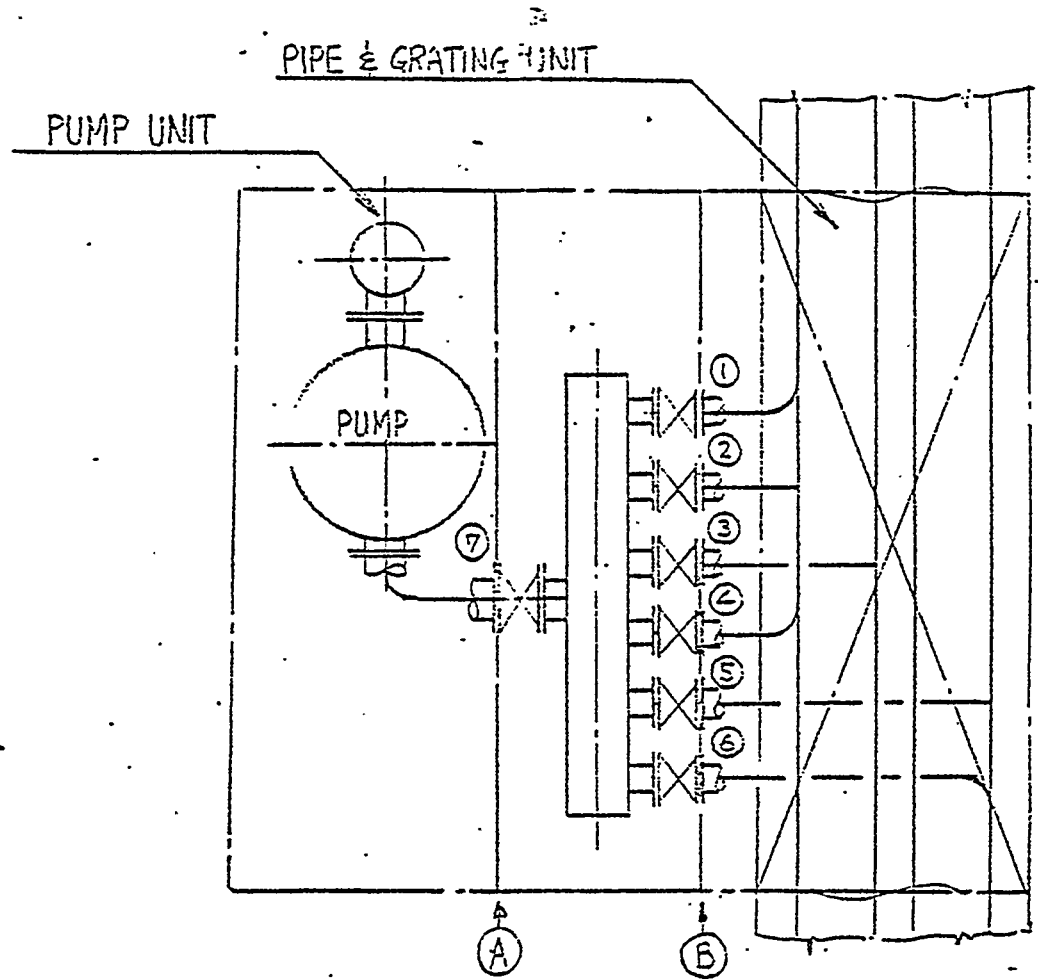


Fig. 2-21

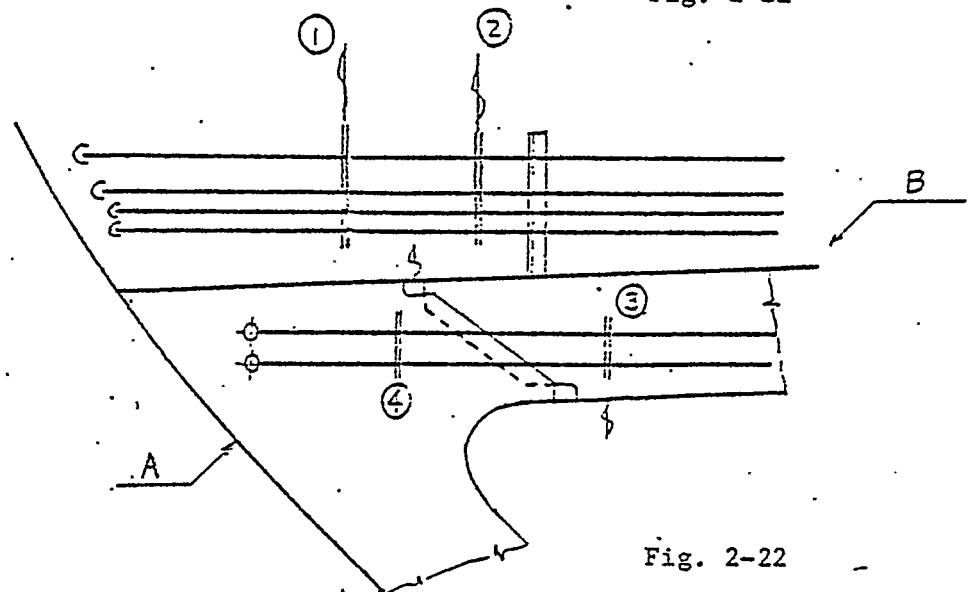
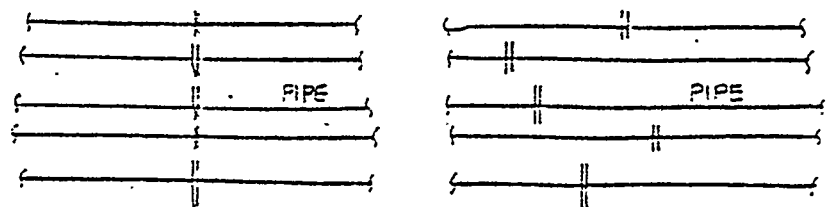


Fig. 2-22



Then, joints of pipes have to be 1; if they are 2, the hull block plate edge has to insert between the, pipes of block A and pipes when loading. In connection with the hull block joint, the pipe joints must be given at 3 and 4, and the pipe between 3 and 4 is installed on-board as a make-up pipe. Otherwise the piping that is already installed at the on-block stage disturbs welding for the web joint. On Fig. 2-23, lined joints are better than zig-zag joints for ease of unit installation.

4.3 Material Marshalling and Palletizing

1). Role of Material Preparation Group

The role of the Material Preparation Group is to assure the-best supply of materials to the production department from the material department in a timely manner. It is one of the most important jobs in the process of palletization because, as we have discussed, the best material preparation will result in the best productivity.

Therefore, the role is not limited to the palletizing and transportation of materials but also includes expediting and communicating about material and material preparation with the design engineers as well as PPS engineers.

Materials which might be delayed are always picked up and

expedited together by an expediter in the Material Procurement Dept. When it is found that the delay is unavoidable the PPS engineer is informed so that he can reschedule the outfitting work to meet the delay. Flow of material preparation is shown in Fig. 2-24.

2) Organization (Example of IHI Kure Shipyard)

As shown in Fig. 2-25, the Material Preparation Group is subdivided into five groups. Four of them correspond to the subdivisions of the Outfitting Dept., so that each group can closely communicate with its corresponding subdivision about material preparation. The spare parts group takes care of spare parts independently so as not to disturb palletizing, because handling of spare parts is a troublesome job at the end stage.

Transportation is operated by one independent group for efficient and safe operation of carriers.

In IHI Kure Shipyard the material preparation group belongs to the Outfitting Production Dept. But this group can alternatively belong to the warehouse. Advantage and disadvantage in this case are:

- Being able to save manhours for marshalling and palletizing thanks to good communication within the warehouse dept.

- Being liable for poor communication with PPS engineers and production site.

3) Material Preparation

Each group gathers information for material preparation and takes actions such as:

- Preparing requests for scheduling of working drawing and "Material List of Pallet," referring to production schedule, lead time of materials and feedback data. (actual situation of material preparation in the last ship).
- Expediting materials to meet palletizing schedule.
- Communicating production schedule changes to material control engineer in order to adjust material receiving schedule.
- Informing PPS engineers of delayed materials and making tentative changes in the palletization schedule to meet changes caused by the delay.

4) Inspection (proposed)

When materials arrive, inspection is carried out for each item material by referring to the drawings. If a defect is found, that material is sent back to the vendor or manufacturing shop and re-receipt date is determined.

When the pallet of that material has already been issued, excluding that material, re-receipt date is communicated to the PPS engineers

5) . Palletizing

Materials are palletized as follows:

0 When delivery date of pallet indicated in the latest monthly schedule is received, material issue from the warehouse and manufacturing shop of the pallet is requested (pallet-by-pallet).

o The-warehouse and manufacturing shop issue materials pallet-by-pallet, referring. to "Material List Of Pallet" with "List of Missing Material."

o These materials from the warehouse and the manufacturing-shop are combined into one pallet.

o A daily pallet transportation schedule is prepared and sent to the transportation group.

o Missing materials which should have been contained in the pallet that has already been delivered are exped and sent to the production site when received.

6) Transportation

Pallets are transported to the area which was previously determined near on-unit outfitting and on-block outfitting site, or to the spot on deck, hold, accommodation, engine room near onboard outfitting site.

7) Marshalling Area

Since outfitting materials vary in size, type, weight, quality, etc., a relatively large area is required for effective palletizing. The area should be *as close* to both warehouse-and outfitting area as possible. If impossible, it should be close to the warehouse. Fig. 2 - 25 also shows the area used in IHI Kure Shipyard.

8) Facilities

The marshalling area is provided with cranes with light lifting capacity and rapid travelling speed. Also, considerable number of fork lifts or pallet carriers are required. Fig. 2-25 shows the crane and carrier used in IHI Kure Shipyard.

MATERIAL PALLETISING FLOW

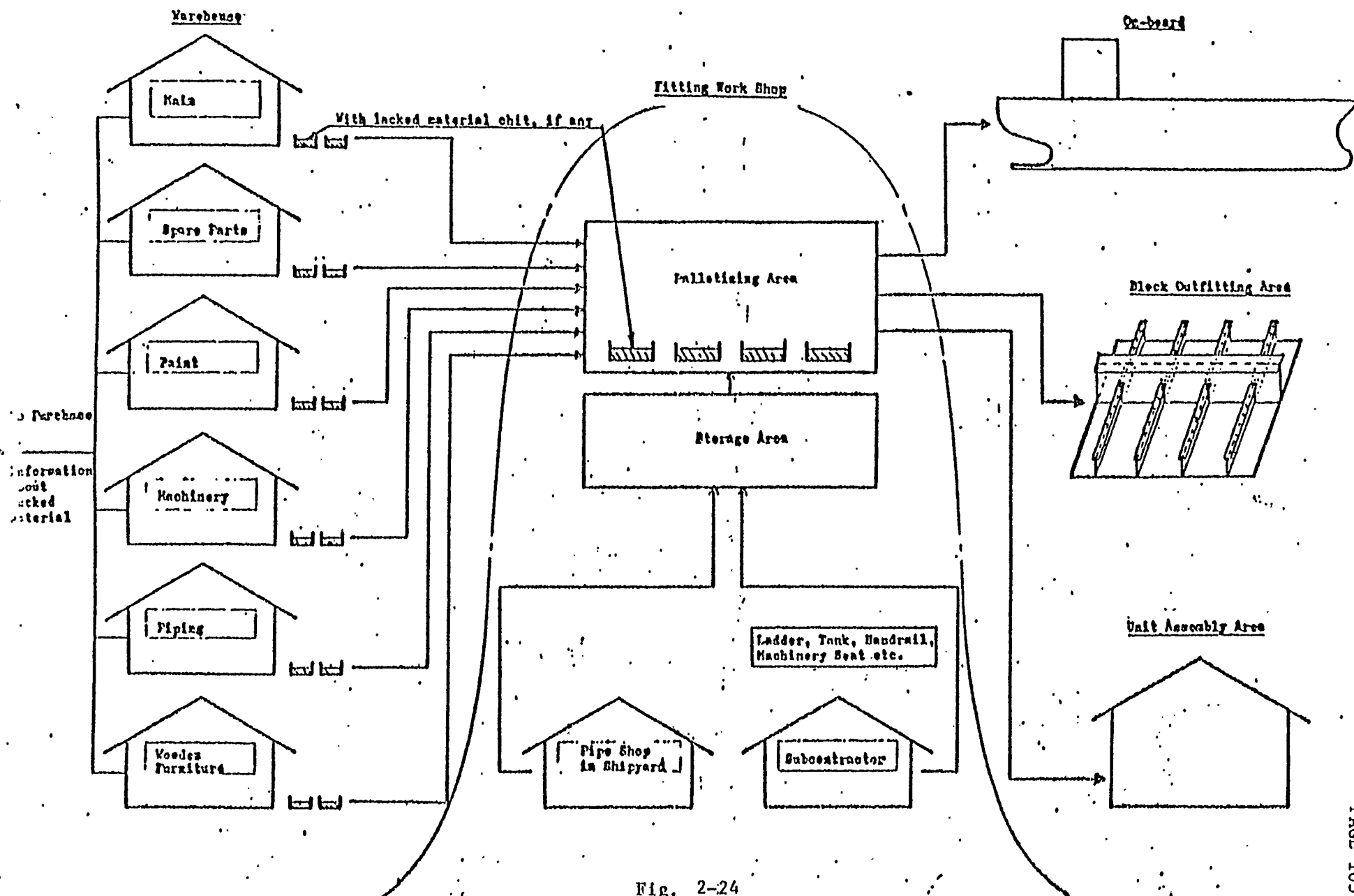
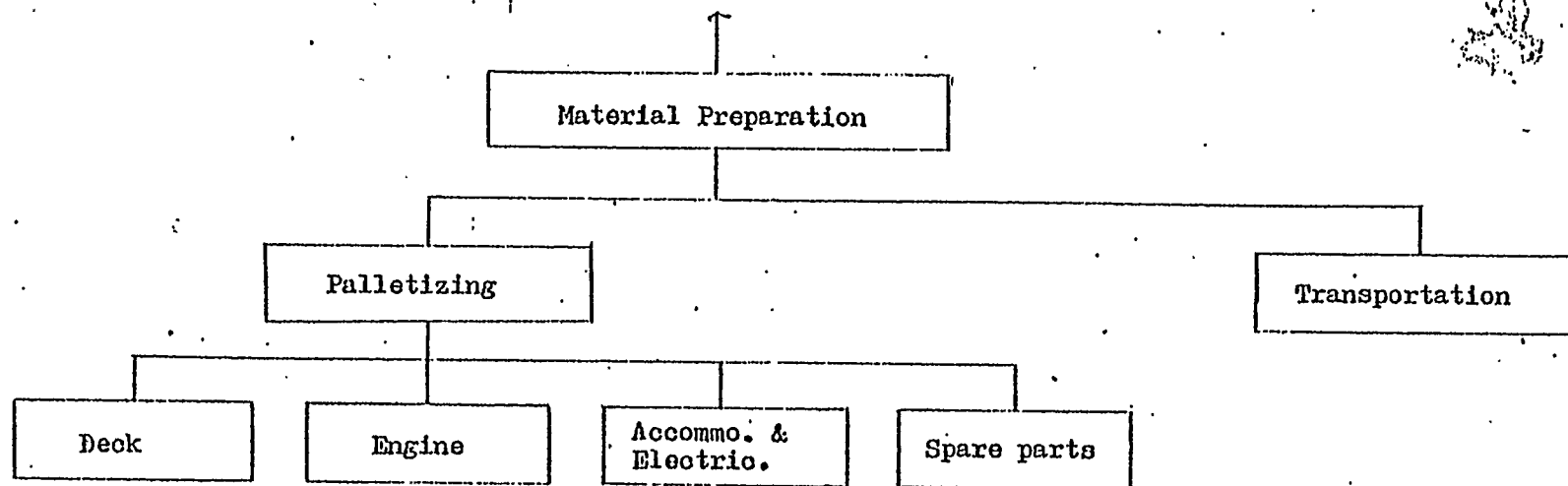


Fig. 2-24



No. of Workers

6

5

6

5

8

Marshaling Area

5456 m²

2089 m²

Facilities

10 ton Crane - 1

2.8 ton Crane - 1

2 ton Crane - 1

Tractor 4

1 ton Crane - 1

Mobile Crane 3.5 ton 1

Fork Lift 6

Pallet Carrier 10 ton 2

6 ton 34

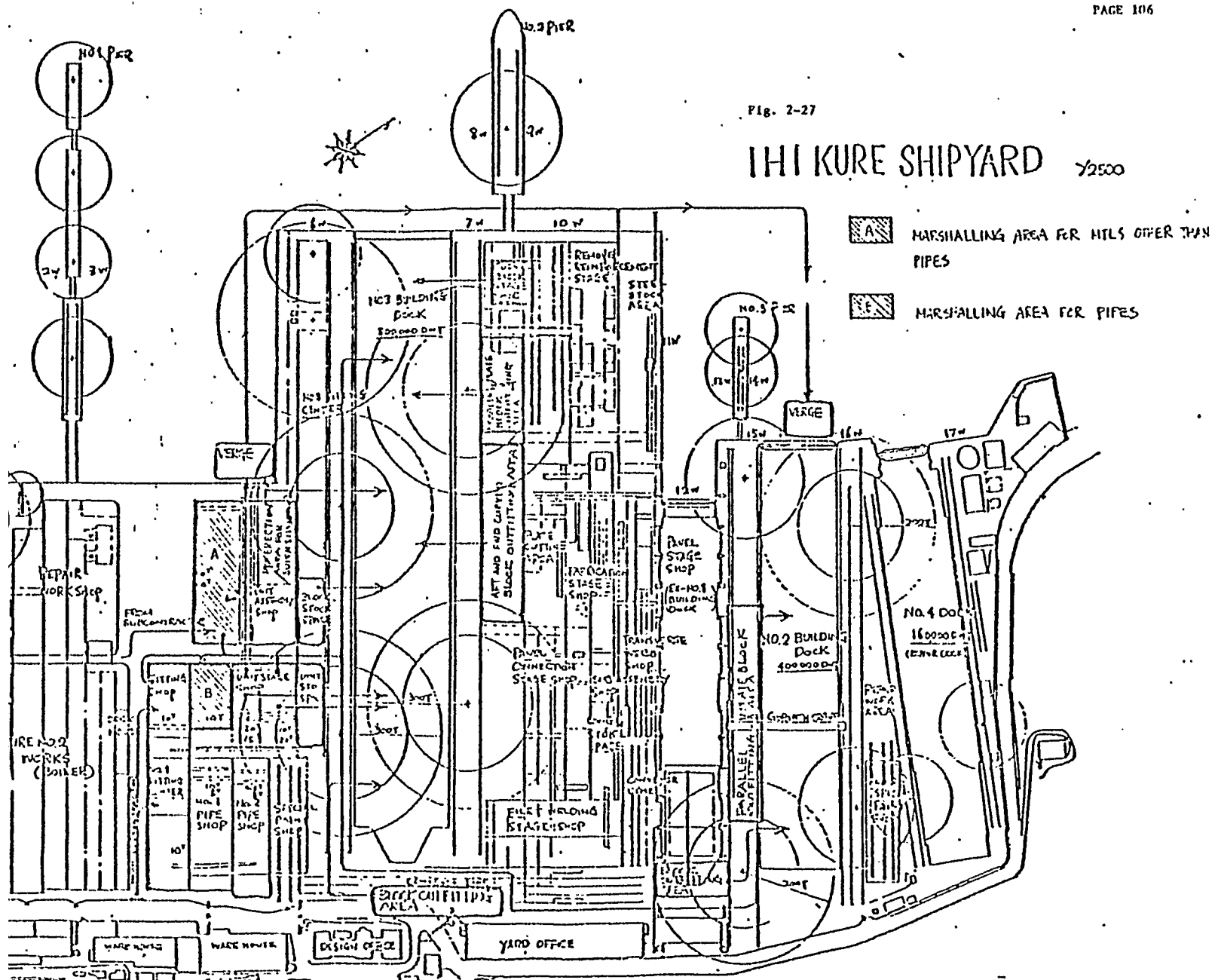
4 ton 4

3 ton 19

Mobile Truck 6

Fig. 2-27

IHI KURE SHIPYARD 72500



Following three chapters introduce the IHI's standards related.
to Palletization;

CHAPTER III ZONING AND SYMBOL MARK

CHAPTER IV ML(F) AND FORM OF MLF-NO. (GENERAL)

CHAPTER V CODING GUIDANCE OF MLF-NO. (MACHINERY PART)

CHAPTER III- ZONING AND SYMBOL MARK

1. Composition of Zone Symbol

Level A	Level B	Level C

1.1 Level A

Level A defines the zones of the first level re-presenting the outfitting part or structure of a ship, such as upper deck, shell, fore section, machinery space, living quarters, pump room, etc. The initial letter (English) of each zone is usually used as the symbol mark.

1.2 Level B

Level B defines the subdivision of Level A.

There are two types in zones of Level B, i.e., general zone and special zone.

A special zone is a zone whose location is changeable due to owner's requirement of design improvement.

A general-zone is a zone other than the special zone. A general zone is given a sequential number as its symbol to show its fore-aft location in the zone of Level A and a special zone its initial letter.

1.3 Level-C

Level C is the subdivision of Level B and defines the location in the zone of Level B.

The following five types (symbols) of zone are at Level C.

P Port side
 S Starboard side
 C Center
 F Foreside
 A Aft side

In case there are two or *more* special zones with the same name, a sequential number shall be assigned for Level C, and in case of only one special zone for. one name, an alphabetical letter to give some-significance to its superior zone of Level B may be placed in the column of Level C.

1.4 Examples

a) General zone

<u>Level A</u>	<u>Level B</u>	<u>Level C</u>
U	2	P
Upper-deck	Second from fore	Port side

b) Special zone

<u>Level A</u>	<u>Level B</u>	<u>Level C</u>
L	F	s
Living accommodation	Fan room	Starboard side

2. Zones and Symbols of Level A

2.1 Fore part "F"

All zones forward of the aft bulkhead of the fore peak tank except shell plate.

2.2 Shell Plates "S"

All hull shell plate. This zone is used for outfitting of sea chests, cathodic protection, zincs, marks (draft marks, etc.) on the shell plates.

2.3 Upper Deck "U"

Upper deck between the aft bulkhead of fore peak tank and fore end of accommodation superstructure.

2.4 Aft Part "A"

All zones aft of the aft end bulkhead of engine room except shell plates.

2.5 Weather Part of Accommodation "W"

Weather part of all accommodations including upper deck side by the accommodation and engine casing; the top and wall of engine casing **are** not included in "W".

2.6 Weather Part of Engine Casing "E"

Weather part of the top and wall of engine casing.

2.7 (Living) Accommodation "L"

All inside zones of the accommodation.

2.8 Machinery Room "M".

Machinery (main engine) room, all inner zones of engine casing and funnel.

Emergency generator room and inert gas fan room side by the engine casing, if any, are included in "M". Stores, recreation room, pool, etc., side by the engine casing are included *in* "E".

2.9 Pump Room "P"

All inside zones of pump room including the entrance.

2.10 Hold Part

a) Tanker "T".

All inside zones of cargo tanks and slop tanks.

b) B/C, O/C, P/C

1) Wing tank, slop tank "T"

2) Cargo hold "H" .

3) Double bottom tank and duct keel "B".

c) Container ship

1) Side tank "T"

2) Cargo hold "H"

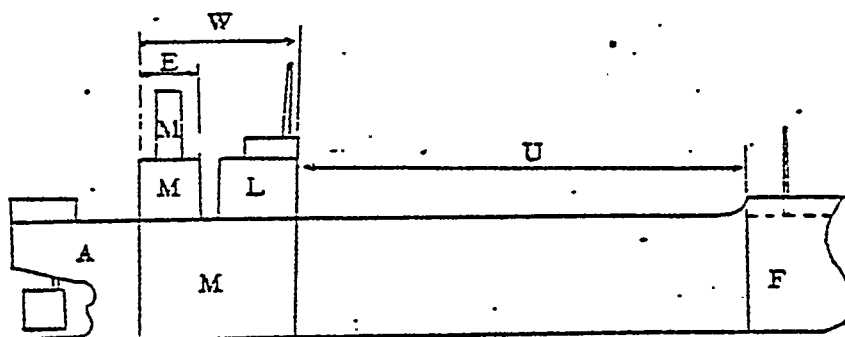
2.11 Double Bottom "B"

Zones in double bottom.

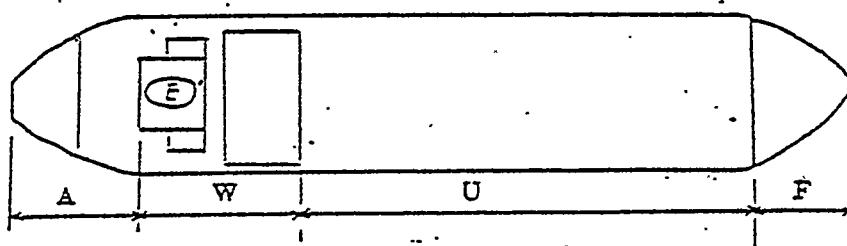
2.12 Overall "Z"

Zones relating to all parts of the ship.

Zoning of Level A



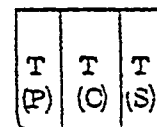
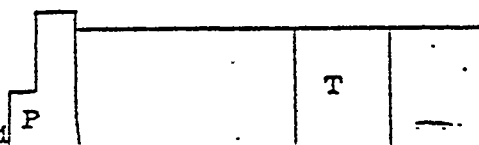
All shell plates : S



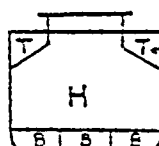
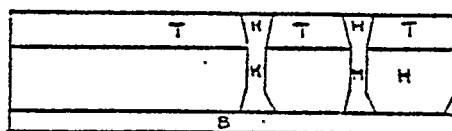
(Upper deck & weather part)

Hold part of
TANKER

PUMPROOM

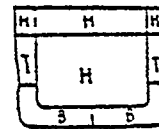
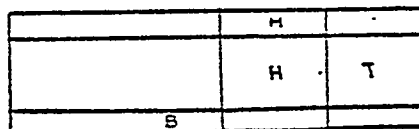


Hold part of
O/O, O/B
BULK/C, CARGO/C



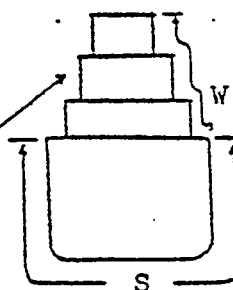
WING TANK

Hold part of
CONTAINER SHIP.



PIPE PASSAGE
WING TANK

Weather part of ACC.



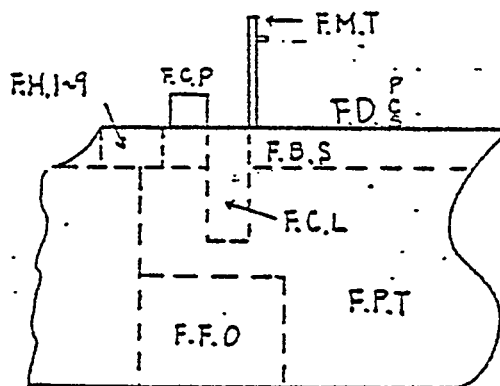
W (Incl. upper deck)

Upper deck

3. Zones and Symbols of Level B and C

3.1 Fore part "F"

Zone	Col. of M/R No.			Remarks	E F
	4	5	6		
Level	A	B	C		
FORE PEAK TANK	F	P	T	* 1	
FOR' D F.O. TANK		F	O		
WATER BALLAST T		W	B		
CHAIN LOCKER		C	L		
FOR' D PUMP ROOM		P	R		
BOW THRUSTER ROOM		B	T		
BOSUN STORE		B	S		
COMPANION		C	P		
FO' C' LE DECK		D	P S C		
HYDRO PUMP ROOM		H	1~9	* 2	
FORE MAST		M	T	* 1	



Note: * 1. Not identified by P.S.C.

* 2. Numbering sequence of level C shall be from fore to aft and from S to P.

* 3. D Hull part other than accommodation

M Machinery part

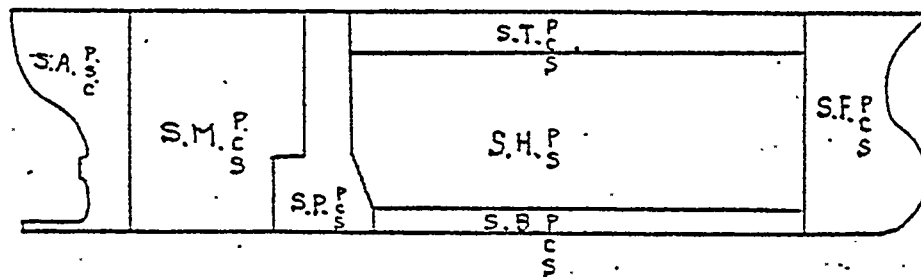
E Electric part

cf. A Accommodation

3.2 Shell plates "S"

Zone	Col. of MLF-No.			Remarks	Relevant parts
	Level	4	5	6	
	A	B	C		
ALL SHELL PLATES	S	—	—	To be used for out-fitting of sea chest; anode, marks, bottom plugs etc. If level C is not necessary col. 6 of MLF-No. shall be filled with hyphen "-".	D E
FORE PART			F	P.C.S	
PARALLEL PART (T)			T		
PARALLEL PART (B)			B		
PARALLEL PART (H)			H		
MACHINERY PART			M		
AFT PART			A		
PUMP ROOM			P		

Shell plate S —



3.3 Upper Deck "U"

Zone	Col. of M.F. No.			Remarks	P
	Level	4	5	6	
		A	B	C	
PARALLEL PART	U		1~9 U~Z A, B	P.S.C	Level B is numbered in order of 1-9, U-Z, A, B from fore to aft corresponding to the arrangement of tanks and holds.
HYDRO PUMP ROOM			H	1~9	Level C is numbered 1-9 from fore to aft and from S to P..
DECK HOUSE			D		
MAST HOUSE			M		
DERICK POST			P		
LAMP POST			L		
CO ₂ ROOM			N		
COMPANION		↓	C	↓	

Tanker

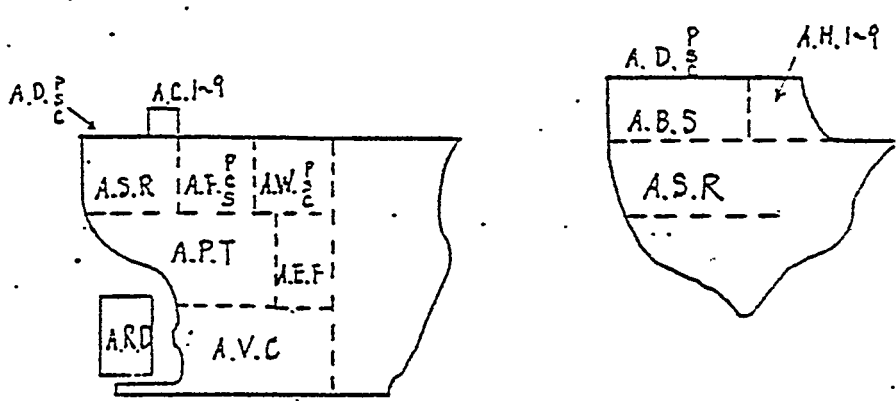
U.V.P	U.U.P	U.Q.P				U.4.P			U.I.P
U.V.C	U.U.C	U.Q.C				U.5.C			U.I.C
U.V.S	U.U.S	U.Q.S			U.6.S				U.I.S

O/O, O/B/O, B/C. Container ship

U.V.P		U.Q.P				U.4.P			U.I.P
U.V.C		U.Q.C				U.5.C			U.I.C
U.V.S		U.Q.S			U.6.S				U.I.S

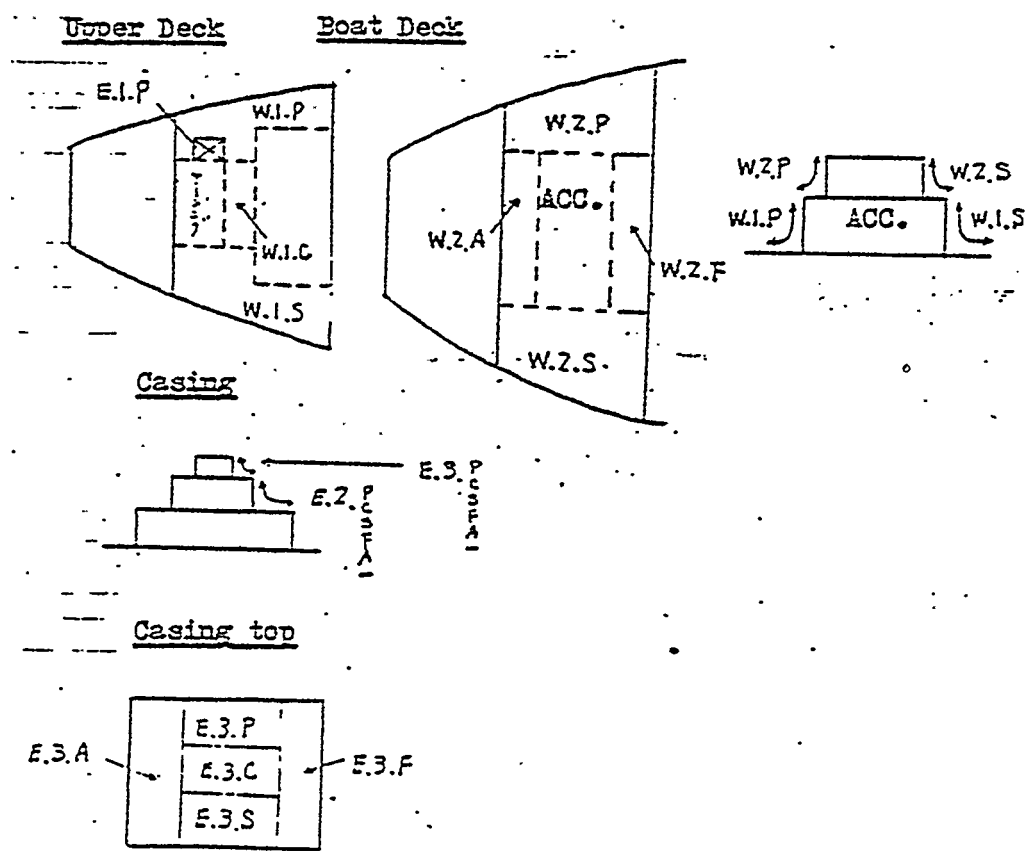
Note: Hatch cover is not treated as a zone.

3.4 Aft part "A"

Zone	Coll. of MLE No.			Remarks	Relevant parts
	Level	4	5	6	
		A	B	C	
BOSUN STORE		A	B	S	Level C is fixed and not identified by P.S.C.
AFT UPP DECK			D	P.S.C	D M E
VOID SPACE (COOLING WATER TANK)			V		
POTABLE WATER TANK			P		
FRESH WATER TANK			F		
DRINK WATER TANK			W		
AFT PEAK TANK			P	T	Level C is fixed and not identified by P.S.C.
EMERG FIRE PUMP ROOM			E	F	
HYD PUMP ROOM			H	1~9	Level C to be numbered from fore to aft and from S to P.
REF MACH ROOM			R	F	Level C is fixed and not identified by P.S.C.
RUDDER PLATE			R	D	
STEERING GEAR ROOM			S	R	
COMPANION			C	1~9	
DISTILLED WATER TANK			J	P/S	
 Note: Rudder tank to be included in A.P.T.					

3.5 Weather part of accommodation and engine casing "W", "E"

Col. of MLE No.		4	5	6	Remarks
Zone	Level	A	B	C	
ALL ZONES		W	—	P.S.C A.F—	1. Level B : Tier 2. Level C : Location 3. "-" : All zone at the superior level :
1ST TIER			1		
7TH TIER			7	↓	
RADER MAST		↓	R	M	Level is not identified by P.S.C.
ALL ZONE OF ENGINE CASING		E	—	P.S.C A.F—	1. Level B : Tier 2. Level C : Location 3. "-" : All zone at the superior level.
1ST TIER			1		
7TH TIER		↓	7	↓	



3.6 (Living) Accommodation "I"

Col. of MLF No.		4	5	6	Remarks	Relevant parts
Zone	Level	A	B	C		
ALL ZONES	L	—	P.S.C	A.F	1. Level B : Tier	A
1ST TIER			1		2. Level C : Location	
					3. "-" : All zone at the superior level	
7TH TIER			7			
BATTERY ROOM			B		1. Level B : Symbols to identify special zones 2. Level C : Location 3. "-" : All zone at the superior level	A D E
CARGO CARE ROOM			A			
CARGO OIL CONT ROOM			C			
CO ₂ GAS ROOM			D			
ENGINE CONT ROOM			E			
EMERG GEN ROOM			J			
FAN ROOM (INCL. THERMO T.R)			F			
FOAM TANK ROOM			L			
GALLEY , PANTRY			G			
GYRO ROOM			K			
HYDRAULIK P. ROOM			H			
INERT GAS ROOM			N			
INNER PASSAGE			P			
REF. MACH. ROOM			M			
RADIO ROOM			R			
REF CHAMBER			Q			
WORK SHOP			S			
ELEVATOR SPACE			E	L	Not identified by P.S.C	
DUMB-WAITER SPACE			D	W	—	
L7 L6 L5 L4 L3 L2 L1 EX. (plan) 150,000~250,000 DWT split casing L1.P ~L7.P L1.C ~L7.C L1.S ~L7.S 60,000 DWT 1~2 tier 3~4 tier 5~6 tier L1.P L1.F L1.S L3.P L3.S L5.S L4.S 15,000~25,000 DWT L1.A L1.F L4.S						

3.7 Machinery room "M"

Zone	COL. of MLF No.			Remarks
	Level	A	B	C
MAIN FLOOR (UNDER GRATING incl. GRT'G)	M	1	1~6	PS-
MAIN FLOOR -- (ABOVE GRATING)			2	PS-
LOWER ENG FLAT			3	PS-
UPPER ENG FLAT			4	PS
ENGINE CASING (INSIDE)			5	PS
INERT GAS FAN ROOM			5	5
EMERG GEN ROOM			5	6
FUNNEL (INSIDE, OUTSIDE)			6	1
AROUND M/E AFTER ERECTION			7	1
DIESEL OIL TANK			D	O
ENGINE CONT ROOM			C	R
FUEL OIL TANK			F	P.S.C
F.O. SETT TANK			S	P.S.C
WORK SHOP			W	S
ELEVATOR SPACE			E	L
DISTILLED WATER TANK			J	P.S.C

1. Level B shows flats or decks in the engine room. In special zones, level B is a significant alphabetical letter.

2. Level C defines P or S. Odd number (1, 3, 5...) means S and even number P. Hyphen "-" means all are in the superior zone level.

3. Special examples:

(1) M1P ... all portsid zone of main floor

(2) M1-.... All area of main floor

(3) Grouping of two zones
M31 + M32 = M31
(M31 represents the two zones)

M11 + M21 = M21
(M21 represents the two zones)

MAIN FLOOR
(UNDER GRATING)

16	14	12
15	71	11
	13	

LOWER ENG. FLAT
(UPPER ENG. FLAT)

36 (45)	34 (44)	32 (42)
35 (45)	71	31 (41)
	33 (43)	

ENGINE CASING

56
54 52
53 51
55

MAIN FLOOR
(ABOVE GRATING)

26	24	22
25	71	21
	23	

(DIESEL ENGINE)
2S: COOLER FLAT

MAIN FLOOR
(ABOVE GRATING)

26	24	22
25	71	21
	23	

(TURBINE ENGINE)

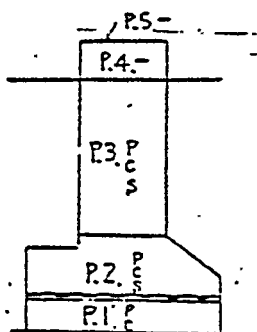
27, 28: OPERATING
21, 22: TURBINE

3.8 Pump room and Tank part of Tanker "P", "T"

Zone	Col. of MLP No.			Remarks	Relevant parts
	Level	4	5	6	
	A	B	C		
GRATINGS & UNDER GRATINGS	P	1	P.C.S		D E
ABOVE GRATINGS		2			
RISERS (PIPES)		3			
INSIDE OF ENTRANCE		4			
OUTSIDE OF ENTRANCE		5			
WHOLE ZONE		↓	—	—	

TANK PART OF TANKER	T	1~9 U~Z A, B	P.C.S	Level B to be numbered in order of 1-9, U-Z, A, B from fore to aft corresponding to tank arrangement.	D
SLOP TANK	T	S	↓		

PUMP ROOM



PLAN OF TANK PART

(Parallel Part)

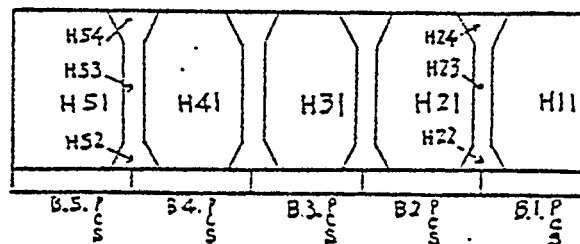
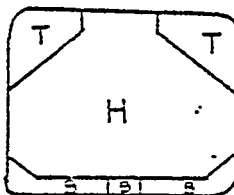
T.S.P	T.U.P	T.Q.P	T.3.P	T.I.P
T.V.C	T.U.C	T.Q.C	T.3.C	T.I.C
T.V.S	T.U.S	T.Q.S	T.3.S	T.I.S

→ F

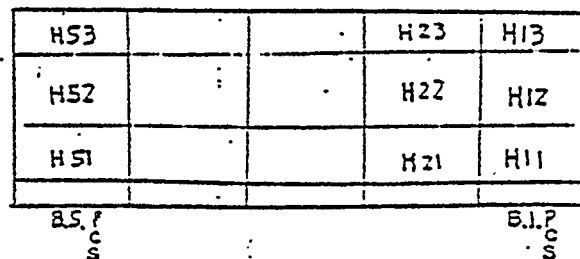
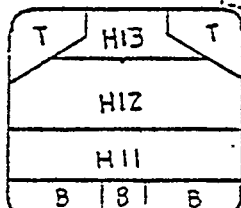
3.9 Parallel part of B/C, O/O, O/B and Cargo Ship

Col. of MLE No.		4	5	6	Remarks
Zone	Level	A	B	C	
UPPER WING TANK	T		1~9 U~Z A, B	PCS	Level B to be numbered in order of 1-9, U-Z, A, B from fore to aft corresponding to tank arrangement.
SLOP TANK	T		S	↓	
CARGO HOLD	H		1~9 U~Z A, B	1~9	1. Level B: Hold No. from fore to aft 2. Level C: See sketches below
DOUBLE BOTTOM	B		1~9 U~Z A, B	PCS	1. Level B to be numbered in order of 1-9, U-Z, A, B from fore to aft corresponding to arrangement of tanks and duct keel. 2. C of level C means duct keel.

ZONING OF CARGO HOLD
B/C, O/O, O/B



CARGO SHIP



3.10 Parallel Part of Container Ship

Zone	Col. of MLF No.			Remarks	Relevant parts
	Level	4	5	6	
		A	B	C	
SIDE TANK	T		1~9 U~Z A, B	P.S.C	Level B to be numbered in order of 1-9, U-Z, A, B from fore to aft corresponding to hold arrangement.
CARGO (CONTAINER) HOLD	H		1~9 U~Z A, B	1~4	Level B : Hold No. from fore to aft Level C : See sketches below
DOUBLE BOTTOM	B		1~9 U~Z A, B	P.S.	Level B to be numbered in order of 1-9, U-Z, A, B from fore to aft corresponding to hold arrangement.
H14 H42					

3.11 Overall Zone "Z"

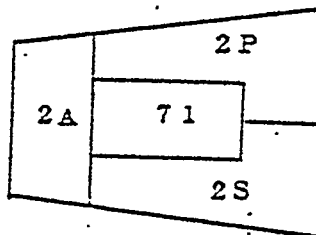
Zone	Col. of MLF No.			Remarks	Relevant parts
	Level	4	5	6	
		A	B	C	
OVERALL	Z		Struc- ture symbols	P.S.C -	1. Name plates, canvas, nets, spare parts etc. 2. Level B: Structure symbols to be used if necessary 3. Level C: P.S.C and "-" to be used if necessary

3.12 Zoning for Electric Outfitting

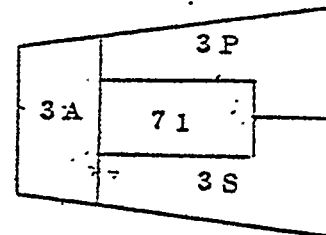
For electric outfitting, the inside of engine room and accommodation is zoned as follows.

Zone	Col. of Plan No.			Remarks
	Level	4	5	
		A	B	C
MAIN FLOOR	M	2	P, S A, -	1. Zoning to be as example below. 2. "-" means whole flat. 3. Main floor includes its upper and lower sides. 4. Inside of engine casing is not divided down to level C.
LOWER ENG. FLAT			3	
UPPER ENG. FLAT			4	
M/E & ITS VICINITY			7	
ENGINE CASING (COMBINED WITH ACC)			5	
ENGINE CASING (SPLIT TYPE)			5	
1ST. TIER OF ACCOMMODATION	L	1	P, S, C F, -	1. Zoning to be as example below. 2. "-" means whole tiers.
7TH TIER OF ACCOMMODATION			7	

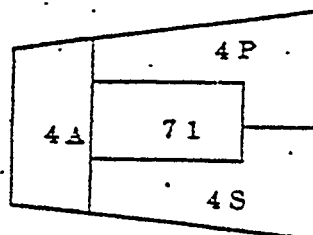
MAIN FLOOR



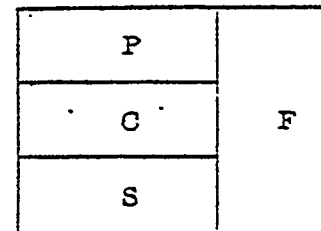
LOWER ENG. FLAT



UPPER ENG. FLAT



ACCOMMODATION



(All tiers to be zoned like this example.)

CHAPTER IV - ML(F) AND FORM OF MLF-NO. IN IHI

1. Definition of ML(F)

ML(F) is literally Material List for Pallet (Fitting) and one ML(F) corresponds to one pallet. The significance of ML(F) is detailed as follows:

1.1 A ML(F) contains the following information:

- 1) List of all materials to be prepared and fitted in a pallet with their specifications, weight, quantity, piece number, painting schedule, etc.
- 2) Job guidance for outfitting work such as "zone" or trade identification.
- 3) Production control data such as total weight of the, materials in the pallet for resources allocation, stage identification, etc.
- 4) Outfitting scheduling data such as starting date of the job, etc.

1.2 Coding for each item of information contained in ML(F) is stipulated by respective coding standard of IHI (i.e. piece numbering, staging of outfitting work, zoning, etc.).

1.3 Each ML(F) has MLF-No., meaning respective pallet -No.

This MLF-No. implies stage, trade, schedule and sequence of outfitting work in the pallet, which allows planning, scheduling and controlling of outfitting work by the Production Department, as well as allowing scheduling the issue of drawings by the Design Department and controlling or chasing receipt of purchased materials by the warehouse.

1.4. One pallet (MLF) shall be made for one work package.

The quantity of materials in one work package (pallet) shall be decided 'so as to be easily handled or controlled by the available *resources*, but all materials in a pallet zone or for a unit must be listed in the ML(F).

2. Breakdown of. Outfitting Work and MLF-No.

In IHI, a ship is divided into four outfitting parts:

- 1) Hull part other *than* accommodation
- 2) Accommodation part
- 3) Machinery part (main *engine* room)
- 4) Electrical part

Further, outfitting for each part is grouped into one of the following five stages:

- 1) Piece outfitting on-block
- 2) Unit outfitting on-block (an assembled unit to be installed on block)
- 3) Machinery unit outfitting both on-block and onboard (a machinery unit = a unit assembled with a machine or machinery *such* as a pump *or* motor, etc., and in most cases used in the machinery part);
- 4)Unit outfitting onboard
- 5) Piece outfitting onboard

For each ML(F), a MLF-No. is assigned identification to imply such information as type of ML(F), outfitting part, zone, hull block, outfitting stage, trade, or sequence of outfitting work, etc.

A MIF-No. consists of ten (10) columns which are a significant combination of alphabetical letters and numerical numbers implying each item of information mentioned above and as detailed hereunder.

3. Basic Form of MLF-No. (common for all parts)

3.1 Basic Form

1) Outfitting on-block

Col.	1	2	3	4	5	6	7	8	9	10
	T	Part	Block stage		Hull Block Name					Sub-division

2) Unit outfitting on-block

Col.	1	2	3	4	5	6	7	8	9	10
	B	Part	X or Y		Hull Block Name					Sub-division

3) Machinery unit outfitting on-block and onboard

Col.	1	2	3	4	5	6	7	8	9	10
	B	Part	X or Y	Machinery No.			-	-	-	Sub-division
							(hyphen)			

4) Unit outfitting onboard

Col.	1	2	3	4	5	6	7	8	9	10
	B	Part	X or Y	Zone Name			Unit Name		-	Sub-division

5) Piece outfitting onboard

Col.	1	2	3	4	5	6	7	8	9	10
	T	Part	Z or K	Zone Name			Pallet Name		-	Sub-division

3.2 Definition by Column of MLF-NO.

1) Column 1 (Type of ML(F))

This column signifies type of the ML(F) as follows:

"T" ML(F) for piece outfitting

"B" ML(F) for unit outfitting

2) Column 2 (Outfitting part)

This column shows the outfitting part where the pallet is installed.

"2" Hull part other than accommodation

"3" Accommodation part

"4" Machinery part

"5" Electrical part

3) Column 3 (Outfitting stage)

This column shows the detailed outfitting stage at which the pallet is outfitted as follows:

(1) Piece outfitting on-block

Hull block stage symbolized by an alphabetical letter at which the pallet is to be outfitted. Symbols of stages are given by another standard.

Example:

"S" Sub-assembly stage

"A" Assembly stage

"B" Back-assembly stage (turned over)

(2) Unit outfitting on-block

"X" signifies a unit which is installed on-block without being assembled into a large unit.

"Y" means a large unit to be installed on-block which consists of one *or more* units of "X" level anti/or other materials.

(3) Machinery unit outfitting

"X": A unit which is installed on-block or directly onboard without being assembled into a large unit.

"Y": A large unit to be installed on-block or directly onboard which consists of one or more units of "X" level and/or other materials.

(4) Unit outfitting onboard

"X": A unit to be installed onboard without being assembled into a large unit.

"Y": A large unit to be installed onboard which consists of **one** or more units of "X" level and/or other materials.

(5) Piece outfitting. onboard

"X" : Workstage standard (general)

"Y" : Accommodation outfitting at grand block stage before erection (pre-erection stage) and machinery outfitting stage for grand engine casing block before erection..

4) Columns 4 - 9

These columns signify the hull block, machinery number representing the unit or zone in a ship as follows:

(1) piece outfitting on-block-

Name of the hull block on which the pallet is outfitted. " Naming of hull block is stipulated by other standard..

(2) Unit outfitting on-block

Same as(1) above.

(3) Machinery unit outfitting on-block and onboard

Columns 4 - 6: Machinery number which represents the unit. Numbering of machinery is given by other standard.

columns.7 - 9: Hyphen (fixed).

Note: To be applied to, in most cases, machinery
p a r t .

(4) Unit outfitting onboard

Columns 4-6: Name of zone where the pallet is outfitted.

Zoning is to be referred to other standard (Chapter VII).

Columns 7 - 8: Name of the unit.

Detailed naming is given by the
respective MLF-coding guidance for
each part.

column 9 : Hyphen (fixed)

(5) Piece outfitting onboard

columns 4 - 6: Name of zone where the pallet is
outfitted.

columns 7 - 8: Name of the pallet..

Column 7 . . . Trade of the work based
on kinds of fittings.

Column 8 Sub-trade or sequence
of the work.

Detailed naming is given by the
respective MLF-coding guidance for
each part.

Column 9 : Hyphen (fixed)

5) Column 10 (Sub-division)

Usually, palletization is so determined as to compile all
outfitting materials for one assembly block, zone in the
ship or *a unit* into one pallet, and the pallet number, or
MLF-No., is allocated at the planning stage of ship con-
struction when complete composite drawings for outfitting
or palletization are not available, and it could happen

that materials in a certain pallet zone or unit are *too* numerous to be compiled in the allocated pallet in terms of resources available or fitting weight when *the design* progresses further. In such cases, the pallet is sub-divided further by giving a sequential number or significant alphabetical letter in column 10 for identification.

Column.10 is also used for identification of detailed assembly stage or a group of fittings in tune electrical part.

Details of sub-division *are* given respectively for each part by the guidance of MLF-No.

CHAPTER V- CODING GUIDANCE OF MLF NO. (MACHINERY PART)

As an example of MLF-coding outlined in the preceding chapter, coding guidance for MLF-No. for machinery part is introduced herein.

1. Piece Outfitting On-block

Example:

1	2	3	4	5	6	7	8	9	10
T	4	A	2	D	3	1	P	-	0
Type	Part	Block Stage	Block Name					Sub-division	

Col	Item	Symbal.	Description
1	Type of MLF	T	Fixed
2	part	4	Fixed
3	Block Stage	S T M* N H A* B* G	Symbols defined by other standard to be used Sub-assembly Sub-assembly (turned over) Middle-assembly - Do - (turned over) Assembly without shell plate (crate) Assembly (block assembly before erection) Back assembly (turned over) Grand assembly (pre-erection)
Note: Usually, outfitting is done at *-marked stages.			
4-9	Block Name	Alpha & Numeric	Block name decided by hull part to be used. The columns are to be filled from column 4, and rest of columns, if any, are to be filled with a hyphen.
10	Sub-division	0 - 9	Guidance for sub-division guidance of Article 6 is to be referred to.

2. Unit outfitting On-block,

Example: 1 2 3. 4 5 6 7 8 9 10

Col	Item	symbol	Description	
1	Type ,	B		I
2	Part			
3	Unit Stage	X or Y	Refer to 3..2.3 (2) of Chapter IV.	
4-9	Block Name	Alpha & Numeric	Same as columns 4-9 of 1 above. Piece outfitting on-block.	
10	Sub-division	Block Stage symbol	To be sub-divided by block stage.	

Note: In case two or more units are installed on one block, assembly sign (A, B, C or 1, 2, 3) shall be put in the corresponding column of ML(F) for identification in consideration of sequence of installation.

3. Machinery- Unit Outfitting.

Example: 1 2 3 4 5 6 7 8 9 10

B	4	X	1	9	8	-	-	-	0
Type	Part	Unit Stage	Mach. No.			Hyphen			Sub-division

Col	Item	Symbol	Description
1	Type c	B	Fixed
2	Part	4	Fixed
3	Unit Stage	x or Y	Refer to 3.2.3 (3) of Chapter IV.
4-6	Machinery NO.	Numeric	Machinery No. is given by other Standard.
7-9	Hyphen		Fixed
10	sub-division	0 - 9	Sequential; sub-division guidance of Article 6 is to be referred to.

4. Unit Outfitting Onboard

Example: 1 2 3 4 5 6 7 8 9 1 0

B	4	X	M	1	1	0	1	-	0
Type	Part	Unit Stage	Zone			Unit Number		Hyphen	Sub-division

Col	Item	symbol	Description
1	Type	B	Fixed
2	Part	4	Fixed
3	Unit Stage	X or Y	Refer to 3.2.3 (4) of Chapter IV.
4	Zone	M	Machinery space
		A .	Steering gear room
5-6	Zone No..	Numeric	Zone numbering is given by other standard.
7-8	Unit Number	01-49	Unit with pipes
		50-69	Unit without pipes
		70-89	Unit with small pipes (for control air piping etc.)
9	Hyphen		Fixed
10	Sub-division	0 - 9	Sequential; Subdivision guidance of Article 6 is to be referred to.

5. Piece Outfitting Onboard

Example: 1 2 3 4 5 6 7 8 9 10

T	4	Z	M	1	1	P	-	-	2
Type	Part	Stage	Zone			Pallet Name	Hyphen	Sub-division	

Col	Item	Symbol	Description
1	Type	T	Fixed
2	Part	4	Fixed
3	Stage	Z	Onboard stage (General
		K	Outfitting stage on grand block (Engine casing outfitting and joiner fitting in the engine control room)
4	Zone	M	Machinery room
		A	Steering gear room
5-6	Zone No.	Numeric	Zone numbering is given by other standard.
7-8	Pallet Name	Alpha	By combination of columns 7 and 8 pallet name is defined as detailed below
9	Hyphen	-	Fixed
10	Sub-division	0 - 9	Sequential; Subdivision guidance of Article 7 is to be referred to.

Pallet Name

COL.7	COL.8	Description (Trade & Fitting)
P		Piping (including miscellaneous tanks)
P	A	Piping at "Blue sky" stage*
P	-	Other pipings
		* "Blue sky".stage is the stage immediately after erection of a certain block at which the overhead block is not yet erected and the zone is opened to the atmosphere.
c		Control and automation system
c	A	Fitting or units at "Blue Sky" stage
c		Fittings
K		Traffic system
K	A	Traffic fittings at "Blue sky" stage
K		Other traffic fittings
G		Machining and adjusting
G	A	Auxiliary machinery at "Blue sky" stage
G	s	Sea chests
G	R	Handle lock for valves
G	w	Wiring system
G	D	Damper controllers
G	E	Remote-operated closing devices
G	B	Pipe-bonding strips

COL.7	Col. 8	Description (Trade & Fitting)
G	V	Distance pieces (pipes) for ship side valves
G	T	Tank fittings
G	H	Extension spindles for valves
G	L	Liners for auxiliary machinery
G	Z	Others
I		Insulation
I	E	Funnel
I	M	Main exhaust pipes
I	s	Ventilation trunks
I	u	Upper deck
I	P	Pipings
I	T	Tanks
T		Steelwork (ventilation trunks)
T	A	Ventilation trunks at "Blue sky" stage
T		Other ventilation trunks
F		Steelwork (foundation seats)
F	A	General foundation seats at "Blue sky" stage, seat units and spare parts units
F	x	Seats for spare parts .
F		Other seats .
u		Steelwork (funnel. part)
u	E	Stack (uptake for boilers)
u	s	Supply air duct for boiler (or M/E)
u	H	Main engine exhaust gas pipe

Col. 7	Col. 8	Description (Trade & Fitting)
x	A	Spare parts, accessories
x		Spare parts and accessories at "Blue sky" stage
x		Other spare parts and accessories
E	D H L R T c	Main engine
E		Diesel main engine
E		High pressure turbine
E		Low pressure turbine
E		Reduction gear
E		Thrust bearing
E		Main condenser
B	B H c s F. G I N E L D	B o i l e r
B		Boiler
B		Gas air heater
B		A.C.C. (Auto-Combustion Control)
B		Soot blower
B		F.W.C. (Fresh Water Cooler)
B		Gauge panel
B		Smoke indicator
B		Burner-and related parts
B		Exhaust gas economizer
B		Double evaporation boiler
B		Separator drum

Col.7	col.8	Description (Trade & Fitting)
A		Auxiliary machinery"
A.	T	T/G (Turbo-Generator)
A	D	D/G (Diesel Generator)
A	c	C.O.P.T. & B.W.P.T. (Cargo Oil Pump Turbine & Ballast Water Pump Turbine) .
A	E	Emergency generator
A	F	Emergency fire pump
A	s	Steering gear
A	R	Rudder
J		Propeller-shaft
J	s	Spare propeller shaft
J	P	Propeller, propeller fastening devices
J	I	Intermediate shaft
J	T	Propeller shaft
J	B	Intermediate shaft bearing. (including thrust bearing, aftmost bearing, overhang bearing)
J	E	sealings and washers
J	D	stern bearing (tube), lignum vitae, cutless bearing
J	R	Revolution meter and shaft grounding device
J	Y	Spare propeller
J	J	Bulkhead stuffings

C01.7	C01.8	Description (Trade & Fitting)
z		Miscellaneous .
z	N	Marking tapes, name plates for valves, caution plates
z	T	Thermometers and their cases
z	H	Skylights, hatches
z	c	Covers for fly-wheel and couplings
z	B	Stowage boxes for chain blocks
z	D	Doors (except for shaft tunnel), wire nets
z	E	Eye plates
z	M	Bolts & gaskets for manholes
D		Joiner work in engine control room and workshop
D	T	Fitting pieces for joiner
D	M	Joiner fittings
D	X	Furnitures
D	D	Deck covering
D	I	Insulation
	z	Fitting (welding) of materials temporarily installed at preceding stages (pallet for fitting work and not for preparation of materials)

6. Guidance for Sub-division of a Pallet on Piece Outfitting On-block and Unit Outfitting

6.1 General

- a) No sub-division is applied to a pallet of machiner], steel fittings (gratings; handrails, etc.) and pipe fittings (valves, filters, etc.).
- b) A pallet for pipes may be so sub-divided as to group about 30 pieces of pipe in each sub-division.
- c) When the joiner fitting in the engine control room and workshop is carried out on-block (grand block) the ML(F) shall be numbered according to the numbering system for piece outfitting onboard. In Such a Case, Column 3 of MLF-No. shall be "K" and sub-division shall be made same es piece outfitting onboard.
- d) Outfitting of steering gear by unit is made as detailed herein.

6.2 Sub-division Guidance (Except Steering Gear Unit)

Col. 10	Description
0	a) Auxiliary machinery, valves, joint pieces, eye plates (except. stock materials). <i>Spectacle flanges, expansion joints, special gaskets & bolts, foundation seats for auxiliary machinery, supports for gratings and floor plates, pipe bands (excluding stocked ones), penetration pieces, manholes, scupper washer, grids for seachests, coatings (excluding stocked ones), tanks, window sashes of control room, remote-operated closing devices, doors, ventilation trunks, air passages in funnel, gratings, ladders, vibration, absorbers, spring hangers, trolleys, zinc plates in seachests.</i> b) All fittings installed at block stage "H" by hull construction dept. such as bottom plugs, safety gratings for holes, eye plates for lifting propeller. c) p i p e s
1 - 7	Pipes
8	Insulation materials
9	Spare number

6.3 Sub-division Guidance for Steering Gear Unit

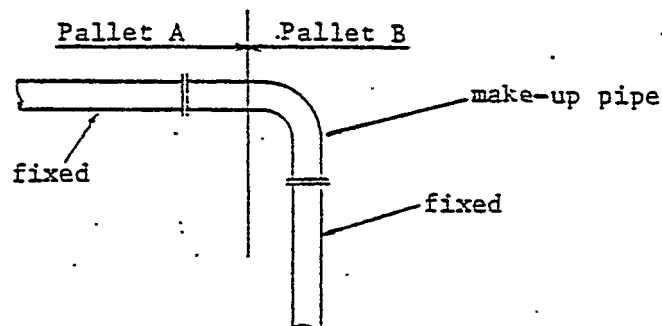
Col. 10	Description
1	Tiller, carrier key, tiller key
2	Weld liners
3	Common bed, chock liners, foundation bolts, side stoppers
4	Steering gear, accessories
5	Rudder carrier, foundation bolts, side stopper, bearing
6	Electric parts

7. Guidance for Subdivision' for Piece Outfitting Onboard

7.1 Piping....."P"

1) General

- (1) subdivision shall be made in order of fitting work of each material.
- (2) Workload shall be leveled appropriately for one pallet.
- (3) Number of pipes in one pallet shall be about-30 excluding make-up pipes, but pallet weight shall include all pipes.
- (4) Pipe fitting pieces such as supports, bands, boks, etc., shall be included in the pallet of corresponding pipes.
- (5) Make-up pipes (short pipes to connect the corresponding pipes (of same system) of two adjacent pallets, and dimensions of which are decided after installation of the two pallets), shall be included in eithex one of the pallets.



- (6) Materials to be included in the pallet as the "blue sky" stage shall be those with weights over 30 kg each and suitable for "blue sky" fitting. some materials with weight less than 30 kg may be installed at the "blue sky" stage, if convenience.
- (7) Some materials to be installed at *the* "blue sky" stage in a certain zone whose installation date is different from others, may be grouped separately by applying subdivision.
- (8) Spring hangers, vibration absorbers (including fitting stands and seats) shall be grouped into subdivision 9.
- (9) L. O. piping for the stern tube shall be installed at the "blue sky" stage.

2) Subdivision guidance

Col. 7.8	Col. 10	Description	Remarks
PA	0 1 - 9	No subdivision (one pallet) Sequential for two or <i>more</i> pallets	Detailed materials to be same as "P-"
P-	0 1 - 8 9	No subdivision with pipes less than 30 pieces Sequential; pipes, valves, joint pieces, expansion joints, rose boxes, pipe bands, blind flanges, small <i>tanks</i> , L.O. pipes for seal- ing of stern tube, sounding head valve, saw dust supplier. Spring hanger, vibration absorber	

7.2 Control and Automation System "C"

Col. 7.8	Col. 10	Description	Remarks
CA	0	No division	* A pallet is to made for each flat
	1 - 9	Sequential	
C-	1	Control & automation equipment & foundation seats; gauge panels (with fitting pieces), gauges, transmitters, limit switches, controllers, pressure switches, manometers, air purge unit, solenoid valve panels, seats for panels, meters and their seats, pressure control system for L. O. for stern tube.	
	-2	Pipes and pipe fittings; pipes (10 mm in dia. or less), pipe joints, valves (100 or less), pressure reducing valves, 3-way valves, pipe guards, special flanges, plugs, gaskets, pipe bands, gauge packings, supports for multiple pipes, supports for vinyl pipes, oil sprayer, seal pot, etc.	
	3	Multiple pipes and the terminals.	
	4	Vinyl pipes for CO ₂ analyzer	

7.3 Traffic System "K"

1) General

- (1) Subdivision shall be made as to group materials of similar function in order of installation sequence.
- (2) Materials to be installed at "blue sky" stage shall be those that are installed before assembled unit(s) .
- (3) combinations of "-2" and "-3", "-4" and "-5", "-6" and "-7" show the materials to-be installed together.
- (4) Material, installation of which is started very late in one zone, shall be grouped into "-9."

2) Subdivision Guidance

Col. 7.8	Col. 10	Description	Remarks
KA	0	Materials to be installed before assembled unit(s)	
K	1	Stanchions, hand rails, round bars, stays, end pieces, flat bars for coaming around the gratings.	- Number of gratings in one pallet shall 10 in principle. If no problem all gratings one zone may grouped in one pallet. - Materials of "-2" shall correspond to ones of "-3."
	2	Grating supports, furrings	To be installed together
	3	Gratings, floor plates, inclined ladders, vertical ladders, steps, manholes, pillars for floor plate	
	4	Same as 2	-Do-
	5	Same as 3	
	6	Same as 2	-Do-
	7	Same as 3	
	9	Materials to be installed late	

7.4 Machining and Adjusting "G"

1) General

(1) Materials to be installed at "blue sky" stage shall be subdivided into the following two pallets in order of installation sequence, if necessary.

a) Materials to be installed immediately after erection of the deck or flat.

(b) Materials to be installed *'after* installation of foundation seats or similars at prior stages and before installation of assembled . units *or* erection of overhead blocks.

(2) Materials to be installed at other than "blue sky" stage, shall be grouped by their functions.

(3) One pallet shall be made per flat or deck, in principle. However, only one *or two* pallets may be enough for a whole ship in the case *of* a certain material, as remarked herein.

2) Subdivision Guidance

Col 7.8	Col. 10	Description	Remarks
GA	0	No sub-division	
	1	See 1), (1) "a) above. "	
	2	See 1), (1) b). above.	
		Materials to be included in 0 - 2 are: overboard penetration pieces and brackets, shipside (sea water suction or overboard discharge) valves with Packing bolts, washer for echo sounder (including log sonar), bilge hat cover, incinerator, seats for fan motors and stuffing boxes for pump room, watertight doors of shaft tunnel, main L. O. pump and guide, machining tools (universal machining tool, lathe, boring machine, grinder, electric saw, hose reel, gas welder, electric welder), fittings in control room, CO₂ meter, sampler, cooler, basin, water fountain, toilet unit, wash basin, unit cooler, COP local control panel, FWC control box, local gauge board for M/B, local gauge board for boiler, sterilizer, chemical cleaning device for heat exchanger, boiler fan, hychrorator, aux. condenser, calorifier, ref. machine, air-tank, compressor, emergency fire Pump, air tank and compressor for emergency fire pump, air tank for emergency shut-off valve, sampling cooler with piping for control, hydrofore tank for drinking water.	

Col. 7.8	Col. 10	Description	Remarks
GS	0	Fittings for seachests and cathodic protection (seachest grids, zones & bolts).	To be grouped into 3 pallets for respective 3 zones M1F, M1M, and M1A per ship, in principle.
GR	0	Hadle lock for valves	1 pallet/ship, in principle.
GW	0	Wiring system (steel wire & wiring fittings)	--Do--
GD	0	Damper controller	-Do-
GE	0	Remote operation devices for emergency valves and doors, etc.	"
GB	0	Pipe bonding strips	"
GV	0	Sea water suction and overboard discharge valves, bolts & nuts, distance pipe pieces	To be palletized by zones (M1F, M1M, M1A) and flow direction (suction, discharge)... Total 6 pallets/ship, in principle.
GT	0	Tank fittings, level gauge, level indicator (scale), float switches, thermometer bosses, cocks with lock.	1 pallet/flat, in principle
GF	0	Emergency fuel oil stopping device	

Col. 7.8	Col. 10	Description	Remarks
GH	0	Extension spindles for valves	1 pallet/s in princip
GL	0	Liners, bolts & nuts for aux. machinery	
GZ	0	Miscellaneous; Sight window of pump room, trolley stopper, etc.	

7.5 Ventilation Trunk "T"

In principle, subdivision by Col. 10 is not applied unless specially required. If required, subdivision shall be numbered in order of outfitting sequence.

Col. 7.8	Col. 10	Description	Remarks
TA	0	Unit or materials to be installed before erection of the block ("Blue sky" stage)	
T-	1 { 8	Main trunks, branch trunks, ventilation fans & foundation seats, expansion trunks, supports, bolts & nuts, gaskets, terminal trunk*	* Terminal trunk shall be put into the last pallet.
	9*	Materials whose installation is very late (damper handle, etc.).	* "-9": 1 pallet/ship

7.6 Foundation Seat "F"

Col. 7.8	Col. 10	Description	Remarks
FA	0	No subdivision	Material to be installed at "Blue sky" stage shall be those that are fitted or temporarily fitted before installation of a unit or erection of the block.
	1	Seats for aux.machinery and tanks, foam coaming, pipe	
	9	Coamings, deck coaming, sub-materials for aux. machinery seats, units	
F-	0	No subdivision	Pipe coamings and deck coamings treated as stock material are not palletized at this stage.
	1	Seats for aux. machinery and tanks, foam coamings, pipe	
	8	coatings, deck coamings, sub-materials for aux machinery seats, etc.	
	9	Materials whose installation is. very late.	
Fx	1	Seats for spare parts fitted on the hull shell (to be installed before units).	To be installed at "Blue sky" Stage.
	2	Seats for spare parts fitted on units (to be installed after units)	
	3	Seats whose installation is very late (hook for handle rotator, etc.)	

7.7 Funnel Part. . . "U"

Col. 7.8	Col. 10	Description	Remarks
UA	0	No sub-division	Materials installed at "Blue sky" stage shall be assembled into large unit before installation
	1 }	Sequential numer	
	9		
UE US UH	1	Stack (uptake), supply air duct; main engine, exhaust gas pipes, expansion joints, bolts & gaskets for flange, ladders (inside) sleeves, supports with bolts	
	2	Streight uptake & upper funnel, spring hangers, blind plates for branch pipes near the outlet of inert gas, angle supports of , insulation material.	

7:8 Insulation "I"

No sub-division is applied in principle.

7.9 Spare parts, Accessories "X"

Col. 7.8	Col. 10	Description	Remarks
XA	0	No sub-division	"Blue sky" stage
	1	Materials to be installed immediately after installation of a block or on unit	
	2	Materials to be installed after installation of foundation seats for them.	
X-	1.	General spare parts and accessories	
	2	Small spare parts storable in the steel cabinet.	

7.10 Main Engine "E"

Col. 7.8	Col. 10	Description	Remarks
ED	1	Main bodies	
EH			
EL	2	Installation liners (welded)	
ER			
ET			
EC	3	Installation liners (chock), bolts, M/E, side stoppers	
	4	Fittings Pipes, valves, orifices, bolts	
	5	<i>Fittings</i> Gauge for installation, jigs for shaft alignment, seats for jacking Up test for 2nd wheel, F.O. handles	
	6	L. O. discharge Pipes for the crank case (lower)	
	7	-Ditro (Upper)	
	8	Materials to be used just before the trial of M/E such as sight glass to bubbler pipes, water level gauge, float switch, etc.	
	9	Miscellaneous	

7.11 Boiler "B"

Col. 7.8	col. 10	Description	Remarks
BB	1	Main bodies	
BH			
BC	2	Installation liners, bolts, seats	
BS			
BF	3	Fittings (vendor's supply)	
BG			
BI	4	Fittings (other than vendor's supply)	
BH			
BL	9	Miscellaneous	
BE			

7.12 Auxiliary Machinery "A"

Sub-division shall be made so as to group materials by their functions. Sub-division is not applied to steering gear rudder plate, in principle.

Col 7.8	col. 10	Description	Remarks
A T	1	Main bodies	
AD			
AC	2	Installation liners (welded)"	
AE			
AP	3	Instllation liners (Chock)	
	4	Fittings	
	9	Miscellaneous	
As	0	Bush bolder or lignite bush, bush stopper	
AR	0	Rudder stock, rudder plates, coupliag bolts, (With Stoppers), pintle for cement, cement, rudder cover	

7.13 Propeller Shaft "J"

Col. 7.8	Col. 10	Description	Remarks
JS	1	Main bodies (JP includes propeller fastening devices, propeller nut and CPP)	
JP			
JT			
JB	2	Installation liners (welded)	
JE			
JD			
JR	3	Installation chock liners and bolts	
JY			
JJ			
	4	Fittings (vendor's supply)	
	5	Fittings (other than vendor's supply)	
		JP stuffings	
		JD lignum vitae, cutless bearing, etc.	
	6	Coupling bolts	
	9	Miscellaneous	
		JP anti-corrosive zinc, etc.	
J1	1	Sequential by each intermediate shaft (in case of two or more int. shafts)	
	8		
	9	Joint bolts & nuts	

7.14 Miscellaneous "Z"

Sub-division shall not be made (i.e., one pallet per ship) except for ZT (two pallets per ship), in principle.

Col. 7.8	Col. 10	Description	Remarks
ZN	0	Marking tapes, nameplates for valves, caution plates	1 pallet/ship
ZT	1	Thermometers & cases (for stern tube)	2 pallets/ship
	2	-Do- (others)	
ZH	0	Skylights, hatches	1 pallet/ship
ZC	0	Flywheel cover, coupling cover	"
ZB	0	Stowage boxes for chain blocks	"
ZD	0	Doors (except for shaft tunnel),	"
ZE	0	Eye plates (specially ordered)	" Eye plates treated as stock material not to be listed in MLF.

7.15 Joiner Work in Engine Control Room and Work Shop "D"

Col. 7.8	Col. 10	Description	Remarks
DT	1	Fitting pieces	
	2	Coamings	
	3	Fitting pieces for ceilings	
	4	Steel joist	
	5	Window sash	
DD	1	Cement	
	2	Titles	
DM	1	Base ceilings of walls	
	2	Base ceilings of ceiling	
	3	Finish linings of walls	
	4	Finish linings of ceiling	
	5	Entrance doors	
	6	Windows	
DI	1	Heat insulation of walls	
	2	Heat insulation of ceilings	
DX	1	Furniture	

7.16 "-" Fitting (welding) of materials temporarily installed at preceding stages.

This-pallet is for fitting work and does not include physical materials. MLF for this pallet is automatically made by the computer based on the key sign for temporary installation at preceding stages. For each designated zone, the pallet with MLF-NO. could be made, but normally, one pallet per flat or deck is made and subdivision by Col. 10 is not applied.

Col. 7.8	Col. 10	Description	Remarks
-Z	0	Fitting of temporarily installed materials at preceding stages.	

CHAPTER VI - AN INTRODUCTORY EXAMPLE OF PALLETIZATION ON NASSCO'S DRAWINGS

1. Introduction

In May, 1979, we (IHI Engineers)" visited NASSCO to make a basic survey on outfitting system currently applied at NASSCO and had discussions and meetings with relevant people from Design *Engineers* to Field Supervisors.

Through discussions with Design Engineers we learned that NASSCO had already utilized composite drawings for some congested outfitting compartments like engine *room* for development of working drawings though the composite drawings were used only for clearance of interference between different systems such as steam piping system and cooling sea water piping system;

We brought back to Japan some of the composite drawings of the machinery space of San Diego class 185,000 DWT oil tanker and tried to make an example of palletization (pallet list and MLF) based on them to give concrete idea of palletization.

Based on IHI standards and some assumptions our design engineers made a partial and tentative palletization as introduced herein.

The attached copies of NASSCO's drawings are the result of the tentative palletization and to be referred to concurrently with the-description of this chapter.

As we did not get all the details about hull structure or machinery arrangement of the engine room; there might be some misunderstandings of the drawings by our design engineers. So, it is recommended that NASSCO shall complete the palletization on these drawings correcting misunderstandings, if any, by themselves in the same manner introduced by this example.

2. Assumption

As described in the preceding chapters, palletization is made by stage, zone and trade in principle. In other words, block segregation, zoning and partition of outfitting pares except details etc. should be decided before starting of composite drawings and pallet-making.

For introduction of an example of palletization on NASSCO'S drawings, we applied some assumption concerning block arrangement and zoning as follows:

2.1. Block Arrangement

As we are not *familiar* with NASSCO'S way of block segregation, we assumed the hull block arrangement as shown in Fig. 6-1. In Fig. 6-1, pallet names at on block stage are also given. BLock name is given in the parentheses and pallet name under respective number in circle.

IHI has a standard for block naming and the block name in Fig. 6-1 was decided according to this standard.

For example,

<u>DB</u>	<u>1</u>	<u>P</u>	
			Portside
			<u>First from fore</u>
I			<u>Double bottom</u>

LS 2 S

| . | Starboard side
| Second from fore
| Lower shell

2.2 Zoning

Zoning is assumed as Fig. 6-2. The number given for each compartment in Fig. 6-2 defines Level B and C of the zone symbol as described in Chapter III. This example is for the machinery space and the initial letter for Level A. "shall be "M". Namely, zone name in full will be;

MLL, M12, M22, M23 etc.

All materials to be outfitted onboard are palletized based on this zoning and the zone name (= zone symbol) is used as a part of MLF-No. (See Chapter IV, V)

2.3 Staging

Three stages are applied to this tentative palletization on the ground that pre-erection outfitting is applied.

The three stages are;

on-block stage (Blue)

Unit stage . (Green)

Onboard stage (Pink)

At first we studied at what stage each material should be installed and what materials could be grouped into units (machinery unit, piping units etc.) in consideration of convenience of outfitting work, sequence of installation, block arrangement and zone. And then we grouped materials into pallets by block, unit and zone.

In the attached NASSCO's drawings, material to be outfitting on-block stage are identified by blue color, *unit* stage by green color and onboard stage by pink color.

2.4 Machinery Name

In-NASSCO'S drawings we brought back, -no system or machinery name is given though the system number like (209-03) or

— (514-09) — is provided for each system. We guessed the

system and machinery names from the drawings for identification of pallet as written in the drawings.

FIG. 6-1 - ARRANGEMENT OF FULL BLOCK AND PALLET ON BLOCK

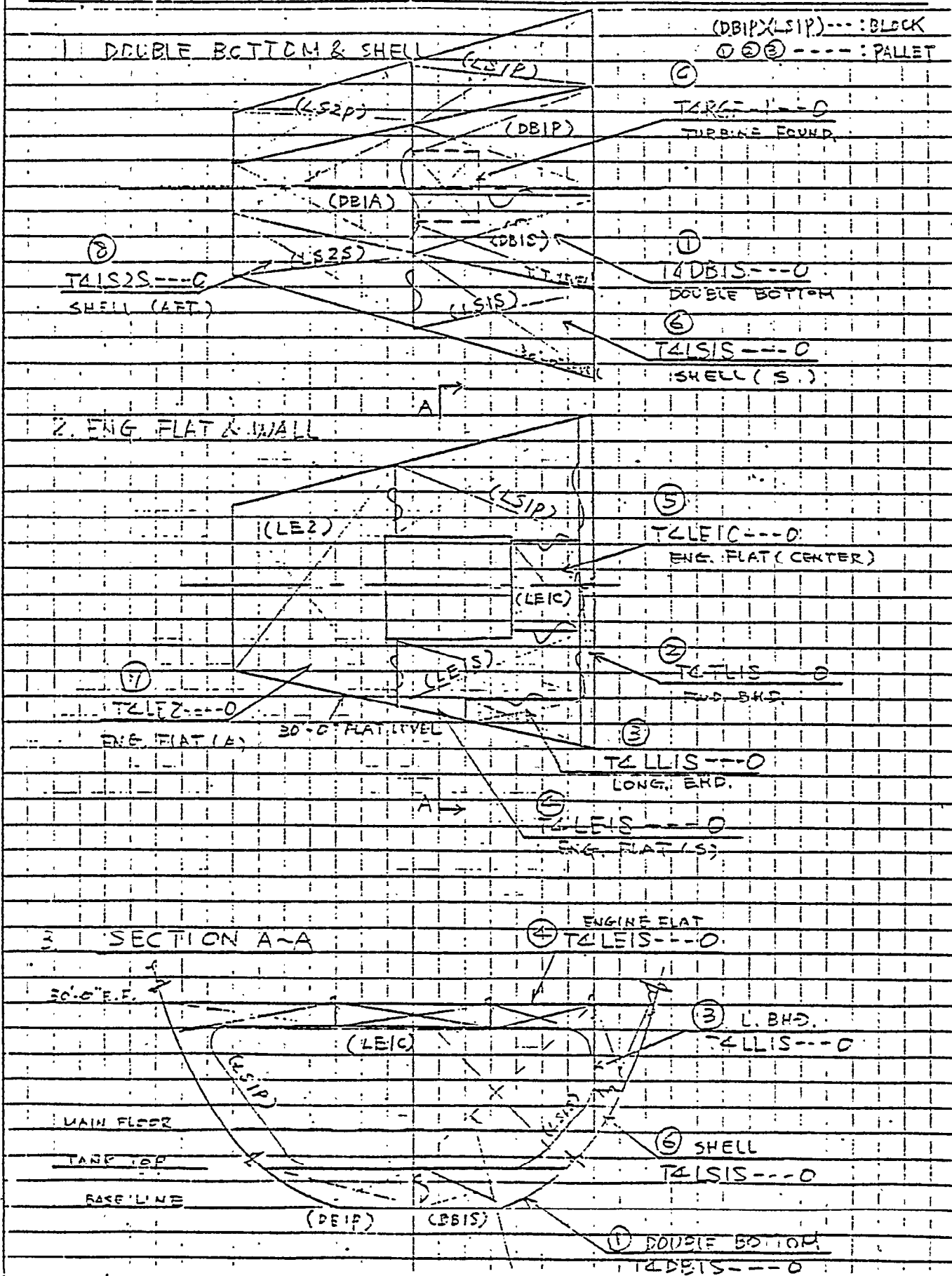
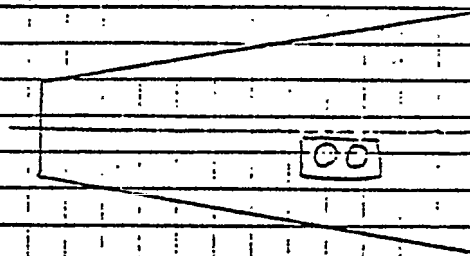


FIG. 6-2 ZONING OF ENGINE ROOM

DOUBLE BOTTOM



ENG. FLT.

51

71

35

71

21

35

MAIN FL.

T. TOP

11

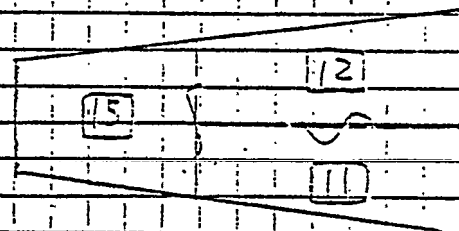
12

15

D. R.

50

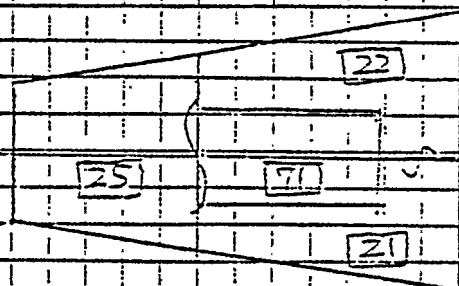
MAIN FLOOR (UNDER)



SECTION

MAIN FLOOR (UPPER)

ZONE SYMBOL



M

1

1

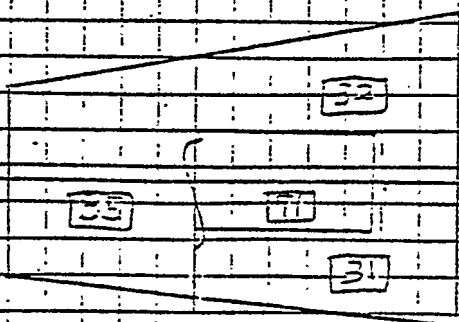
Level

Level B

Level A

ENG. FLAT

(See Chapter I)



32

35

71

31

3. Pallet List

Sample pallets are listed in the pallet list of Fig. 6-3. MLF-No. is coded in accordance with the coding guidance introduced in Chapter V with exception for on-block stage. In the Pallet list of Fig. 6-3, MLF-No. of on-block pallets is coded as

Col	1	2	3	4	5	6	7	8	9	10
	T	4	D	B	1	s	-	-	-	0
	I									
or	T	4	T	L	1	s	-	-	-	0
	I					Block name				

As may be noticed, the substage of hull block assembly such as "A. ..Assembly" or "B. ..Back assembly" which is to be identified by column 3 according to the guidance of Chapter V is omitted here. This is only for this example and in "actual palletizing " the substage must be clearly given.

There are many pallets as shown in the drawings, but all pallets are not listed in the. pallet list of Fig. 6-3. "It is recommended for NASSCO to complete grouping the remaining materials into pallets and make pallet list as a practice.

6-3 (1/2)

-MLF. NO. 出図依頼表

PALETTE

LIST. ($\frac{1}{2}$)

· 物理 1. 内容 2. 修正 3. 消去

• 5 4 1 2 3

目錄改正

世新報

未修正

[illegible][illegible]

MLF. NO. 出図依頼表

一、修改 1.内容 2.格式 3.图表

117改正 — { 116現
 115正

[illegible]

4 - 1 Ma	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

[illegible]

4. MLF (Material List for Pallet)

For a typical pallet at each stage, we tie a MLF assuming major information like piece number or weight of material etc. as shown in Fig. 6-4: *Minor* information to be contained in actual MLF are omitted here for simplification.

As for explanation for each column, the Article 2.4 of Chapter II should be referred to.

4.1 On-Block Stage

Fig. 6-4 (1/5) shows the MLF for (9) piping pallet "T4RGF-2-0 on-block taken up as an example. This pallet is installed on the hull block "RGF-1" at pre-erection stage. All materials to be outfitted on "RGF-1" at pre-erection stage including pipe supports, gaskets or bolts and nuts should be grouped into this pallet as listed in Fig. 6-4 (1/5).

All materials are prepared by this pallet and delivered to the block site to be outfitted at appropriate stage of block assembly, and proceeded to the next stage with the block.

In general, materials to be fitted at on-block stage should be;

Pieces directly fitted to hull structure such as manholes, penetration pieces, corrosion protection zinc etc.

pipes, ventilation ducts or electric cable trays which are laid right above or beneath the decks and flats, or near the bulkheads and steel walls.

Fittings directly welded to the hull structure in the cargo hold such as vertical ladders, steps, sounding pipes of **tanks**; foundation seats for deck machinery etc.

Pipes, valves, suction mouths or any *other* fittings located in the enclosed spaces workability in which at later stage-is very bad such as double bottom or deep tanks.

In making on-block pallet, size and segregation of z pallet, location of pipe joints and time of installation etc. are *to be* so decided as not to disturb hull construction work badly ,or in consideration of subsequent outfitting work and facilities availability. For example, a pipe must not overhang a block nor be located at a place which requires very careful positioning of adjacent *or* upper hull blocks at erection to avoid damage. And position of pipe joints should be decided to minimize the number of make-up pipes. The best efficiency of shipbuilding in total span including both hull construction and outfitting must always be in mind for Planning of Palletization.

←

4.2 Unit Stage (On-block and Onboard)

Taking up 16) condensate pump unit (machinery unit) as an example, the HLF for this unit "B4X152-----0" is listed in Fig. 6-4 (2/5), (3/5). The number "152" in the MLF-NO. is machinery number for a condensate pump given by shipyard's design standard.

This pallet of unit includes pipes, valves, expansion joints "gaskets, foundation seats for the pumps as well as two sees of condensate pumps and motors.

The all materials are assembled into one unit in the unit assembly shop and installed in "zone "zone M12" at "Blue skystage", or in the case of IHI, the assembled machinery unit is installed on the grand block (large block composed of two or more unit block) which is temporarily located in the roofed unit shop for concentrated unit outfitting before erection. Connection of systems between units are completed as much as possible at this stage.

Materials to be installed by unit shall be, in general, auxiliary machinery and seats, pipes, valves and other pipe fittings in their vicinity which can be grouped into one unit with the machinery, a group of pipes running through a same zone which can be outfitted with pipe fittings, if any, on common supports, or components whose

fittings can easily be fitted in a shop before erection such as radar masts, steering gears" or miscellaneous tanks.

Indecision of units, the best stage at which each material is installed (on-block or onboard), location of machinery, pipes, ducts, cable etc., boundary of units, necessity and best position of make-up pieces and so forth should be taken into account.

These points are studied based on the composite drawings at planning stage, and therefore the composite drawings must be worked out paying attention to these points. For this purpose, as discussed before, the draftsmen of the composite drawings must be familiar with outfitting procedure or method at production site or collect necessary information or knowledge from production people.

4.3 Onboard Stage (Fig. 6-4 (4/5), (5/5))

The sampled pallet is "T4ZMLlp--0". This MLF-No. implies this pallet is piping pallet onboard and in zone M1l. All pipes and pipe fittings located in the zone MLL are compiled in this pallet.

As may be understood, the materials to be outfitted on-board shall be;

Heavy machinery which cannot be installed at preceding stage such as main diesel engine, main boiler, main turbine, reduction gear for propulsion etc.

Machinery or components which cannot be installed before the hull construction is completed. or need precise adjustment when installed such as steering gear, main turbine, reduction gear, rudder, propeller; propulsion shaft etc.

Deck maching except those in the machinery space or accommodation which installed at grand block stage such as windlass, mooring winches etc., or deck fittings like boat davits, masts, derrick poses etc.

° Pieces whose location, size or connection with other systems cannot be decided at preceding stages or are better to be decided at onboard stage, such as make-up pieces and distance pipe pieces between" machinery unit and hull shell.

° Machinery or-equipment which could be damaged stalled at preceding stages such as electric measurement equipment or furnitures.

In general, it is recommended to outfit materials as many as possible at earlier stages for better outfitting efficiency, but hull construction efficiency declines due to pre-erection outfitting to a certain extent. Shipbuilding efficiency in total span in case pre-erection outfitting is applied depends on availability of material preparation area and facilities, punctual receipt of materials from the vendors, close interrelation between different trades or shops, size of blocks etc. as well as size and type of the ship. Therefore careful study among every section involved is necessary as to whether and to what extent pre-erection outfitting shall be applied at NASSCO.

Fig 6-4.(1/5)

MLF (On Block)

※ 1. 型式 2. 寸法 3. 材質 4. 仕様 5. 備考

3. 寸法 4. 仕様 5. 備考

6. 仕様 7. 備考

8. 仕様

1. 仕様 2. 仕様 3. 仕様

4. 仕様 5. 仕様 6. 仕様

1. 型式 2. 寸法 3. 材質 4. 仕様 5. 備考

6. 仕様 7. 備考

8. 仕様 9. 備考

SOT-A210201 仕様

1. 仕様

2. 仕様

1. 仕様 2. 仕様 3. 仕様

4. 仕様 5. 仕様 6. 仕様

7. 仕様 8. 仕様 9. 仕様

1. 仕様 2. 仕様 3. 仕様

4. 仕様 5. 仕様 6. 仕様

7. 仕様 8. 仕様 9. 仕様

品名	部品符号	引当指示項目 (コメント)	数量	重量 (kg)	単位	引当箇所	仕様	部品コード	備考
PIPE	Q-P-1	6"	1	165	F35	ステージ移行			
	Q-P-2	6"	1	165					
	Q-P-3	6"	1	128	F82				
	Q-P-4	8"	1	145	F35				
	Q-P-5	6"	1	116					
	Q-P-6	6"	1	120					
	Q-P-7	6"	1	67					
	Q-P-8	4"	1	30					
	Q-P-9	2"	1	18					
SWING CHECK VALVE	Q-LV-1	CAST IRON 125" 8"	1	160	F35				
GASKET 150" 8"			1						
			1						
BOLT, NUT SS W 3/4" x 3 1/2"			8	16					

Fig 6-4 (7/5)

MLF (Unit 1/2)

※第1品目は0.1m 1台用 (1000mm) 2.台用 (1500mm)
3.全周用 4.1/2周用 (1000mm) 5.1/2周用 (1500mm)
6.1/2周用 7.1/2周用

1.式組立本機 2. 3. 4. 5. 6. 7. 8. 9.

※第1品目は0.1m 1台用 (1000mm) 2.台用 (1500mm)

SOT-A100201 5M

※第1品目は0.1m 1台用 (1000mm) 2.台用 (1500mm)

1.式組立本機 2. 3. 4. 5. 6. 7. 8. 9.

1. 引当品 2. 引当品
3. 引当品 4. 引当品
5. 引当品

品名 材質・型式・規格・寸法	部品符号	引当指示項目 (コメント)	数量	重量 (kg)	引当箇所 ステージ移行	積込品コード	備考
PIPE	⑩-P-1	1/2"	1	7			
	⑩-P-2		1	7			
	⑩-P-3		1	9			
	⑩-P-4		1	8			
GLOBE VALVE BRASS 1 1/2" 150#	⑩-V-1		1	3			
	⑩-V-2		1	3			
BUTTERFLY VALVE CAST IRON 8" 125#	⑩-V-3		1	25			
	⑩-V-4		1	25			
EXPANSION JOINT RUBBER 8" 150#	⑩-E-1		1	12			
	⑩-E-2		1	12			
GASKET 150# 1 1/2"			6	6			
			4	8			
BOLT/ NUT SS W 1/2" x 2 1/4"			24	24			
			32	64			

品名	MLF - No	作業開始日	次のステージ
77:7	B1X152---0		

電検長	バット重量	管理重量	積込重量	注
				1/2

M L F (Unit $\frac{3}{2}$)

日 次 与 日 日
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31

Fig 1-4 (4/5)

M L F (On Board 1/2)

8管 5.1A外 0加1.管 1合せ管 (外周げ本管) 2.合せ管 (外周げ本管)
3.全管管 4.外管管 (外周げ本管) 5.外管管 (外周げ本管)
6.現場用1管 8.バルブ

1.式解用4.改 2. 3. 3g 4. m 5. m² 6. m³ 7. 1000m² 8. 1

取替サイン 1.止のステージのM.L.F.No
取替サイン 2.出のステージの M.L.F.No

SOT-A220201事項

取替品承認
1.管理承認

1. 引当購入品 2. 外周購入品
3. 加工外品 4. 引当貯蔵品
5. 貯蔵品

作成年月日
.

品名 目録・型式・規格・寸法	部品符号	引当指示項目 (コメント)	数量	重量	単位	引当箇所 ステージ移行	取替品コード	備考
PIPE ↓	(21)-P-1	4"	1	24	kg			
	(21)-P-2	4"	1	22	kg			
	(21)-P-3	1 1/2"	1	9	kg			
	(21)-P-4	2 1/2"	1	10	kg			
	(21)-P-5	10"	1	68	kg			
	(21)-P-6	3"	1	26	kg			
GATE VALVE CAST IRON 2 1/2" 125"	(21)-V-1		1	6	kg			
GASKET 150" 10"			2	5	kg			
↓ 4"			4	4	kg			
↓ 3"			2	2	kg			
↓ 2 1/2"			3	1	kg			
↓ 1 1/2"			2	1	kg			

番 号	M.L.F. - No	作業開始日	次のステージ
7777	1421411P-0		

電検員	バレット重量	管理重量	搭載重量	頁
				1/2

M L F (On Board 2/2)

[illegible]

5. Relocation of Pipes

Yellow colored pipes in NASSCO'S drawings show examples of re-located pipes. These pipes, if arranged by IHI, would be re-located to the routes shown in the drawings (system Nos. 210-01, 511-01, 508-02, 211-01). By this relocation each pipe can be easily included in the *respective* unit nearby the pipe.

Fig. 6-5 is another example of relocation of pipes. As shown in Fig. 6-5, pipes are staged by its location, i.e., pipes marked B are installed on block, pipes and valves marked $\textcircled{U}$ -1 and $\textcircled{U}$ -2 are grouped into units with No. 1 and No. 2 Fresh Water Circulating Pump respectively and mak-up pipes (loose pipe) marked $\textcircled{E}$ are fixed on board.

The assumptions for above relocation are;

- 1) Machinery location is not changed.
- 2) Bending angle of pipes is limited to 90 or 45 degrees in principle for manufacturing of accurate pipe pieces, easiness. of drafting drawings and adjustment of make-up pipes *on board*.
- 3) Pump, foundation seat for the pump, pipes and pipe fittings are assembled into a unit in the unit shop and installed together. Units U-1 and U-2 are lifted by crane and installed separately on board.

- 4) The make-up pipes between two adjacent units, if any, are cut in required length with excess or loose flanges before erection by setting the two units in the relative position temporarily in the unit shop.
- 5) The make-up pipes marked E in Fig. 6-5, are measured in length on board and finished in the pipe shop thereafter

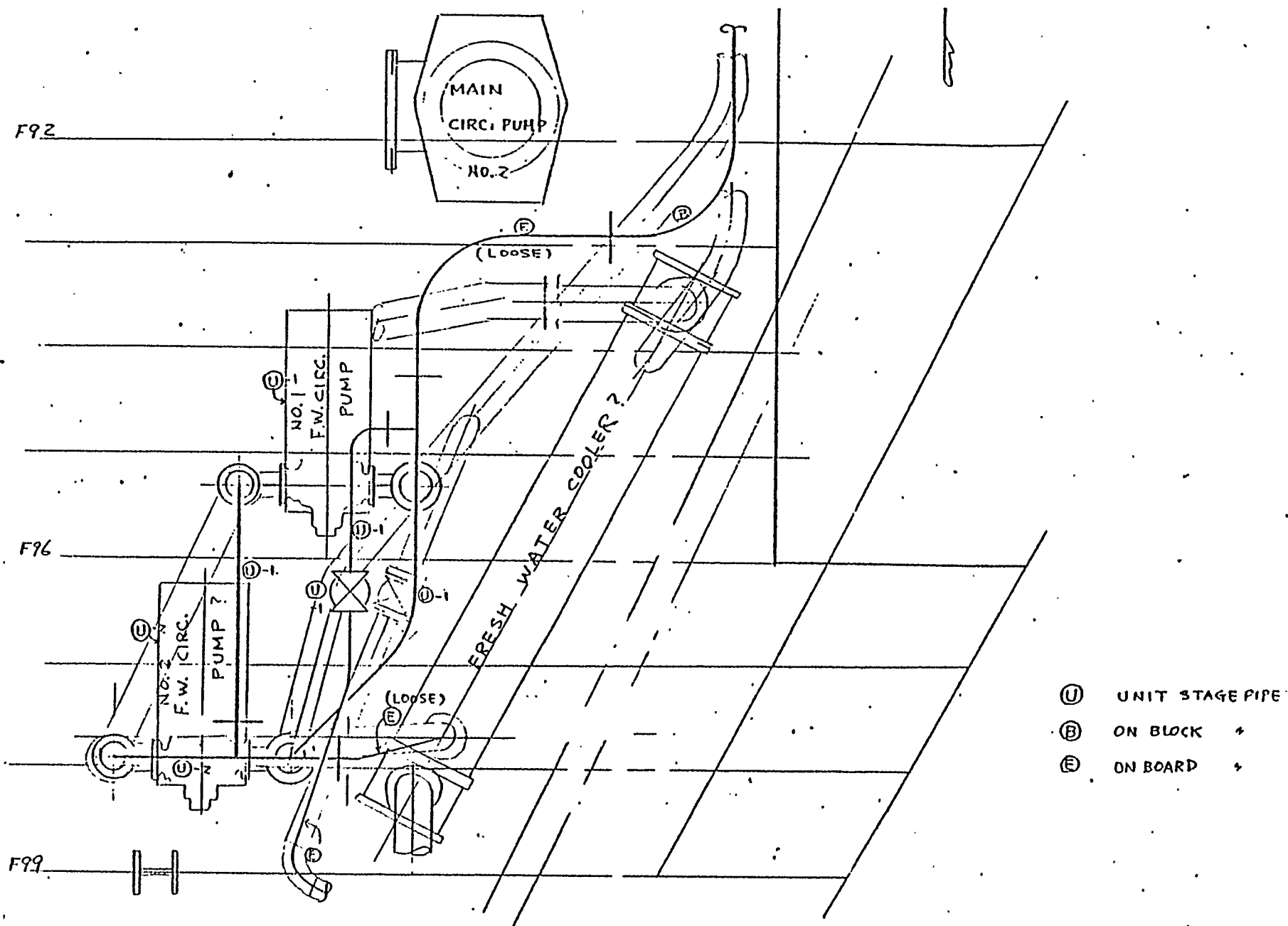


Fig 6-5 FRESH WATER PUMP UNIT

6. Other Notes on NASSCO's Drawings

In addition to the facts described already, the followings are pointed out as recommendation or reference for NASSCO

- 1) To make composite drawings with minimum design manhour and error, or to maintain consistency in the quality of the drawings, development of technical standard including system and piece numbering standards or form of MLF is strongly recommender.
- 2) A composite drawing shall include all materials and necessary information for outfitting as many as possible including hull structural information such as system No., piece No., location (three dimensional) of pipe supports, flange reducers, strainers, sleeves, block joints, zone boundary, unit boundary, pallet boundary, flow direction, work lot number, dimension and position of web frame or irregular hull structure etc.
- 3) To make a composite drawing sale or to express information clearly, most of the pipes except extra large one are drawn by one line and many symbol marks for fittings are used (See example of 'IHI's composite drawing in the following Chapter).
- 4) Computer program for developing pipe piece drawings from composite drawings used in IHI is a very powerful tool for design manhour reduction and manufacturing of accurate pipe pieces.

CHAPTER VII - AN EXAMPLE OF PALLETIZATION ON IHI'S DRAWINGS

In this chapter, an example of actual palletization in XI IHI is introduced based on its composite drawings.

1. Composite Drawings

Attached two plans are the sampled composite fitting plans of Main Floor and Lower Engine Flat of a 1,854 TEU container ship actually built in IHI Rure Shipyard recently.

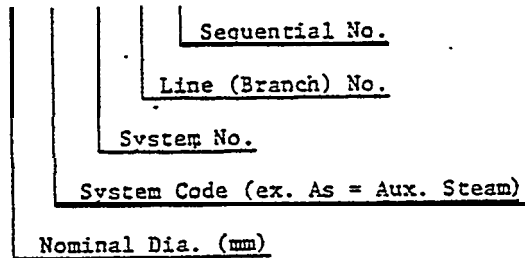
Both drawings are for outfitting of *pipng* system and machinery at all stages. Ventilation ducts, traffic system like passage way, electric equipment and electric cables are outfitted by other composite drawings. Identification by color is same as NASSCO'S example drawings.

As shown in the drawing, many materials under lower engine flat . are installed at on-block stage, and very few at on-board stage. Most of the machinery and equipment are grouped into units together with pipes and other fittings in their ViCinity. Pipes' are arranged in longitudinal and transverse direction only with a few exceptions and grouped on common supports. Such grouped pipes are assembled into units before erection.

AH systems and materials are identified by system code or piece number according to respective numbering standard of IHI which are of significant numbering system.

For example, a piece number for an auxiliary steam pipe piece is given as;

40 AS (03-265-5



Locational information such as height of pipes above the floor or distance from the frame line is also provided. Most of the pipes except extra large ones are drawn by one line with flange by scale. Machinery or equipment are simply drawn or symbolised but their outline or position of joints with pipes or valves etc. are clearly shown.

As may be understood instantly, IHI'S composite drawings contain much more information in a simplified way than NASSCO'S. When implementing a composite drawing system at NASSCO, careful study of IHI drawing is recommended.

2. MLF (Figs. 7-1, 7-2, 7-3)

For each stage, one pallet in the composite drawings is taken up as an example and the MLF's thereof are shown in Figs. 7-1, 7-2 and 7-3. As for the details of each column of, MLF Article 2.4 of Chapter II is to be *referred* to. (See the attached composite drawings together.)

2.1 On-Blok Stage

Fig. 7-1 is MLF for the hull block "3D31S" at block stage of "G" (grand block). This pallet contains all materials as well as piping materials to be loaded at this stage. Ventilation trunks, floor & gratings and inclined ladders etc. are outfitted by other composite drawings than sampled piping and machinery composite drawing.

Pipe piece number is listed in MLF by shortened form, i.e., by (System Code) ÷ (Line No.) + (Sequential Piece No-) like AS271-2, and nominal size, length, end treatment (flange, sleeve, reducer etc.) and classification are given in the specification column. Pipe piece drawing or information are printed out by the computer and issued to the pipe fabrication shop well in advance of pallet preparation;

Units to be installed at this stage are assembled prior to pallet preparation according to their MLFs "B4X3D31S-J"

and "B4X3D32S-A" Details of components not shown in the composite drawings can be referred to by the reference drawings whose drawing number is given in this MFL, if necessary. For example, The details of penetration piece "FO-001" is shown by its fabrication drawing "F4070011" and ventilation trunk "NV-213Z" by fabrication drawing "F4821T21".

Total weight of materials in this pallet except the assembly units (pallet weight) is 2,775 kgs and execution weight including the units is 4,6-11 kgs. The control weight which is, in proportion to fitting manhour is 2,775 kg, namely in this example the pallet weight is equal to the control weight.

By referring MFL to the composite drawings the production people can confirm the contents of pallets and plan outfitting schedule with appropriate resources allocation including manhour.

2.2 Unit

Fig.7-2 lists materials assembled in a unit with the ballast pump. The MFL of this pallet is "B4Y059-0" which is *installed* on the block "DS31S" at "back-assembly" stage.

The pallet weight and erection weigh: are 3,500 kgs and the control weigh: is 2,370 kgs. The control weight is exclusive of the ballast pump and motor because the outfitting manhour there for is not in proportion to their weight and calculated independently. Other descriptions are same as above 2.1 On-Block Stage.

2.3 On-Board Stage

Fig.. 7-3 is the sampled on-board pallet "T42X2LP-0". This MIS-NO. implies this is piping pallet for the zone "M21" You may easily understand this pallet by comparing the MLF With the composite drawing.

M L F

※品 品1分 8kg 1台用 (2) 15kg 1台用 (3) 20kg 1台用 (4) 25kg 1台用 (5) 30kg 1台用 (6) 35kg 1台用 (7) 40kg 1台用 (8) 45kg 1台用 (9) 50kg 1台用 (10) 55kg 1台用 (11) 60kg 1台用 (12) 65kg 1台用 (13) 70kg 1台用 (14) 75kg 1台用 (15) 80kg 1台用 (16) 85kg 1台用 (17) 90kg 1台用 (18) 95kg 1台用 (19) 100kg 1台用 (20) 105kg 1台用 (21) 110kg 1台用 (22) 115kg 1台用 (23) 120kg 1台用 (24) 125kg 1台用 (25) 130kg 1台用 (26) 135kg 1台用 (27) 140kg 1台用 (28) 145kg 1台用 (29) 150kg 1台用 (30) 155kg 1台用 (31) 160kg 1台用 (32) 165kg 1台用 (33) 170kg 1台用 (34) 175kg 1台用 (35) 180kg 1台用 (36) 185kg 1台用 (37) 190kg 1台用 (38) 195kg 1台用 (39) 200kg 1台用 (40) 205kg 1台用 (41) 210kg 1台用 (42) 215kg 1台用 (43) 220kg 1台用 (44) 225kg 1台用 (45) 230kg 1台用 (46) 235kg 1台用 (47) 240kg 1台用 (48) 245kg 1台用 (49) 250kg 1台用 (50) 255kg 1台用 (51) 260kg 1台用 (52) 265kg 1台用 (53) 270kg 1台用 (54) 275kg 1台用 (55) 280kg 1台用 (56) 285kg 1台用 (57) 290kg 1台用 (58) 295kg 1台用 (59) 300kg 1台用 (60) 305kg 1台用 (61) 310kg 1台用 (62) 315kg 1台用 (63) 320kg 1台用 (64) 325kg 1台用 (65) 330kg 1台用 (66) 335kg 1台用 (67) 340kg 1台用 (68) 345kg 1台用 (69) 350kg 1台用 (70) 355kg 1台用 (71) 360kg 1台用 (72) 365kg 1台用 (73) 370kg 1台用 (74) 375kg 1台用 (75) 380kg 1台用 (76) 385kg 1台用 (77) 390kg 1台用 (78) 395kg 1台用 (79) 400kg 1台用 (80) 405kg 1台用 (81) 410kg 1台用 (82) 415kg 1台用 (83) 420kg 1台用 (84) 425kg 1台用 (85) 430kg 1台用 (86) 435kg 1台用 (87) 440kg 1台用 (88) 445kg 1台用 (89) 450kg 1台用 (90) 455kg 1台用 (91) 460kg 1台用 (92) 465kg 1台用 (93) 470kg 1台用 (94) 475kg 1台用 (95) 480kg 1台用 (96) 485kg 1台用 (97) 490kg 1台用 (98) 495kg 1台用 (99) 500kg 1台用 (100) 505kg 1台用 (101) 510kg 1台用 (102) 515kg 1台用 (103) 520kg 1台用 (104) 525kg 1台用 (105) 530kg 1台用 (106) 535kg 1台用 (107) 540kg 1台用 (108) 545kg 1台用 (109) 550kg 1台用 (110) 555kg 1台用 (111) 560kg 1台用 (112) 565kg 1台用 (113) 570kg 1台用 (114) 575kg 1台用 (115) 580kg 1台用 (116) 585kg 1台用 (117) 590kg 1台用 (118) 595kg 1台用 (119) 600kg 1台用 (120) 605kg 1台用 (121) 610kg 1台用 (122) 615kg 1台用 (123) 620kg 1台用 (124) 625kg 1台用 (125) 630kg 1台用 (126) 635kg 1台用 (127) 640kg 1台用 (128) 645kg 1台用 (129) 650kg 1台用 (130) 655kg 1台用 (131) 660kg 1台用 (132) 665kg 1台用 (133) 670kg 1台用 (134) 675kg 1台用 (135) 680kg 1台用 (136) 685kg 1台用 (137) 690kg 1台用 (138) 695kg 1台用 (139) 700kg 1台用 (140) 705kg 1台用 (141) 710kg 1台用 (142) 715kg 1台用 (143) 720kg 1台用 (144) 725kg 1台用 (145) 730kg 1台用 (146) 735kg 1台用 (147) 740kg 1台用 (148) 745kg 1台用 (149) 750kg 1台用 (150) 755kg 1台用 (151) 760kg 1台用 (152) 765kg 1台用 (153) 770kg 1台用 (154) 775kg 1台用 (155) 780kg 1台用 (156) 785kg 1台用 (157) 790kg 1台用 (158) 795kg 1台用 (159) 800kg 1台用 (160) 805kg 1台用 (161) 810kg 1台用 (162) 815kg 1台用 (163) 820kg 1台用 (164) 825kg 1台用 (165) 830kg 1台用 (166) 835kg 1台用 (167) 840kg 1台用 (168) 845kg 1台用 (169) 850kg 1台用 (170) 855kg 1台用 (171) 860kg 1台用 (172) 865kg 1台用 (173) 870kg 1台用 (174) 875kg 1台用 (175) 880kg 1台用 (176) 885kg 1台用 (177) 890kg 1台用 (178) 895kg 1台用 (179) 900kg 1台用 (180) 905kg 1台用 (181) 910kg 1台用 (182) 915kg 1台用 (183) 920kg 1台用 (184) 925kg 1台用 (185) 930kg 1台用 (186) 935kg 1台用 (187) 940kg 1台用 (188) 945kg 1台用 (189) 950kg 1台用 (190) 955kg 1台用 (191) 960kg 1台用 (192) 965kg 1台用 (193) 970kg 1台用 (194) 975kg 1台用 (195) 980kg 1台用 (196) 985kg 1台用 (197) 990kg 1台用 (198) 995kg 1台用 (199) 1000kg 1台用 (200) 1005kg 1台用 (201) 1010kg 1台用 (202) 1015kg 1台用 (203) 1020kg 1台用 (204) 1025kg 1台用 (205) 1030kg 1台用 (206) 1035kg 1台用 (207) 1040kg 1台用 (208) 1045kg 1台用 (209) 1050kg 1台用 (210) 1055kg 1台用 (211) 1060kg 1台用 (212) 1065kg 1台用 (213) 1070kg 1台用 (214) 1075kg 1台用 (215) 1080kg 1台用 (216) 1085kg 1台用 (217) 1090kg 1台用 (218) 1095kg 1台用 (219) 1100kg 1台用 (220) 1105kg 1台用 (221) 1110kg 1台用 (222) 1115kg 1台用 (223) 1120kg 1台用 (224) 1125kg 1台用 (225) 1130kg 1台用 (226) 1135kg 1台用 (227) 1140kg 1台用 (228) 1145kg 1台用 (229) 1150kg 1台用 (230) 1155kg 1台用 (231) 1160kg 1台用 (232) 1165kg 1台用 (233) 1170kg 1台用 (234) 1175kg 1台用 (235) 1180kg 1台用 (236) 1185kg 1台用 (237) 1190kg 1台用 (238) 1195kg 1台用 (239) 1200kg 1台用 (240) 1205kg 1台用 (241) 1210kg 1台用 (242) 1215kg 1台用 (243) 1220kg 1台用 (244) 1225kg 1台用 (245) 1230kg 1台用 (246) 1235kg 1台用 (247) 1240kg 1台用 (248) 1245kg 1台用 (249) 1250kg 1台用 (250) 1255kg 1台用 (251) 1260kg 1台用 (252) 1265kg 1台用 (253) 1270kg 1台用 (254) 1275kg 1台用 (255) 1280kg 1台用 (256) 1285kg 1台用 (257) 1290kg 1台用 (258) 1295kg 1台用 (259) 1300kg 1台用 (260) 1305kg 1台用 (261) 1310kg 1台用 (262) 1315kg 1台用 (263) 1320kg 1台用 (264) 1325kg 1台用 (265) 1330kg 1台用 (266) 1335kg 1台用 (267) 1340kg 1台用 (268) 1345kg 1台用 (269) 1350kg 1台用 (270) 1355kg 1台用 (271) 1360kg 1台用 (272) 1365kg 1台用 (273) 1370kg 1台用 (274) 1375kg 1台用 (275) 1380kg 1台用 (276) 1385kg 1台用 (277) 1390kg 1台用 (278) 1395kg 1台用 (279) 1400kg 1台用 (280) 1405kg 1台用 (281) 1410kg 1台用 (282) 1415kg 1台用 (283) 1420kg 1台用 (284) 1425kg 1台用 (285) 1430kg 1台用 (286) 1435kg 1台用 (287) 1440kg 1台用 (288) 1445kg 1台用 (289) 1450kg 1台用 (290) 1455kg 1台用 (291) 1460kg 1台用 (292) 1465kg 1台用 (293) 1470kg 1台用 (294) 1475kg 1台用 (295) 1480kg 1台用 (296) 1485kg 1台用 (297) 1490kg 1台用 (298) 1495kg 1台用 (299) 1500kg 1台用 (300) 1505kg 1台用 (301) 1510kg 1台用 (302) 1515kg 1台用 (303) 1520kg 1台用 (304) 1525kg 1台用 (305) 1530kg 1台用 (306) 1535kg 1台用 (307) 1540kg 1台用 (308) 1545kg 1台用 (309) 1550kg 1台用 (310) 1555kg 1台用 (311) 1560kg 1台用 (312) 1565kg 1台用 (313) 1570kg 1台用 (314) 1575kg 1台用 (315) 1580kg 1台用 (316) 1585kg 1台用 (317) 1590kg 1台用 (318) 1595kg 1台用 (319) 1600kg 1台用 (320) 1605kg 1台用 (321) 1610kg 1台用 (322) 1615kg 1台用 (323) 1620kg 1台用 (324) 1625kg 1台用 (325) 1630kg 1台用 (326) 1635kg 1台用 (327) 1640kg 1台用 (328) 1645kg 1台用 (329) 1650kg 1台用 (330) 1655kg 1台用 (331) 1660kg 1台用 (332) 1665kg 1台用 (333) 1670kg 1台用 (334) 1675kg 1台用 (335) 1680kg 1台用 (336) 1685kg 1台用 (337) 1690kg 1台用 (338) 1695kg 1台用 (339) 1700kg 1台用 (340) 1705kg 1台用 (341) 1710kg 1台用 (342) 1715kg 1台用 (343) 1720kg 1台用 (344) 1725kg 1台用 (345) 1730kg 1台用 (346) 1735kg 1台用 (347) 1740kg 1台用 (348) 1745kg 1台用 (349) 1750kg 1台用 (350) 1755kg 1台用 (351) 1760kg 1台用 (352) 1765kg 1台用 (353) 1770kg 1台用 (354) 1775kg 1台用 (355) 1780kg 1台用 (356) 1785kg 1台用 (357) 1790kg 1台用 (358) 1795kg 1台用 (359) 1800kg 1台用 (360) 1805kg 1台用 (361) 1810kg 1台用 (362) 1815kg 1台用 (363) 1820kg 1台用 (364) 1825kg 1台用 (365) 1830kg 1台用 (366) 1835kg 1台用 (367) 1840kg 1台用 (368) 1845kg 1台用 (369) 1850kg 1台用 (370) 1855kg 1台用 (371) 1860kg 1台用 (372) 1865kg 1台用 (373) 1870kg 1台用 (374) 1875kg 1台用 (375) 1880kg 1台用 (376) 1885kg 1台用 (377) 1890kg 1台用 (378) 1895kg 1台用 (379) 1900kg 1台用 (380) 1905kg 1台用 (381) 1910kg 1台用 (382) 1915kg 1台用 (383) 1920kg 1台用 (384) 1925kg 1台用 (385) 1930kg 1台用 (386) 1935kg 1台用 (387) 1940kg 1台用 (388) 1945kg 1台用 (389) 1950kg 1台用 (390) 1955kg 1台用 (391) 1960kg 1台用 (392) 1965kg 1台用 (393) 1970kg 1台用 (394) 1975kg 1台用 (395) 1980kg 1台用 (396) 1985kg 1台用 (397) 1990kg 1台用 (398) 1995kg 1台用 (399) 2000kg 1台用 (400) 2005kg 1台用 (401) 2010kg 1台用 (402) 2015kg 1台用 (403) 2020kg 1台用 (404) 2025kg 1台用 (405) 2030kg 1台用 (406) 2035kg 1台用 (407) 2040kg 1台用 (408) 2045kg 1台用 (409) 2050kg 1台用 (410) 2055kg 1台用 (411) 2060kg 1台用 (412) 2065kg 1台用 (413) 2070kg 1台用 (414) 2075kg 1台用 (415) 2080kg 1台用 (416) 2085kg 1台用 (417) 2090kg 1台用 (418) 2095kg 1台用 (419) 2100kg 1台用 (420) 2105kg 1台用 (421) 2110kg 1台用 (422) 2115kg 1台用 (423) 2120kg 1台用 (424) 2125kg 1台用 (425) 2130kg 1台用 (426) 2135kg 1台用 (427) 2140kg 1台用 (428) 2145kg 1台用 (429) 2150kg 1台用 (430) 2155kg 1台用 (431) 2160kg 1台用 (432) 2165kg 1台用 (433) 2170kg 1台用 (434) 2175kg 1台用 (435) 2180kg 1台用 (436) 2185kg 1台用 (437) 2190kg 1台用 (438) 2195kg 1台用 (439) 2200kg 1台用 (440) 2205kg 1台用 (441) 2210kg 1台用 (442) 2215kg 1台用 (443) 2220kg 1台用 (444) 2225kg 1台用 (445) 2230kg 1台用 (446) 2235kg 1台用 (447) 2240kg 1台用 (448) 2245kg 1台用 (449) 2250kg 1台用 (450) 2255kg 1台用 (451) 2260kg 1台用 (452) 2265kg 1台用 (453) 2270kg 1台用 (454) 2275kg 1台用 (455) 2280kg 1台用 (456) 2285kg 1台用 (457) 2290kg 1台用 (458) 2295kg 1台用 (459) 2300kg 1台用 (460) 2305kg 1台用 (461) 2310kg 1台用 (462) 2315kg 1台用 (463) 2320kg 1台用 (464) 2325kg 1台用 (465) 2330kg 1台用 (466) 2335kg 1台用 (467) 2340kg 1台用 (468) 2345kg 1台用 (469) 2350kg 1台用 (470) 2355kg 1台用 (471) 2360kg 1台用 (472) 2365kg 1台用 (473) 2370kg 1台用 (474) 2375kg 1台用 (475) 2380kg 1台用 (476) 2385kg 1台用 (477) 2390kg 1台用 (478) 2395kg 1台用 (479) 2400kg 1台用 (480) 2405kg 1台用 (481) 2410kg 1台用 (482) 2415kg 1台用 (483) 2420kg 1台用 (484) 2425kg 1台用 (485) 2430kg 1台用 (486) 2435kg 1台用 (487) 2440kg 1台用 (488) 2445kg 1台用 (489) 2450kg 1台用 (490) 2455kg 1台用 (491) 2460kg 1台用 (492) 2465kg 1台用 (493) 2470kg 1台用 (494) 2475kg 1台用 (495) 2480kg 1台用 (496) 2485kg 1台用 (497) 2490kg 1台用 (498) 2495kg 1台用 (499) 2500kg 1台用 (500) 2505kg 1台用 (501) 2510kg 1台用 (502) 2515kg 1台用 (503) 2520kg 1台用 (504) 2525kg 1台用 (505) 2530kg 1台用 (506) 2535kg 1台用 (507) 2540kg 1台用 (508) 2545kg 1台用 (509) 2550kg 1台用 (510) 2555kg 1台用 (511) 2560kg 1台用 (512) 2565kg 1台用 (513) 2570kg 1台用 (514) 2575kg 1台用 (515) 2580kg 1台用 (516) 2585kg 1台用 (517) 2590kg 1台用 (518) 2595kg 1台用 (519) 2600kg 1台用 (520) 2605kg 1台用 (521) 2610kg 1台用 (522) 2615kg 1台用 (523) 2620kg 1台用 (524) 2625kg 1台用 (525) 2630kg 1台用 (526) 2635kg 1台用 (527) 2640kg 1台用 (528) 2645kg 1台用 (529) 2650kg 1台用 (530) 2655kg 1台用 (531) 2660kg 1台用 (532) 2665kg 1台用 (533) 2670kg 1台用 (534) 2675kg 1台用 (535) 2680kg 1台用 (536) 2685kg 1台用 (537) 2690kg 1台用 (538) 2695kg 1台用 (539) 2700kg 1台用 (540) 2705kg 1台用 (541) 2710kg 1台用 (542) 2715kg 1台用 (543) 2720kg 1台用 (544) 2725kg 1台用 (545) 2730kg 1台用 (546) 2735kg 1台用 (547) 2740kg 1台用 (548) 2745kg 1台用 (549) 2750kg 1台用 (550) 2755kg 1台用 (551) 2760kg 1台用 (552) 2765kg 1台用 (553) 2770kg 1台用 (554) 2775kg 1台用 (555) 2780kg 1台用 (556) 2785kg 1台用 (557) 2790kg 1台用 (558) 2795kg 1台用 (559) 2800kg 1台用 (560) 2805kg 1台用 (561) 2810kg 1台用 (562) 2815kg 1台用 (563) 2820kg 1台用 (564) 2825kg 1台用 (565) 2830kg 1台用 (566) 2835kg 1台用 (567) 2840kg 1台用 (568) 2845kg 1台用 (569) 2850kg 1台用 (570) 2855kg 1台用 (571) 2860kg 1台用 (572) 2865kg 1台用 (573) 2870kg 1台用 (574) 2875kg 1台用 (575) 2880kg 1台用 (576) 2885kg 1台用 (577) 2890kg 1台用 (578) 2895kg 1台用 (579) 2900kg 1台用 (580) 2905kg 1台用 (581) 2910kg 1台用 (582) 2915kg 1台用 (583) 2920kg 1台用 (584) 2925kg 1台用 (585) 2930kg 1台用 (586) 2935kg 1台用 (587) 2940kg 1台用 (588) 2945kg 1台用 (589) 2950kg 1台用 (590) 2955kg 1台用 (591) 2960kg 1台用 (592) 2965kg 1台用 (593) 2970kg 1台用 (594) 2975kg 1台用 (595) 2980kg 1台用 (596) 2985kg 1台用 (597) 2990kg 1台用 (598) 2995kg 1台用 (599) 3000kg 1台用 (600) 3005kg 1台用 (601) 3010kg 1台用 (602) 3015kg 1台用 (603) 3020kg 1台用 (604) 3025kg 1台用 (605) 3030kg 1台用 (606) 3035kg 1台用 (607) 3040kg 1台用 (608) 3045kg 1台用 (609) 3050kg 1台用 (610) 3055kg 1台用 (611) 3060kg 1台用 (612) 3065kg 1台用 (613) 3070kg 1台用 (614) 3075kg 1台用 (615) 3080kg 1台用 (616) 3085kg 1台用 (617) 3090kg 1台用 (618) 3095kg 1台用 (619) 3100kg 1台用 (620) 3105kg 1台用 (621) 3110kg 1台用 (622) 3115kg 1台用 (623) 3120kg 1台用 (624) 3125kg 1台用 (625) 3130kg 1台用 (626) 3135kg 1台用 (627) 3140kg 1台用 (628) 3145kg 1台用 (629) 3150kg 1台用 (630) 3155kg 1台用 (631) 3160kg 1台用 (632) 3165kg 1台用 (633) 3170kg 1台用 (634) 3175kg 1台用 (635) 3180kg 1台用 (636) 3185kg 1台用 (637) 3190kg 1台用 (638) 3195kg 1台用 (639) 3200kg 1台用 (640) 3205kg 1台用 (641) 3210kg 1台用 (642) 3215kg 1台用 (643) 3220kg 1台用 (644) 3225kg 1台用 (645) 3230kg 1台用 (646) 3235kg 1台用 (647) 3240kg 1台用 (648) 3245kg 1台用 (649) 3250kg 1台用 (650) 3255kg 1台用 (651) 3260kg 1台用 (652) 3265kg 1台用 (653) 3270kg 1台用 (654) 3275kg 1台用 (655) 3280kg 1台用 (656) 3285kg 1台用 (657) 3290kg 1台用 (658) 3295kg 1台用 (659) 3300kg 1台用 (660) 3305kg 1台用 (661) 3310kg 1台用 (662) 3315kg 1台用 (663) 3320kg 1台用 (664) 3325kg 1台用 (665) 3330kg 1台用 (666) 3335kg 1台用 (667) 3340kg 1台用 (668) 3345kg 1台用 (669) 3350kg 1台用 (670) 3355kg 1台用 (671) 3360kg 1台用 (672) 3365kg 1台用 (673) 3370kg 1台用 (674) 3375kg 1台用 (675) 3380kg 1台用 (676) 3385kg 1台用 (677) 3390kg 1台用 (678) 3395kg 1台用 (679) 3400kg 1台用 (680) 3405kg 1台用 (681) 3410kg 1台用 (682) 3415kg 1台用 (683) 3420kg 1台用 (684) 3425kg 1台用 (685) 3430kg 1台用 (686) 3435kg 1台用 (687) 3440kg 1台用 (688) 3445kg 1台用 (689) 3450kg 1台用 (690) 3455kg 1台用 (691) 3460kg 1台用 (692) 3465kg 1台用 (693) 3470kg 1台用 (694) 3475kg 1台用 (695) 3480kg 1台用 (696) 3485kg 1台用 (697) 3490kg 1台用 (698) 3495kg 1台用 (699) 3500kg 1台用 (700) 3505kg 1台用 (701) 3510kg 1台用 (702) 3515kg 1台用 (703) 3520kg 1台用 (704) 3525kg 1台用 (705) 3530kg 1台用 (706) 3535kg 1台用 (707) 3540kg 1台用 (708) 3545kg 1台用 (709) 3550kg 1台用 (710) 3555kg 1台用 (711) 3560kg 1台用 (712) 3565kg 1台用 (713) 3570kg 1台用 (714) 3575kg 1台用 (715) 3580kg 1台用 (716) 3585kg 1台用 (717) 3590kg 1台用 (718) 3595kg 1台用 (719) 3600kg 1台用 (720) 3605kg 1台用 (721) 3610kg 1台用 (722) 3615kg 1台用 (723) 3620kg 1台用 (724) 3625kg 1台用 (725) 3630kg 1台用 (726) 3635kg 1台用 (727) 3640kg 1台用 (728) 3645kg 1台用 (729) 3650kg 1台用 (730) 3655kg 1台用 (731) 3660kg 1台用 (732) 3665kg 1台用 (733) 3670kg 1台用 (734) 3675kg 1台用 (735) 3680kg 1台用 (736) 3685kg 1台用 (737) 3690kg 1台用 (738) 3695kg 1台用 (739) 3700kg 1台用 (740) 3705kg 1台用 (741) 3710kg 1台用 (742) 3715kg 1台用 (743) 3720kg 1台用 (744) 3725kg 1台用 (745) 3730kg 1台用 (746) 3735kg 1台用 (747) 3740kg 1台用 (748) 3745kg 1台用 (749) 3750kg 1台用 (750) 3755kg 1台用 (751) 3760kg 1台用 (752) 3765kg 1台用 (753) 3770kg 1台用 (754) 3775kg 1台用 (755) 3780kg 1台用 (756) 3785kg 1台用 (757) 3790kg 1台用 (758) 3795kg 1台用 (759) 3800kg 1台用 (760) 3805kg 1台用 (761) 3810kg 1台用 (762) 3815kg 1台用 (763) 3820kg 1台用 (764) 3825kg 1台用 (765) 3830kg 1台用 (766) 3835kg 1台用 (767) 3840kg 1台用 (768) 3845kg 1台用 (769) 3850kg 1台用 (770) 3855kg 1台用 (771) 3860kg 1台用 (772) 3865kg 1台用 (773) 3870kg 1台用 (774) 3875kg 1台用 (775) 3880kg 1台用 (776) 3885kg 1台用 (777) 3890kg 1台用 (778) 3895kg 1台用 (779) 3900kg 1台用 (780) 3905kg 1台用 (781) 3910kg 1台用 (782) 3915kg 1台用 (783) 3920kg 1台用 (784) 3925kg 1台用 (785) 3930kg 1台用 (786) 3935kg 1台用 (787) 3940kg 1台用 (788) 3945kg 1台用 (789) 3950kg 1台用 (790) 3955kg 1台用 (791) 3960kg 1台用 (792) 3965kg 1台用 (793) 3970kg 1台用 (794) 3975kg 1台用 (795) 3980kg 1台用 (796) 3985kg 1台用 (797) 3990kg 1台用 (798) 3995kg 1台用 (799) 4000kg 1台用 (800) 4005kg 1台用 (801) 4010kg 1台用 (802) 4015kg 1台用 (803) 4020kg 1台用 (804) 4025kg 1台用 (805) 4030kg 1台用 (806) 4035kg 1台用 (807) 4040kg 1台用 (808) 4045kg 1台用 (809) 4050kg 1台用 (810) 4055kg 1台用 (811) 4060kg 1台用 (812) 4065kg 1台用 (813) 4070kg 1台用 (814) 4075kg 1台用 (815) 4080kg 1台用 (816) 4085kg 1台用 (817) 4090kg 1台用 (818) 4095kg 1台用 (819) 4100kg 1台用 (820) 4105kg 1台用 (821) 4110kg 1台用 (822) 4115kg 1台用 (823) 4120kg 1台用 (824) 4125kg 1台用 (825) 4130kg 1台用 (826) 4135kg 1台用 (827) 4140kg 1台用 (828) 4145kg 1台用 (829) 4150kg 1台用 (830) 4155kg 1台用 (831) 4160kg 1台用 (832) 4165kg 1台用 (833) 4170kg 1台用 (834) 4175kg 1台用 (835) 4180kg 1台用 (836) 4185kg 1台用 (837) 4190kg 1台用 (838) 4195kg 1台用 (839) 4200kg 1台用 (840) 4205kg 1台用 (841) 4210kg 1台用 (842) 4215kg 1台用 (843) 4220kg 1台用 (844) 4225kg 1台用 (845) 4230kg 1台用 (846)

Fig. 7-1(2/7) Pallet on block

MLF

品名		部品符号		引当指示項目 (コメント)		数量		重量		引当階層		賦装品コード		備考	
材料・型式・規格・寸法															
Pape		CE001-2	U	0030 3.5M 20SC		10	11	79	678	11				+	
		CE001-4	U	S011 2.6M 65SC		10	11	332	678	09				+	
		Dh651-3	U	S010 4.4M 4000		10	11	123	801	07				+	
		F0015-1	U	FF70 2.5M 800B 16		10	11	336	F64	27				+	
		F0031-2	U	FF21 3.1M 25B		10	11	117	F79	11				+	
		F0032-1	U	FF70 2.7M 25B		10	11	93	F79	41				+	
		F0063-1	U	FF30 2.5M 40B		10	11	123	F79	41				+	
		F0254-4	U	S020 3.8M 65C		10	11	479	E79	14				+	
		F0301-2	U	0021 3.8M 250B		10	11	2314	E79	34				+	
		F0301-3	U	SS20 1.4M 250B		10	11	1091	E79	57				+	
		F0620-1	U	OF50 2.6M 25A		10	11	77	D79	11				+	
		F0620-2	U	SF31 3.9M 25A		10	11	113	E79	41				+	
		F0625-1	U	SS30 1.6M 65A		10	11	169	D79	14				+	
		F0625-2	U	SS50 2.6M 65A		10	11	242	E79	14				+	
		F0629-1	U	0021 5.9M 65A		10	11	452	E79	44				+	

品名	MLF - No	作業開始日	次のステージ	生産量	在庫量	管理在庫	総在庫量	単位
				614	614	614		
				76	76	2590		

Fig.7-1(3/7) Pallet on block

M L F

※第一品以外 0.4m以上 1.6m以下 (必要) 2.合巻管 (任意) 3.合巻管 (任意)

3.合巻管 4.合巻管 (任意) 5.合巻管 (任意)

6.現場加工管 8.バルブ

※本製品

1.既製品 (次のステージで加工されるもの)

2.既製品 (別のステージで加工されたもの)

1.式鋼管 (4.2. 3. 4. 5. 6. 7. 1000mm 8. 9)

SOT-A200201多層

※部品番号

1.管径

取付サイン 1.次のステージの M.L.F.No

取付サイン 2.前ステージの M.L.F.No

※1. 引当品 2. 外品 3. 加工品 4. 引当品

5. 加工品

7's. 06. 00

品 名	部品番号	引当指示項目 (コメント)	数 量	重 量	備 考
材質・型式・規格・寸法					
Pipe	FR425-1	OS50 3.0M 250B	10	44N0P	07
	FR425-2	OS50 2.2M 250B	10	32N0P	07
	SW049-2	FF20 1.6M 125A	10	30.5S91	61
	SW049-3	FF11 3.3M 125A	10	61.8S91	61
	SW049-4	FF20 1.0M 125A	10	21.6S91	61
	SW049-5	FF10 2.5M 125A	10	43.7S91	04
	SH216-1	FF10 5.2M 100A	10	72.6G78	61
	SH497-1	FF10 5.2M 125A	10	85.4S91	61
	SH497-2	FF20 0.7M 125A	10	17.0S91	61
	SH497-3	FF20 0.7M 125A	10	17.0S91	61
	SH497-4	FF20 0.7M 125A	10	17.0S91	
FC ANGLE VALVE					
FC/BC FL 5063B	DH-606V		10	18.3E79	403020091
BC GLOBE VALVE					
BC FGU 5040	FR-201V		10	6.9N0P	5403201071
BC S.p.C.GLOBE VALVE					
BC FNU 5040G	BS-247V		10	6.7N0P	54032030071
BC GLOBE VALVE					

Fig.7-1(4/7) Pallet on block
M.L.F

5.第一品目 6.第二品目 1.合設管 (用材は不要) 2.合設管 (用材は不要)
3.全型管 4.非型管 (用材は不要) 5.非型管 (用材は不要)
6.現場加工品 7.バルブ

8.本製品
1.取組品 (次のステージで本製品は不要)
2.取組品 (次のステージで取組されたもの)

1.式例用本数 2. g 3. kg 4. m 5. m² 6. m³ 7. 1/100mm² 8. f

取組品イン 1.次のステージのM.L.F No
取組品イン 2.前ステージの M.L.F No

SOT-A280201 5.01

8.取組品
1.取組品

1. 引取品 2. 引取品
3. 引取品 4. 引取品
5. 引取品

79.00.03

品名 材質・型式・規格・寸法	部品符号	引当指示項目 (コメント)	数量	重量	単位	引当国番 ステージ移行	無製品コード	備考
BC GLOBE VALVE BC FGU 16040	CA-512V		1011	87	NOP		540322100710	+
BC S.D.C. GLOBE VALVE BC FNU 16015G	AS-270V		1011	27	NOP		540322300310	+
10K HOSE GLOBE VALVE BC ANSI HG 1015	CA-247V		1011	23	NOP		14045C125310	+
BLIND FLANGE SS41 FB 10K 15SS			1011	06	E79		540651110310	+
PNET.PIECE(STEEL PIPE)	FO-001		1011	120	E42	F4070011	2407C19000	+
PNET.PIECE(STEEL PIPE)	FO-002		1011	120	E42	F4070011	2407C19000	+
PNET.PIECE(STEEL PIPE)	FO-003		1011	80	E42	F4070011	2407C19000	+
PNET.PIECE(STEEL PIPE)	FO-004		1011	80	E42	F4070011	2407C19000	+
PNET.PIECE(STEEL PIPE)	FO-005		1011	320	E42	F4070011	2407C19000	+
PNET.PIECE(STEEL PIPE)	FO-006		1011	40	E42	F4070011	2407C19000	+
PNET.PIECE(STEEL PIPE)	FO-007		1011	50	E42	F4070011	2407C19000	+
PNET.PIECE(STEEL PIPE)	FO-008		1011	20	E42	F4070011	2407C19000	+
EXPANSION JOINT, BELLWOS EXP. J. SUS FREE 5K 500	GL-001K		1011	87	NOP		1408C5C72110	+
GASKET ASBESTOS PA 5K 4000			5011	00			540840110710	+
GASKET ASBESTOS PA 5K 12500			9011	00			540840111310	+

品名	M.L.F - No	作業開始日	次のステージ
540322100710	540322100710	2011.01.20	

7A03 1 D 7 42 PNO 17

電検具	パレット重量	管理重量	搭載重量	tt
	186	186	186	
	135	135	135	4

M L F

品 名	部品符号	引当指示項目 (コメント)	数 量	重 量	引当図番	製品コード	備 考
材質・型式・規格・寸法					ステージ係行		
GASKET							
ASBESTOS PA 10K 1500			1011	00		540641110310	+
GASKET							
ASBESTOS PA 10K 2500			5011	00		540841110510	+
GASKET							
ASBESTOS PA 10K 4000			4011	00		540841110710	+
GASKET							
ASBESTOS PA 10K 8000			1011	01		540841111010	+
GASKET							
ASBESTOS PA 10K 10000			1111	01		540841111210	+
SCUPPER FOR STEEL DECK	BS/401K		4011	48603		540863107710	+
SCUPPER SS 18F 5K 400							
SCUPPER FOR STEEL DECK	BS/408K		1111	80603		540863612710	+
SCUPPER SS 2F 5K 400							
SCUPPER FOR OIL PAN							
SCUPP/OIL PAN SS 10K 25	FO-631K		1011	15056		540863740510	+
SCUPPER FOR OIL PAN							
SCUPP/OIL PAN SS 10K 25	FO-645K		1011	15056		540863740510	+
SCUPPER FOR OIL PAN							
SCUPP/OIL PAN SS 10K 25	FO-646K		1011	15056		540863740510	+
HEXAGON HEAD BOLT/NUT							
SS GALV-BN 12S 40SG			22011	22600		540921731110	+
HEXAGON HEAD BOLT/NUT							
SS GALV-BN 16S 45SG			14011	14600		540921751210	+
HEXAGON HEAD BOLT/NUT							
SS GALV-BN 16S 50SG			84011	84600		540921751410	+
HEXAGON HEAD BOLT/NUT							
SS GALV-BN 16S 55SG			12011	24600		540921751410	+

Fig.7-1(6/7) Pallet on block

M L F

AHC-211
1.2.3

※第一品目外 第二品目 1.合目管 (外径100mm) 2.合目管 (外径150mm)

3.合目管 4.合目管 (外径100mm) 5.合目管 (外径150mm)

6.現場加工品 7.バルブ

※本製品

1.取組品 (人のスナージで本製品を組むもの)

2.取組品 (人のスナージで取組まれたもの)

1.式鋼用本尺 2. 3. 4. 5. 6. 7. 1000mm 8. 9.

SOT-A200201 60M

※取組品

1.管理用表

取組品 1.式のスナージのM.L.F. No.

取組品 2.式のスナージの M.L.F. No.

1. 引当品 2. 引当品
3. 引当品 4. 引当品
5. 引当品

79.06.00

品 名	部品符号	引当指示項目 (コメント)	数 量	重 量	引当品番	引当品コード	備 考
材質・型式・規格・寸法					スナージ移行		
SPINDLE DEVICE					F4066914		
SPINDLE DEVICE	NM-7212		100	5000		2460600000	+
PIPE BAND SUPPORT					F4634111		
PIPE BAND SUPPORT		N=92	100	2910		2463400000	+
EYE PLATE					F4005211		
EYE PLATE	NL-080P		200	3140		1400521000	+
VENTILATION TRUNK					F4021121		
VENTILATION TRUNK	NV-2132		100	1112		2402100000	+
VENTILATION TRUNK					F4021121		
VENTILATION TRUNK	NV-2142		100	8210		2402100000	+
FLOOR & GRATING					F4031231		
FLOOR & GRATING	NG-120C	F 図参照 取付は	100	790		2403100000	+
FLOOR & GRATING					F4031231		
FLOOR & GRATING	NG-121C	交通装置取付図	100	760		2403100000	+
FLOOR & GRATING					F4031231		
FLOOR & GRATING	NG-122C		100	540		2403100000	+
FLOOR & GRATING					F4031231		
FLOOR & GRATING	NG-123C		100	460		2403100000	+
FLOOR & GRATING					F4031231		
FLOOR & GRATING	NG-124C		100	600		2403100000	+
FLOOR & GRATING					F4031271		
FLOOR & GRATING	NG-211Z		100	1120		2403100000	+
FLOOR & GRATING					F4031271		
FLOOR & GRATING	NG-311Z		100	420		2403100000	+
FLOOR & GRATING					F40321C1		
INCLINED LADDER	NG-211L	LA-3 H/2500 B/600 A/55	100	1170		2403210000	+
INCLINED LADDER					F4032101		
INCLINED LADDER	NG-212L	LA-3 H/2650 B/500 A/55	100	1150		2403210000	+
INCLINED LADDER					F4032101		
INCLINED LADDER	NG-311L	LA-3 H/2600 B/600 A/55	100	1240		2403210000	+

品 名

M.L.F. - No.

作業開始日

決めのステージ

品 名

品 名

品 名

品 名

品 名

1340

1340

1340

2777

2777

4573

ABC 411
1.2.3...

※本製品

1. 製造品(次のスナージで本製品のもの)
2. 製造品(右のスナージで製造されたもの)

製造サイン 2. 前ステージの M.F. No

1. 管理用紙

→ 1. 引当款人品 2. 外注款人品
3. 和主外注品 4. 引当的藏品
5. 和的藏品

79.06.00

[illegible]

No.	作業開始日	次のスラージ

出賃料	バレット料	管理料	借税料	凡

M L F

PAGE 203

Fig.7-2(2/4) Machiner unit

M L F

品名		部品符号		引当指示項目 (コメント)		数量		重量		引当箇所		部品コード		備考	
材質・型式・規格・寸法		部品符号		引当指示項目 (コメント)		数量		重量		引当箇所		部品コード		備考	
Pipe		SW452-1	0	FF11 .7M 300A		10	11	107	592	61				+	
		SW458-1	0	FF21 .9M 250A		10	11	863	592	61				+	
		SW458-2	0	FF20 .9M 250A		10	11	630	592	61				+	
		SW460-1	0	FF10 .7M 250A		10	11	484	592	61				+	
BC GLOBE VALVE		SW-413V				10	11	57	10P			403221005		+	
BC SCREW/ITE GLOBE V.		SW-412V				10	11	10	10P			403245C021		+	
SC/BC SHLL V-LINING		SV-413V		10K-250		10	11	2590	042	N4041000A		40419C000		+	
BUTTERFLY VALVE (MANUAL)		SW-456V		FC25 SCS13 5K * 250		10	11	500	042	N4044000		40445CC00		+	
BUTTERFLY VALVE (MANUAL)		SW-458V		FC25 SCS13 5K * 300		10	11	400	042	N4044000		40445CC00		+	
BUTTERFLY VALVE (MANUAL)		SW-460V		FC25 SCS13 5K * 300		10	11	400	042	N4044000		40445CC00		+	
SS41 GALV-FR 5K 300SS1						10	11	270	R44			4065101071A		+	
WATER FILTER		SW-402S		5K-250C BALLAST PP		10	11	2460	042	N4002400		40025C500		+	
GASKET						60	11	00				540040111310		+	
ASBESTOS PA 5K 1250U						30	11	00				40040111510		+	
GASKET															
ASBESTOS PA 5K 2000U															
GASKET															

79.06.00

M L F.

番	名	MLP No	作業内容	決のステージ	電圧	パルス幅	パルス高	パルス重	パルス長
1286		1286			1286	156	1286		
1286		1286			1286	156	1286		

M L F

[illegible]

M L F

品名	M.L.F. - No	作業開始日	次のスラージ	品名	バルト重量	管理重量	搭載重量	計
2216	167121P--073 02 2			1E02 1 0 7 42 PNO: 34	155	155	155	1

Fig. 7-3(2/8) Pallet on board

M L F

※ 品目外 0.50 以上 1.00 以下 (1.00 以下 2.00 以下)
3. 2.00 以下 4. 1.00 以下 (1.00 以下 2.00 以下) 5. 1.00 以下 (1.00 以下 2.00 以下)
6. 1.00 以下 2.00 以下

※ 品目
1. 1.00 以下 (1.00 以下 2.00 以下)
2. 1.00 以下 (1.00 以下 2.00 以下)

1. 1.00 以下 2. 1.00 以下 3. 1.00 以下 4. 1.00 以下 5. 1.00 以下 6. 1.00 以下 7. 1.00 以下 8. 1.00 以下

※ 品目
1. 1.00 以下 (1.00 以下 2.00 以下)
2. 1.00 以下 (1.00 以下 2.00 以下)

SOT-A200201 6M

※ 品目
1. 1.00 以下 (1.00 以下 2.00 以下)
2. 1.00 以下 (1.00 以下 2.00 以下)

※ 品目
1. 1.00 以下 (1.00 以下 2.00 以下)
2. 1.00 以下 (1.00 以下 2.00 以下)

19.06.03

品名	部品符号	引当指示項目 (コメント)	数量	重量	引当国番	引当品コード	備考
材質・型式・規格・寸法					ステージ移行		
Pipe	CH051-1	FF20 1.6M 80B	10	221	91		+
	CH051-2	FF20 2.2M 80B	10	296	44		+
	CH051-3	FF30 3.3M 50C	10	260	11		+
	CH051-4	FF10 1.1M 50C	10	37	01		+
	CH121-1	FF50 2.2M 40C	10	137	11		+
	DR649-1	OS70 3.7M 65A 8	10	304	27		+
	DR693-1	FF10 1.3M 50C 15	10	42	27		+
	DR691-1	SS70 2.6M 40UB	10	79	87		+
	LX410-2	FF21 1.9M 700ED	10	513	51		+
	LX420-2	FF30 1.8M 65A	10	169	14		+
	FD190-1	SO70 3.1M 25A	10	80	41		+
	FD216-1	SO50 1.8M 50A	10	108	11		+
	FD231-1	FF20 1.4M 65A	10	148	44		+
	FD251-15	OS30 4.1M 15A	10	56	11		+

M L F

2473 209

Fig.7-3(4/8) Pallet on board

MLF

※第一品以外 0知1.第1合受管 (使用不要) 2.合受管 (使用不要)

3.全受管 4.排気管 (使用不要) 5.排気管 (使用不要)

6.現場組立品 8.バルブ

※本作品

1.取組品 (次のステージで本付されたもの)

2.取組品 (別のステージで取組されたもの)

1.式制用4枚 2. 3. 4. 5. 6. 7. 1000mm² 8. 9.

取組サイン 1.次のステージのMLF No

取組サイン 2.前ステージのMLF No

SOT-A280201 参照

※部品番号

1.管理番号

※1. 引当品 2. 外注品

3. 加工品 4. 引当品

5. 取組品

作 成 年 月 日

79.00.00

品 名	部品番号	引当指示項目 (コメント)	数 量	重 量	引当国番	積装品コード	備 考
材質・型式・規格・寸法					ステージ移行		
Pipe	FR232-1	FF61 1.7M 200	10	4.6G70	41		+
	FR233-1	FF50 2.3M 200	10	5.6G70	41		+
	FR259-4	FF20 1.1M 000	10	16.8G70	91		+
	FR402-1	SS30 1.6M 400B	10	5.2NOP	67		+
	FR404-1	SS30 1.6M 400B	10	5.2NOP	87		+
	FR473-1	SS30 1.6M 400B	10	5.2NOP	87		+
	GE011-1	FS50 1.7M 500EB	10	23.4G004	57		+
	L0261-1	FB10 1.5M 65A	10	10.6G79	91		+
	L0261-2	FB10 1.5M 65A	10	10.6G79	91		+
	SW049-1	FF20 1.6M 125A	10	30.6S91	91		+
	SW049-6	FF20 1.0M 125A	10	23.0S91	61		+
	SW157-11	FF10 3.2M 65A	10	26.8S91	61		+
	SW157-12	FF20 .5M 65A	10	4.0S91	91		+
	SW157-13	FF10 4.1M 65A	10	33.5S91	61		+

Fig.7-3(5/8) . Pallet on board

M L F

※第一品目(外) 0加工品 1.合せ管 (1.14以下) 2.合せ管 (1.14以上)
 3. 5ヶ管 4. 10ヶ管 (1.14以下) 5. 10ヶ管 (1.14以上)
 6. 現場加工品 8. パルプ

※本製品
 1. 製品品名(次のステージで本製品のもの)
 2. 製品品名のステージで販売されたもの

1. 式別用本数 2. g 3. kg 4. m 5. m² 6. m³ 7. l 1000m³ 8. t

取付サイン 1. 込のステージのM.L.F No

取付サイン 2. 出のステージの M.L.F No

SOT A280201 参照

※部品重量

1. 管理重量

※1. 引当品 2. 外引当品
 3. 加工品 4. 引当品
 5. 取付品

79, 06, 08

品名	部品符号	引当指示項目 (コメント)	数量	重量	単位	引当品番	製品品コード	備考
材質・型式・規格・寸法						ステージ移行		
Pipe	SW215-1	FF20 2.0M 150A	10	51.9	G7U	91		+
	SW216-1	FF50 2.3M 100A	10	34.6	G7U	91		+
	SW236-1	FF20 .9M 65A	10	12.3	G7U	91		+
	SW241-1	FF10 3.6M 125A	10	60.2	SS1	61		+
	SW497-5	FF20 .9M 125A	10	21.1	SS1	91		+
BC GLOBE VALVE								
BC FGU 16025	FO-007V		10	57	NOP		4032210091	+
SF SCREWED GLOBE VALVE								
SF M-S FGU 40006C	CA-006V		10	15	NOP		4033410511	+
SF GLOBE VALVE								
SF/SUS FGU 20025	CA-001V		10	7.1	D75		4033450091	+
SPECTACLE FLANGE (SS)						W4C69291		
SPECTACLE FLANGE (SS)	EX-001F	5K-700 SS	10	94.7			406525100	+
SIGHT GLASS								
SIGHT GLASS FC 5K 50	EW-005K		10	3.3	D79		4068351000	+
GASKET								
ASBESTOS PA 5K 400U			40	00			540840110710	+
GASKET								
ASBESTOS PA 5K 500U			20	00			540640110010	+
GASKET								
ASBESTOS PA 5K 650U			40	00			540640110910	+
GASKET								
ASBESTOS PA 5K 800U			60	00			540840111010	+
GASKET								
ASBESTOS PA 5K 1250U			40	00			540840111310	+

品名	M.L.F. No	自 2005年	次のステージ

品名	パレット重量	管理重量	総重量
	293	293	293
	2150	2150	2150

1002 1 0 7 42 PMO. 36

Fig.7-3(6/8) Pallet on board

M L F

コンテナ内
の品目
1.2.3.

※ 1.品目外 0知工費 1.合費等 (計167千円) 2.合費等 (計167千円)
3.全費等 4.体費等 (計167千円) 5.体費等 (計167千円)
6.現場加工費 0.00円

※ 4.品目
1.製品品 (次のステージで仕入れられたもの)
2.製品品 (前のステージで仕入れられたもの)

1.式組出本数 2. 3. 4. 5. 6. 7. 1000m² 8. 9.

SOT-A2302019M

※ 部品系
1.管理部品

取込サイン 1.次のステージのMLF No

取込サイン 2.前ステージの MLF No

※ 1. 引当品 2. 引当品
3. 加工品 4. 引当品
5. 加工品

79,06,00

品名 材質・型式・規格・寸法	部品符号	引当指示項目 (コメント)	数量	重量	単位	引当箇所 ステージ移行	部品コード	備考
GASKET								
ASBESTOS PA 5K 2500U			20	0.0	1		540840111610	+
GASKET								
ASBESTOS PA 5K 650J			20	0.0	1		440840210910	+
GASKET								
ASBESTOS PA 5K 7000J1			10	1.0	1		440840217510	+
GASKET, WIRE NET INSERT.								
ASBESTOS PA 5K 5000G1			10	1.2	1		440840417110	+
GASKET								
ASBESTOS PA 10K 150U			10	0.0	1		540841110310	+
GASKET								
ASBESTOS PA 10K 200U			20	0.0	1		540841110410	+
GASKET								
ASBESTOS PA 10K 250U			50	0.0	1		540841110510	+
GASKET								
ASBESTOS PA 10K 400U			10	0.0	1		540841110710	+
GASKET								
ASBESTOS PA 10K 650U			10	0.1	1		540841110910	+
GASKET								
ASBESTOS PA 10K 800U			10	0.1	1		540841111010	+
GASKET								
ASBESTOS PA 10K 1000U			10	0.1	1		540841111210	+
GASKET								
ASBESTOS PA 10K 1500U			10	0.1	1		540841111410	+
GASKET								
ASBESTOS PA 10K 400J			20	0.0	1		440841210710	+
GASKET								
ASBESTOS PA 10K 500J			10	0.0	1		440841210810	+

M L F.

PAGE 213

M L F

[illegible]

STUDY REPORT ON SHIPBUILDING
FOR
NATIONAL STEEL AND SHIPBUILDING CO.

Volume IV
- Palletization -
Addendum

October, 1979



Ishikawajima-Harima Heavy Industries Co., Ltd.

TOKYO, JAPAN

CONTENTS

1	PREFACE	
CHAPTER 11	MANHOUR SAVING IN DESIGN ENGINEERING	2
CHAPTER 111	MATERIAL PROCUREMENT	5
CHAPTER IV	TECHNIQUE FOR SCHEDULING	10
CHAPTER v	APPLICATION OF PALLETIZATION	
CHAPTER VI	RECOMMENDATION PREPARED BY NASSCO	15

ADDENDUM

CHAPTER I - PREFACE

From August 6 to 31, 1979, IHI engineers stayed at NASSCO for presentation and discussion on palletization based on their prepared text book "Palletization". This addendum supplements the text book finalized through discussions with NASSCO people and covers some additional topics discussed in the meetings for review and reference.

The recommendation prepared by NASSCO at the end of our stay is attached to this addendum as a reference.

It should be stressed that we wish and are sure that NASSCO will enjoy conspicuous improvement in productivity if all NASSCO people from the top management to the production workers fully understand the concept and procedure of palletization as presented by us and palletization is gradually implemented according to the detailed program to be carefully made based on the recommendations with necessary modifications thereto in course of implementation, if any. We have to also mind you that it is NASSCO'S responsibility to decide how and to what extent palletization shall be implemented including reformation of organization, application of pre-erection outfitting, selection of ships and zones to which palletization shall be applied (step by step), education and training of personnel etc. and to track and evaluate the results.

CHAPTER II - MANHOUR SAVING IN DESIGN ENGINEERING

Palletization is a means to make production jobs simple-. By utilizing palletization systematically jobs can be shifted from the bands of trained *workers* to those of untrained workers.

Practices, "knowhows and many other knowledges for outfitting which trained workers usually-have are *transferee* to untrained workers through explanation of the drawings. As a matter of fact, good productivity is almost brought *from* good drawing which is production oriented.

This means actually that good amount of information for production has to be moved from the work force to the design office. A designer has to spend his time *more for thinking of the* grouping of materials: a unit, suitable location of boundaries between the groups of materials: the best sequence for installation, additional reinforcement for the unit, location of pipe joints, location of scaffolding etc.

It burdens the design department more manhour. Even though we can save comparatively a large production manhour at the sacrifice of design department, .i.e, increase in design manhour. Of course, we have to make utmost efforts to minimize the increase in design manhour as much as possible by rationalizing design procedure or introduction of improved techniques.

It can be approached by following ways:

Standardization

Computerization

Photographic technique

Reducing number of the drawings

Editing design:

Standardization is one of the most useful ways to reduce the *design* manhour: when it is applied to various areas relating to design/such as material design, functional design calculation, making diagrams material listing for a pallet, material assembling for a unit, design procedure, vendors drawings if possible etc.

Computerization is also powerful for reducing manhour, when it is applied to production oriented design such as material listing, pipe piece drawing and its material listing, electric wiring drawing and its material listing etc.

Photograph is also useful especially for preparation of production oriented drawings such as making composite drawings or developing working drawings from composite drawings.

Reducing number and kind of drawings is also-effective for manhour savement.

Design manhour is approximately in direct proportion to the number of drawings. Principally, production oriented design requires more number of drawings than conventional design, because the drawings

are issued, in principle, by zone, stage and trade not by *system only*. But, it is just a principle, so actually the drawings by zone, trade and stage can be combined into one drawing if the place is not congested by outfitting materials. For example, one drawing can include several zones, stages and trades. But the planning (i.e. making drawing list) should be so made as the combined drawings do not give the work forces any inconveniences for their use of the working drawings for installation.

Now, we explain a concept of the Editing Design .

The Editing Design is one of the approaches to reducing design manhours as well as keeping good design quality by accumulation of experiences. It means that the drawing is, as much as possible, completed by only editing standards or composing parts of drawing, which are well organized to reform a new design by means of combination of the previously prepared standards or modular design. In other words, the "Editing Design" is an attempt to complete a drawing by paste and scissors instead of a pencil and a ruler.

CHAPTER III - MATERIAL PROCUREMENT

1. In-Time Preparation of Materials

One of the key points to improve the productivity of outfitting jobs is preparation of materials in time.

If we can prepare all materials necessary for a work before starting, we can easily accomplish the work by the most productive way and save manhour. But if we can not, the missing materials will not allow the most productive way for our work and cause the idle time for waiting the coming of the materials. This is essential.

If material preparation is perfect, the productivity could easily go up without any implementation of new method such as palletization.

Good material preparation can be achieved by a good material control system supported by people in all organization throughout the shipyard. Because good results can only be produced from good data which are fed by people through the computer system.

Therefore, people who relate to production - sales, design, material control, planning, scheduling - as well as foremen and workers shall have high interest in the in-time preparation of materials and positively contribute to their role to be done in both formal and informal communication route.

Designer shall have the greatest interest in the material procurement,

The material procurement starts from *the design phase* - material design, vendor evaluation selection, material listing etc.

For example, as soon as a contract of a new ship is awarded to the shipyard, the initial designers (scientific) have to list the particular materials to give a prior notice ---- to the people in detail design, material control and production department because to prepare the listed materials in time is important for giving the shipyard profit.

This list has to list:

Materials which have long lead time,

Materials delay of which must give a considerable negative *impact to* productivity,

Materials which are expensive,

Materials cost of which would be abruptly changed in near " future, etc.

Some times; a *part of this* list must be made even while a negotiation between a shipyard and a ship's owner is going on, when the negotiation is going too late *or* when the in-time preparation *for some* materials seems to be difficult because of a strong seller's market.

This list shall be made by the help of the people in material control and production.

Material control people shall have special attention to these particular materials *for* their preparation.

At the time to determin priority of material procurement, all materials shall be evaluated very carefully; considering two points mainly . One. is the *cost*. If some particular material is expensive, it is of course important to make an effort to reduce the cost by negotiation with the vendor because it could give us big profit without any effort in prociuction. Another is degree of influence over the productivity if a material would not be prepared before starting a job. In case-that some material is one of the parts located at the end of an assembly, delay or lack of the material . during the work does not cause manhour losses so much, because the jobs can be continued without that *material* and without any chahge of work sequences regardless: its *cost*.

But if the material is *located at* the center part of the assembly, delay or lack of the material. will disturb all of the assembly jobs and cause a lot of idle time for waiting the material., changing work sequence or rearranging work order.

2. Evaluation of the Cost of Material

When a vendor is going to be decided by its offered specification and price evaluation of material cost *shall be* carefully done by taking consideration of both material cost and installation cost. It is noticed that person in charge of material purchasing has a tendency to select cheapest material ignoring its installation cost because of his tight budget,

People in production should have much interest in *the* in-time preparation of material. At the beginning of the production planning, their task about materials is to let the design people know what materials are vital for their installations. During the production, they have to pay attention to storing, receiving or manufacturing situation of the *vital* materials not only inside shipyard but also manufacturers shop and to inform material expediter of critical delivery date to keep their schedule. For it is the production people who is best aware of the importance of punctual receipt of materials and troubled by delay of materials most seriously. And if they find any problems in material preparation (manufacturing, receiving from vendors or storing) they have to warn the material expediter of the problems.

The material expediter must always track situation of material preparation and if any problem is perceived he should warn the vendor or manufacturer of the problem without delay and, at the same time, inform the production people of the same problems for

them to cope with the situation by adjusting outfitting schedule or changing job sequence in well advance. Becacse manufacuring of marerial has wide relationship between various organizations such as shipyard organizations for material procurement, vendors, manufac-turexs, raw material suppliers, parts suppliers and so on.

CHAPTER IV - TECHNIQUE FOR SCHEDULING

(PERT VS BAR-CHART)

For scheduling technique of today, the "PERT" is a very popular method as well as the conventional bar-chart method. PERT is a very useful and powerful tool when it is applied to project type jobs, for example development of a particular technology, *research* for some manufacturing procedures, innovation of materials etc. because of reasons;

- 1) Activities and events composing a network can not be defined previously. Sometimes new activities are added and originally scheduled ones deleted while the job is carrying out because, in the project type job planning, nobody can completely define all activities beforehand because there can exist many unknown factors.

Manhours and resources required for completion of each activity difficult to be estimated.

Sometimes *manhours* and resources allocated to the each activity are positively changed to comply with unexpected matters such as unexpected results, discoveries etc. because, flexibility is the most important thing for the control of this kind of jobs.

! path ? !

The critical passes are not clear, because the network for these jobs are *always new* and important thing is study of network itself.

On the contrary, when the PERT is applied to routine *type of* jobs such as shipbuilding, "PERT" method is not so powerful because:

- 1) Activities and events composing a network are usually very clear.
- 2) A shipyard has many experiences. The workers are continuously building ships in proved ways. Planners and schedulers know all necessary activities and events in detail. Even in the case of a new type ship building, all they have to do will be only partial correction of standard schedule.
- 3) Manhours and resources are very steady.
We have good parameter for the manhour calculation and know well how to allocate or how to plan resources;
- 4) The critical passes are clear, because we" know the shipbuilding process very well. through many experiences.

In addition to the aboves, the bar-chart type scheduling is superior to the "PERT" in *this* case by the following reasons:

- 1) Tracking of schedule every day is very easy and we can easily grasp progress of the jobs at a glance of the bar-chart type schedule, which is not so easy with "PERT".
- 2) On the PERT, modification and adjustment are rather easy but grasping the situation caused by these modification and adjustment are not so easy.

If we want to grasp-the situation, we usually have to use an output from *computer*, displayed by the bar-chart type, which : costly and takes time,

One of the merits of the PERT is flexibility in its scheduling. But, we think, too-much flexibility in the outfitting control is not always good. Rather, we would like to Say, schedu stiff gives-us good proeductivuty in the field of shipbuildingti Because a type of scheduling such as outfitting jobs composed of *their activities which are* not *much* different in importance is liable to cause delay from one to next, like the domino, if the the schedule of the key events is left flexible, which should be fixe for keeping total schedule.

Consequently , we can say that the shipbuilding scheduling by the bar-chart type is better than by the PERT type.

CHAPTER V - APPLICATION OF PALLETIZATION

IHI members had a observation of the destroyer tender under construction at the pier and discussed feasibility of palletization at NASSCO.

And we noticed that the palletization is applicable to the engine room and the protection deck we observed And if the unit outfitting method is applied, productivity can be improved without much difficulty

At the same time, we found that:

- 1) These compartments seem to have enough room for application of the unit outfitting method. (Sometimes it requires wider room than for the conventional method)
- 2) Arrangement should be more production-oriented.
 - a) Piping should be grouped and run close to machinery which are major parts of the unit.
 - b) Piping should be run as straight as possible and parallel to the grating.
 - c) Pipe bending angle should be limited to 90 degree, 45 degree and so on. (Sometime this, . production oriented arrangement can be done at the sacrifice of the function oriented arrangement)
 - d) Some machines which are installed closely shall have common foundation instead of individual ones.

- 3) The unit outfitting method is effective for the engine room and on-block outfitting for the protection deck. (Especially for overhead outfitting)
- 4) The pre-outfitting method does not seem to be so effective for the accommodation spaces because completion of jobs (eg. installation of furnitures¹) at early stage and protection of furnitures from damage during hull construction are difficult.

*L) Because the hatch covers have to be fixed both on the deck and the ceiling.

Complete application of the palletization presupposes complete organization which is production-oriented and prepared for the palletization.

On the way to the final target, the organization must meet with many problems and difficulties, especially in getting people to have right understanding and consensus for new system. For example, even a draft has to know what does *this MLF mean?* or *"How does delayed issue of M affect to the production?"*

It would result in confusion in many fields to try to implement palletization in full scale from the very beginning. Instead, if implementation of the palletization is so planned as to expand gradually from small portion ship-by-ship, for example, engine room for the first ship, engine room and protection deck for the second ship and so on, implementation will be successfully accomplished without my big trouble but with solving problems by your hand on the way.

The gentle implementation would be better than the rash implementation.

CHAPTER VI- RECOMMENDATION PREPARED BY NASSCO

For reference, we attach hereto the document "PALLETIZATION" which is prepared by your Program Management Office based on our presentation as recommendations to NASSCO's top management.

Followings are the contents.

1. DEFINITION
2. RECOMMENDATIONS
3. IMPLEMENTATION PLAN
4. PALLETIZATION FLOW CHART
5. SCHEDULE CHART (REINED)
6. SCHEDULE CHART (DISCU_SED)

PALLETIZATION

1. DEFINITION

Palletization is simply a concept to organize materials as they will be used in the shipbuilding process. Implementation of a palletization system demands knowledgeable preplanning at the very onset of a contract. It is this detailed advanced planning by experienced shipbuilders that provides the following benefits:

- a. An advanced bill of material organized to facilitate earlier procurement.
- b. Visibility for zone outfitting, i.e., on-unit, on-block, and on-board.
- c. Integration of information between departments (Engineering, Production & Materials).
- d. Defines production responsibility (lead trade concept).
- e. Results in production oriented drawings reflecting the most economical shipbuilding methods (composite drawings).
- f. Collects specific outfitting materials necessary for production person to complete a defined increment or work (work package).
- g. Assures consistency of all schedules from the top, down.

2. RECOMMENDATIONS

That NASSCO adopt the IHI palletization concept as outlined herein by appointing a committee to develop system procedures & documentation. Concurrently to system development, it is also recommended that the principles of palletization be applied to the T ARC 7 contract to a limited degree to include only the machinery space, the auxiliary machinery space and the accommodation areas of the ship.

3. IMPLEMENTATION PLAN (system development & application to T ARC 7 Contract)

- a. Establish a committee with the following responsibilities:
 - o Develop format for advanced & final bill of material
 - o Determine pallet size & pallet numbering system.
 - o Assure compatibility with existing systems.

- o Act as Chairman for palletization meetings
- o Develop standard practice & system documentation.
- o Assure consistency with all current company policies and procedures.
- o Institute training to assure all departments are sufficiently indoctrinated with the principles & goals of palletization
- o Study applicability to Carlsbad & AD-44 contracts.
- o Monitor departments for compliance to plan.

b. Engineering

- o Develop arrangement drawings & system diagrams.
- o Prepare advanced bill of material (MLS) from system diagrams. Advanced B/M's by SYSTEM by ship zone will result in earlier procurement of materials
- o Design Engineers to develop preliminary composites for each zone to determine system routing. Preliminary composites to be used to determine candidates for "on-unit" and "on-block" construction. Organize meetings with production engineers/planning department to determine "on-unit" and "on-block" construction.
- o Develop final composite drawings.
- o Develop system drawings from final composites, if required. Develop supplemental working drawing for "on-unit" and "on-block" construction as required by production.
- o Prepare final bill of materials.
- o Investigate restructuring of Engineering Dept

c. PRODUCTION/PLANNING & PRODUCTION CONTROL

- o Establish a production engineering group. Advanced planning accomplished by a combined effort of design and production engineers requires a thorough understanding of economical shipbuilding methods. Palletization of material (purchased and/or manufactured) requires the following information:

1. Zone - Where does the material go within the ship?
2. Trade - Who installs the material? Who is responsible?
3. Stage - What stage of construction is the material installed?

Competent production engineers will provide the answers to the above questions thereby assuring the most efficient construction methods.

Therefore, the production engineer will -

- o Define and schedule the contents of the pallet. Pallets to be structured (as indicated above) by zone, by lead trade, and by stage of construction.

Lead trades are defined as:

Shipfitter - hull structure, miscellaneous outfitting items.
Pipefitter - piping systems.
S/M fitter - ventilation and selected outfitting items.
Machinist - machinery installation.
Electricians - electrical
Rigger - rigging

- o Review and approval of preliminary and final composite drawings. General Superintendent to be responsible for preliminary and final composite drawing approval.

- o Develop the lead trade concept. By definition, each pallet would assign trade responsibility. Palletization provides a clear understanding of responsibility and authority.

- o With assistance from the facilities dept., develop an "on-unit" construction area staffed with the required trades reporting to a single supervisor.

- o Structure all material in the SPARDIS system in accordance with the pallet concept, i.e., zone/lead time/stage of construction.

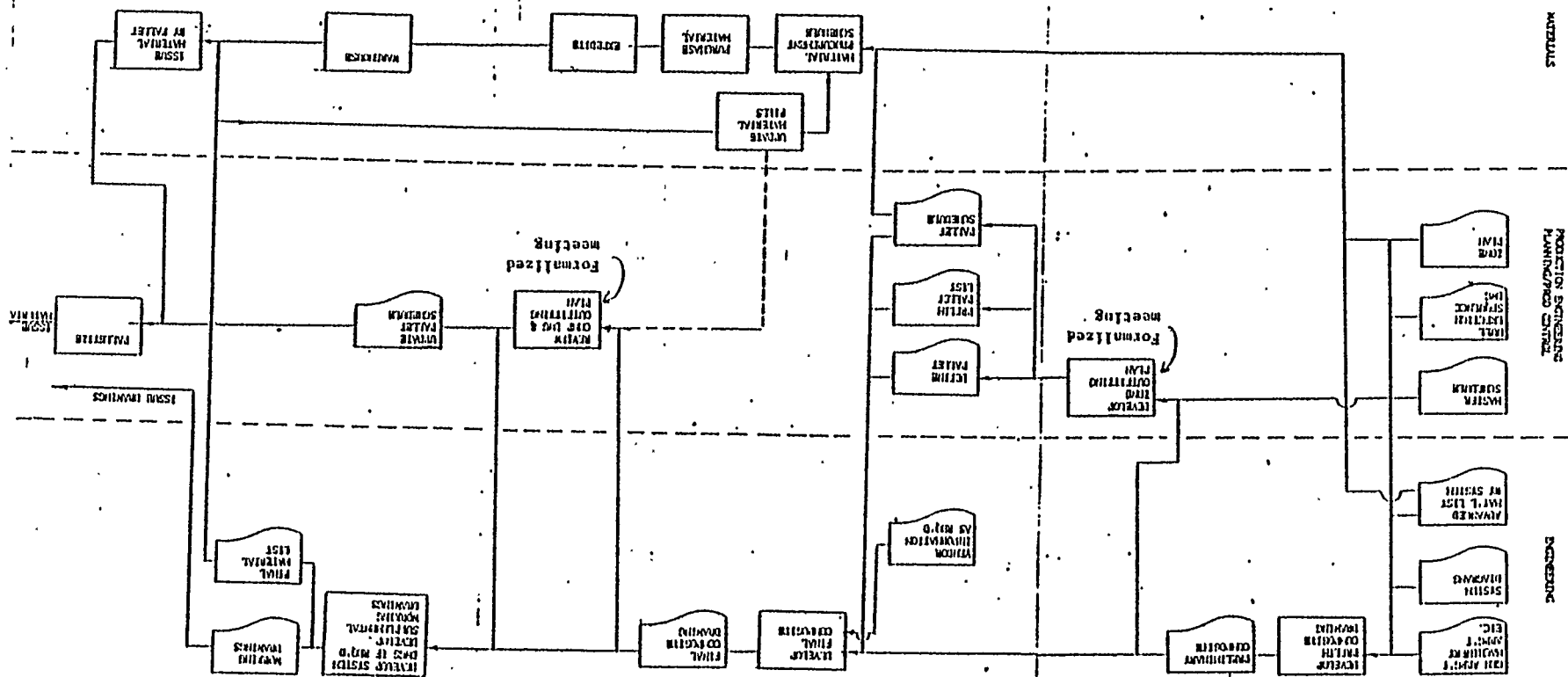
d. MATERIALS

- o Develop material "lead time" history for establishing preliminary bill of materials (MLS)
- o Define (with assistance from the facilities dept) requirements for a marshalling area, possibly two (2) adjacent areas; one for purchased material and one for manufactured parts.
- o Palletize and issue material.
- o Develop awareness of the importance of the material schedule. Palletization concept will function only if all materials are in the shipyard when needed by production. Missing materials must be minimal.

4. ADDITIONAL RECOMMENDATIONS/ASSUMPTIONS

Additionally and in support of palletization, the following recommendations and/or assumptions are provided:

- a. That NASSCO significantly increase "on-unit" and "on-block" construction.
A prerequisite for "on-block" construction assumes:
 - 1. Construction of large three (3) dimensional hull blocks suitable for pre-erection outfitting
 - 2. Implementation of Accuracy Control
- b. Development of Standards
- c. Develop a policy for vendor selection, i.e., evaluate total cost (including production labor) to shipyard.
- d. Investigate IHI's pipe piece program.



4. PALLETIZATION FLOW CHART

2024-25

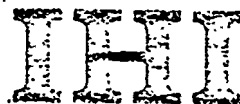
2024-10-24

2024-10-24

STUDY REPORT ON SHIPBUILDING
FOR
NATIONAL STEEL AND SHIPBUILDING CO.

Volume V
- A SURVEY REPORT ON SHIPBUILDING
PROCEDURE. AT XASSCO

November, 1979



Ishikawajima-Harima Heavy Industries Co., Ltd.

TOKYO, JAPAN

A SURVEY REPORT ON SHIPBUILDING
PROCEDURE AT NASSCO

1. PREFACE	1-1
2. LAYOUT	2-1
2-1) Building dock and building ways	2-1
2-2) Pipe shops	2-1
2-3) The flow of hull construction	2-1
2-3-1) To establish the idea of	2-1
"Sub-assembly" and to set up the	
specialized "Sub-assembly yard"	
2-3-2) Bending rollers and press machines	2-3
3. FACILITIES	3-1
3-1) Implementation of the One Side Welding	3-1
equipment for a flat panel unit	
3-2) Implementation of the EPM system	3-2
3-2-1) Characteristics of the EPM system	3-2
3-2-2) The problems of the EPM system	3-3
3-3) Implementation of Pin-jig system	3-4
3-4) The NC frame bender newly developed	3-4
by NASSCO	
3-5) The existing NC burning machine	3-5
3-5) The existing Flange Press Machine	3-5
4. ENGINEERING	
4-1) Design structure of ship's hull	4-1
4-2) Working drawing	4-2
4-2-1) Structure details around the	4-2
erection joints	
4-2-2) To minimize scallops	4-3
4-2-3) The pieces of outfitting	4-4

4-3)	Expression on the working drawings	4-4
4-4)	To install the computer programs of	4-5
	Pipe Piece Drawing and Pipe fabrication	
5.	COMPUTER SYSTEMS	5-1
5-1)	Improvement of output	5-1
5-2)	The system to be more production oriented .	5-1
5-2-1)	SPADES system	5-1
5-2-2)	The scheduling function of SPARDIS ...	5-4
5-3)	Establishment of the parameter of the	5-4
	work volume	
5-4)	Piece mark system (Code system)	
6.	PRODUCTION METHOD AND WORKMANSHIP	6-1
6-1)	Hull units of Fore and Aft parts	6-1
	of a Ship	
6-2)	Category of Hull units and Assembly yard . .	6-1
6-3)	Flat Panel Unit Assembly	6-3
6-4)	Curved Panel Unit Assembly	6-3
6-5)	Three Dimensional Unit Assembly	6-5
6-6)	straightening of Welding deformation	6-7
6-7)	Cable Wring on Board	6-7
6-8)	pipng in tile Machinery Space	5-7
6-9)	Painting	6-7
7.	CONCLUSION	7-1
7-1)	HULL production	7-1
7-2)	Outfitting	7-2
7-3)	Feed Back System	7-3

A SURVEY REPORT ON SHIPBUILDING
PROCEDURE AT NASSCO

1. PREFACE

This report was made by IHI in accordance with the NASSCO Purchase order No. 90997 Item4 "Dispatching IHI's Engineers to NASSCO".

The survey at NASSCO was conducted from August 16, 1979 through August 28, 1979 by IHI team headed by T. Ishibashi and accompanied by S. Kohtake and . . K. Noguchi.

The survey for improvement focussed on the production field as the source of the shipbuilding business among many aspects such as sales, purchasing and many others. The survey was done through the observation of the shipyard and hearing from the related personnel of NASSCO.

2. THE LAYOUT OF THE SHIPYARD

The area of the site at NASSCO (145 acre) is about 1.5 times as large as that of the IHI-KURE (96 acre) and it is wide enough to maintain its steel fabrication of 7,000 tons per month. However the storage area of materials and completed hull unit were found not being well-arranged. Planning and administration for usage of the site area including transportation should be improved.

It is important in this subject to harmonize the long ranged planning (for several years) and the short ranged operation (weekly or daily). Therefore IHI-recommends to reinforce the responsible organization for better planning.

- #1 Daily storage schedule for completed hull units and pallets even scrap
b a g s .

Following are the problems found on the layout.

2-1) Building dock and building ways

It would be better to shift both the houses with roof and the area for scaffolds located at the dock side to another place, because the covering area of the cranes for erection is useful for units storage.

The sheet iron shop fabricating ducts and vents can be easily shifted to the side of the shipyard or the outside of the shipyard since they are light and easy to carry.

Taking account of advantage to keep enough storage area, assignment of the building dock and the building ways is recommended to follow the next priority : #1 building dock → #3 building way → #4 building way/#2 building way. Because following this sequence, both sides of the building dock or the building way can be effectively used as the storage area for the completed assembly units and as the area for pre-outfitting.

2-2) pipe shops

The present flow of pipe fabrication at NASSCO is discontinued because of being separated. In order to raise its productivity, it is recommended to rearrange those shops so as to make the smooth flow from the storage area of pipe material through the area for pipe pallet.

2-3) The flow; of hull construction

The process of parts fabrication and unit assembly of ship's hull is rather long and complicated. In order to simplify the process, the following studies are suggested .

2-3-1) To establish the idea of "Sub-assembly" and to set up the specialized "sub-assembly yard" :

The "Sub-assembly" referred herein means "small assembly" before as-

sembly such as web frames girders and large brackets with stiffeners.

To keep the specialized "Sub-assembly yard", work shops for bollards and, ladders can be shifted to another place out of the fabrication shop.

In addition, taking account of smooth transportation, the stock yard for small subs and semiprocessed goods which are located at the opposite side of the assembly area in the fabrication shop ; should be shifted to the nearer place.

2-3-2) Bending rollers and press machines

From viewpoint of adjusting the work load for bending machines, it is recommended that these machines are gathered to the same place so far as smooth production, flow is not disturbed.

Present layout at NASSCO for this field is needed to rearrange in consideration of implementation of Line Heating Technology. For that improvement, Some dynamic Simulation. and study based on the volume of the work load are requested. Regarding this IHI can assist if ordered.

3. FACILITIES

Following matters on the facility should be carefully studied as well as the improvement of working practice and layout IHI recommends to make use of IHI's experience and achievement.

3:1) Implementation of the One Side Welding equipment for a flat panel unit

Since there are merits and demerits depending on the welding method as described below, careful study and selection is necessary.

Adjusting and operating the equipment require certain skill. Repair works are sometimes requested after welding. Edge preparation at the welded surface requests a certain level of accuracy.

Alternate method should be considered in the time of its machine-down.

-selection of the welding methods should be made comparing their merits and demerits :

o FCB Process

(Flux Copper Backing one side submerged arc welding)

o RF Process

(RF-1 Flux one side submerged arc welding)

o FAB Process

(Flux Asbest Backing one side submerged arc welding)

IHI recommends to adopt first FAB process for which no additional equipment is needed.

- In Japanese shipyards, the one side welding was adopted to prevent the building for plate assembly yard from becoming high for turning over the panel as the size of unit becomes larger and to establish the conveyor system.

3-2) Implementation of the EPM system (Electro Photo Marking system)

3-2-1) Characteristics of the EPM system:

Since the EPM system brings high productivity per area, it is suitable for the shipyard of which site area is narrow. In addition, the EPM seems to be the best machine to transfer the information and data for production such as edge preparation, stiffeners location, plate thickness shifting direction, stiffeners fitting angle, leg length of stiffeners welding and many others as well as parts name. This characteristics is especially effective for repetitive construction. From such reason, many Japanese shipyards installed the EPM system, which is still in now use.

However, the implementation of the EPM to NASSCO is not aggressively recommended by IHI from the following problems.

3-2-2) The problems of the EPM system :

- Since optical projection error is unavoidable, the vital dimensions such as the depth of floors are needed to be checked after the EPM process.
- In order to keep clear pictures, uniform quality of drawn lines on the negative films are required. For that, a NC drafting machine is indispensable. The drafting machine at the Mold Loft of NASSCO is not adequate, therefore a new machine should be installed.
- The characters and lines are sometimes projected ambiguously on the steel plates which are not treated with shop primers.
- its running cost is not cheap, because the spreading powder (called photoner) is expensive.
- The computer program for drafting is needed to add some features in order to make EPH system effective.

Some additional burning tools by hand should be prepared such as : straight guide rails, magnetic tracers and semi-automatic burning tools.

- There are several combinations as the total EPM system with conveyers and platform cars. In order to select

the type and to install the system, a deep study for layout and production process is required.

3-3) Implementation of Pin-jig system

The Pin-jig system is the most fundamental to fabricate a curved shell unit in high grade of accuracy. The existing pin-jig system at NASSCO is urgently needed to be improved.

The Pin-jig system can be also used with the Multi-burners Line Heating Machine. IHI has the same type of the Pin-jig system at the Tokyo shipyard. IHI recommends for NASSCO to install this type of the system. With respect to this, more details are presented in the chapter 6 of this report.

3-4) The NC frame bender newly developed by NASSCO

Since the NC frame bender newly developed by NASSCO was not yet in practice, it is not easy to state any comments at this moment. However IHI recommends to confirm the following matters before practice.

- Accuracy at both ends of a bent frame because these parts can not be accurately bent by its theory. Concrete counter-measurements for that and shaping method after the process should be established.
- The control of the neutral axis of plastic deformation

Checking method after bending

3-5) The existing NC burning machine

For accuracy control of pieces, following should be confirmed :

Investigate the machinery accuracy,
record and adjust

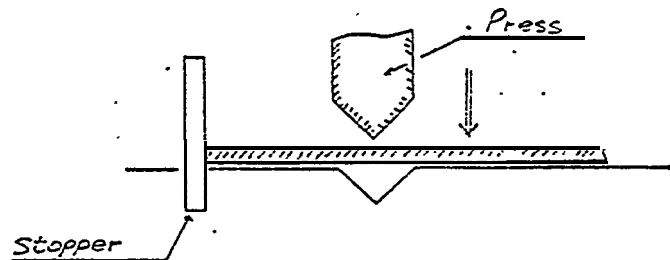
Establish the Maintenance procedure .
and execute

Consider the nesting scheme and cutting
sequence to minimize deformation by
heat distortion

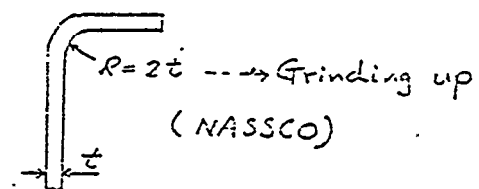
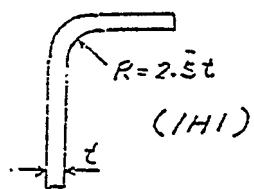
Study to change the marking equipment
from "Center-punched marking" to "LINE
marking"

3-6). The existing Flange Press Machine

To set the flange edge stopper f o r
higher grade of accuracy.



To prevent lacking at the flange
corner, larger radius is recommended.



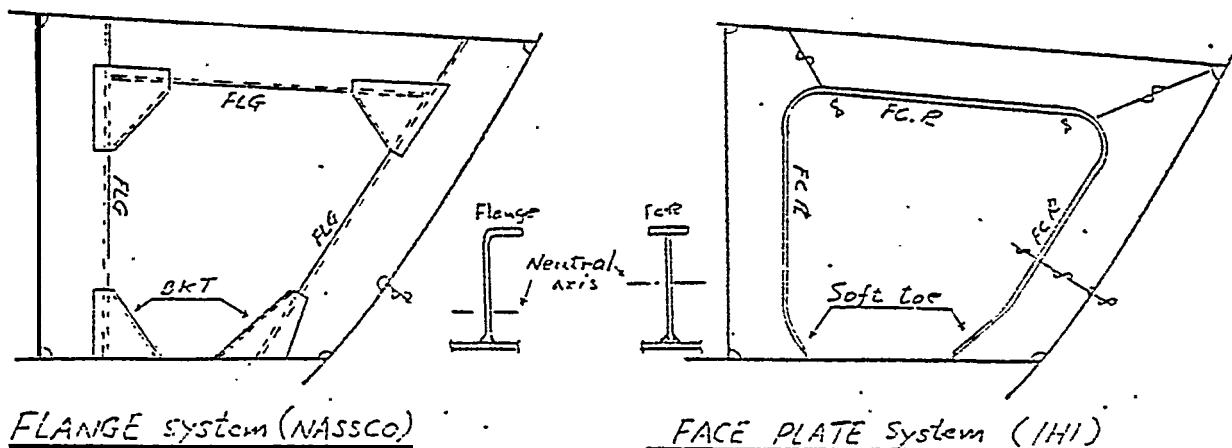
- Standardize design of flange and standardize production practice

4. ENGINEERING

4-1) Design structure of ship's hull

Flange system is one of the characteristics of design structure of ship's hull at NASSCO. IHI ceased to apply the system twenty (20) years ago except at flange bracket but adopts the face plate system instead by the following reasons. From viewpoint of structural design, the face plate system is superior to the flange system. And the face plate system can save weight to keep the same strength compared with the flange system. In addition; the face plate system has another merit that the location of erection joint can be decided more flexibly for easy shipwright comparing with flanged girder connection.

The flange system may be cheaper than the face plate system for NASSCO at present. Because no welding work at the face plate is necessary. However it is recommended to adopt the face plate system instead of the flange system from the reasons described above



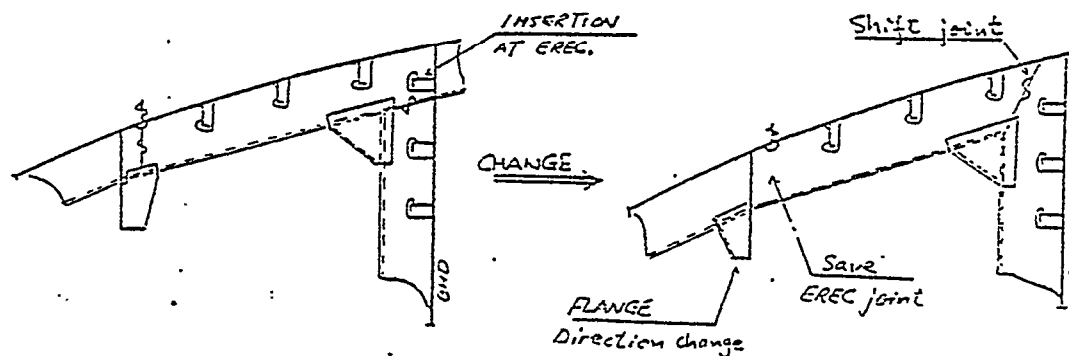
4-2) Working drawing

From the viewpoint that working drawing is to display the structure details based on the target as to how to assemble a unit and how to construct ship's hull, the following points are recommended to be improved. Most of following problems can be improved by standardization.

4-2-1) Structure details around the erection joints :

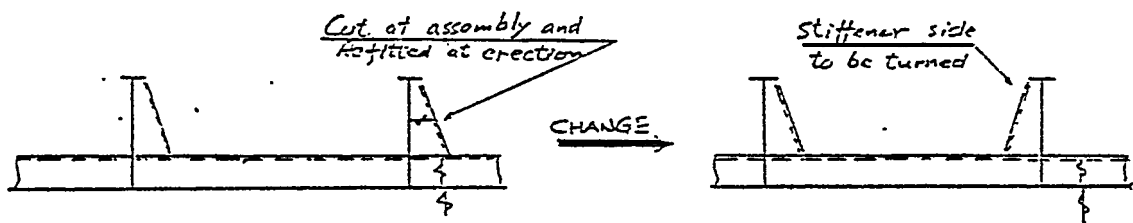
The shift of erection joints between the skin plates and the internal members should be changed for easy connection and for easy shipwright as well as for saving welding length.

The flange direction of the internal members and/or the position of the erection joints at the skin plates should be changed so as to prevent "insertion shipwright" due to inappropriate flange direction.



- The fitting surface of the stiffeners and the brackets to the web plate sh-

ould be selected so as to minimize the short pieces fitted after shipwright.



4-2-2) To minimize scallops :

The scallops should be minimized because of uneffective fillet welding by hand at the corner of the scallops and the convenience of painting. Therefore the scallops should be set in the following limited cases :. the place requested air escape and water stop and the place where welding must be through later.

To solve this problem, following consideration can be available. When all pieces and subs are simultaneously landed and then assembled, no scallops is needed. When some internal members, such as longitudinal frames are welded first and then the other members, such as web frames are landed, corner snips can be applied at the fillet welded part in-

4-2-3) The pieces of outfitting" :

- A large duct in the pump room can be assembled as the part of the ship's hull, because its plate thickness is thick enough (1/4").
- The structure of the bollard can be more simplified. The bottom plate of it has four curved surfaces at NASSCO, however this structure can be more simplified.

4-3) Expression in the working drawings

From the viewpoint that the working drawings should contain only necessary informations in easy expression, it is recommended to review the contents and expressing method of the working drawing at NASSCO. For "that, the survey on "what informations are used by whom and how?" is needed. The tedious expression affects bad effects such as difficult follow to design change, complicated appearance and wasting man hours.

Following is recommended by IHI to simplify the expression in the working drawings.

Establish expression standard and issue the standard booklet to be referred by its users

- Build the standard in the computer program for the thorough application
- Describe the promised symbols in the working drawings

-Example of the concrete objects

- o Leg length of fillet welding
- o Welding method
- o cutout (slot)
- o End shape of stiffeners and sections
- o Type. of valve

4-4) To install the computer program of Pipe Piece Drawing and Pipe fabrication

IHI has developed a series of computer programs of pipe fabrication. Using the calculation results of the Pipe Piece Drawing, editing of the fabrication lot, making the cutting plans and scheduling of pipe fabrication are now in practice. The input work for the Pipe Piece Drawing program from the piping arrangement plan is very easy to learn.

It is recommended to study installation of the computer system together with the planning of the new pipe shop and palletization.

5. COMPUTER SYSTEMS

Many big computer systems are now used in many fields. The computer program itself can be seen in high grade so far as computer technology. However its applying method for practical use based on the actual production process should be improved. Those system shall be fruitful when the following problems are solved.

5-1) Improvement of output

Much computer output sheet were found being piled up without being referred. Distribution of output sheet should be limited since many display terminals have been already installed and through which necessary information can be inquired at the required time.

For easy reference, output should be expressed in the form of bar chart and curve graph as much as possible instead of alphabet and numbers.

5-2). The system to be more production oriented

To make the computer system fruitful for its users, the system should be more production oriented. Taking SPADES system and the scheduling function of SPADES as examples, a few problems are pointed out as follows :

5-2-1) SPADES system :

SPADES is to be the nucleus system to support the hull construction field. According to further investigation by

IHI engineers, each module can be seen generally good enough to cover its primary purpose. However a study of how to use each module is urgently requested to fulfill the needs from accuracy control and line heating technology. It does not necessarily mean to change/improve the computer program itself but to consider the usage to match the request.

- Rearrangement of the Users manual :

The users manual of the SPADES-system is too general for the users of Engineering department and Mold loft. Because the manual was edited and distributed to the all user shipyards of which design practice, production practice and grade of skill are different from each other. It is natural for the users to have the manual of their own.

Especially, NASSCO is going to promote accuracy control and line heating as the basic technology to support accuracy control for curved shell unit. What should be kept in mind here is the fact that these activities are proceeded by the output from the computer program, SPADES, as the media for information transmission. In other words, the manual for the input data to derive the necessary informations from the system and to include those information in the output is very important. And also through

this activity, the idea for improvement of the system itself can be imaged up.

Rearrangement of the output :

For the convenience of production, the outputs should be completed by themselves. If necessary, additional informations should be included by hand writing ; it means production people do not need to refer to another reference or another kind of output.

When several kinds of output are needed such as curved shell assembly on pinjig, those should be put together.

Refinement of the programs for curved shell :

According to further investigation by IHI engineers, the modules of PINJI and PLATDV of SPADES are not necessarily enough for precise development and bending of plates and for precise positioning and checking at plate assembly on pinjig. Some of them can be supplemented by using together with the "Manufacturing Aids" module of SPADES, however the others have to be obligated to add required data by hand.

It is recommended to refine those programs in the future after recognition of the said problems through practice use.

-5_2_2) The scheduling function of SPARDIS :

The scheduling program at NASSCO was observed to be good enough for grasping the current status of the production process, however it seems not to be practical so far as the function of planning is concerned. This kind of system is requested to be a good tool for the production cycle Plan

- Do ... >See>Action . - If its usage is not appropriate nor practical, the result brings confusion only. .

For smooth implementation of the computer scheduling system, it is recommended that the managers of each level plan the master schedule by himself and trace it by hand. Through this, they can recognize the current status, the capacity the neck points and critical path of their own field. In addition, communication between different levels and between different departments can be easy by adjusting the master schedules at the time of planning and tracing. After the hand-made scheduling system is well done, the computer scheduling system can be installed standing on the procedure confirmed by the manual scheduling.

5-3) Establishment of the parameter of the work volume .

For grasping the present status and evaluation of the productivity as well as planning,

the parameter of the work volume should be selected to be proportionate to the actual work volume as possible.

Weight is the only one parameter for hull construction at NASSCO but it is not enough to express the work volume. IHI recommends to use it together with another parameter expressing welding works such as welding length and weight/volume of welding deposit metal. (IHI adopts deposit meter). This parameter should be selected so be easy to calculated by the computer program with simple input data from the drawings.

5-4) Piece mark system (Code system)

The drawing number, piece name and stage code are expressed with many numbers of alphanumeric character. These code are too long to write at every phase from making working drawing through the final product. In fact, following was observed in the production field :

After welding of the name plate to pipes, the code for piping system and assembling stage are additionally described with a pen.

Piece name is written in the small pieces of Ship's hull with a pen. It is difficult to write in the 1/10 scaled film for the EPM if NASSCO installs the EPM system: .

IHI recommends to make short the code system by the following study:

- o To use the code in the plural levels
- o To give a. certain significance to the code (promised code) -

"If this change of the code system is not easy for the computer system, conversion between the nominal code for human being and the original code for the computer can be performed by a simple computer program. This method makes the system change minimum.

6. PRODUCTION METHOD AND WORKMANSHIP

Recommendation in this chapter are very vital and will surely contribute to high productivity if applied at NASSCO

6-1) Hull units Of Fore and Aft parts of-a ship.

Larger units should be adopted for the curved fore and aft parts of a ship.

NASSCO has;facilities enough for *ha-idling* the larger units of same size with the *ones* of parallel part of:a ship now being handled. 'Application of larger units to decrease "number of units will conspicuously save erection manhour and, in addition, assure easy and effective pre-erection outfitting on block. For smooth application of the larger units to the curved parts, however, higher. accuracy in fabrication and assembly together with simplification of erection joints for easy erection are indispensable, which pre-supposes accuracy control based on standard design.

6-2) category of Hull units and Assembly Yard

Hull units should be categorized into following three.by uniqueness of their structure or assembling method.

(A) Flat panel unit. : A- unit mainly composed or flat panels to be jointed together on the platen.

(B) Curved panel unit :: A.unit mainly composed of curved panels to be join-

ted together on the
pin jigs.

- (c) Three dimensional ' : A unit other than
above (A) and (E)
or -a combination
unit of (A) and (B)

The idea of subassembly is recommended to
establish.

The assembly yard shall be arranged according to the category of hull units and sub-assembly. The assembly sites for the curved panel unit and three dimensional unit are - compatible but. the site for the three dimensional unit should be located nearer to the erection site (births or docks).

The assembly site for units of same category shall be concentrated to one area and not be scattered widely over two or more areas within the shipyard.

Master assembly schedule should be so planned in accordance with above categories of units as to level the work load at each fabrication and assembly phase as much as possible. Then, work load for fabrication such as planer cuttings, No cutting, plate bending, frame bending and subassembly will be leveled concurrently. Even. if complete levelling of work load is difficult, the irregularity in the density of work load at each phase must be minimized by appropriate-allocation of resources, which will naturally result in higher productivity.

In case on-block outfitting is applied, the period for the outfitting should be reserved and expressed in the master assembly schedule for preparation of pallets.

The master schedule is vital for shipyard operation. But reliable raster schedule can not be made without accurate estimation of practical work volume. The planners of master schedule must be familiar with procedure of assembly work at site especially in relation to resources allocation.

6-3] Flat panel Unit assembly . . .

Accuracy control for fabrication of internal structural members and horizontal flatness of the assembly platen are important.

We noticed overhead welding by workers lying on their backs for flat panel units which is of low efficiency and can be avoided by appropriate ordering of assembly sequence.

High accuracy of assembly can not be achieved without horizontal flatness of the assembly platen. The measured inclination of inch per 20 feet of the NASSCO's platen must be improved as soon as possible.

6-4) Curved Panel Unit Assembly

The size of a plate for the curved shell units should be larger.

The size of plate now applied at NASSCO is too small especially for bow and stern parts where small plates requires much joint wel-

ding which can be reduced by adopting larger plates.

For more effective assembly of units, a plate must be larger and more complex bending such as longitudinal or twist bending should be applied. 'Line heating is a technology for this purpose and most effective when applied after bending by roller which is very effective for cylindrical bending but not applicable to multi-directional or twist bending which are most neatly done by line heating.

To apply more complex bending to larger plates, the bending templates currently used at NASSCO should be modified because they are only for transverse bending and not applicable to longitudinal or twist bending. For precise bending, the templates with sight line (edge) introduced in the text book of line heating are recommended.

IHI has studied SPADES system in detail and devised a program to develop templates with sight line from the data given by SPADES which will be introduced to NASSCO at your request.

Next we refer to jigs.

We observed discrepancies between jigs, shell plates and frames to be jointed together which are caused by difference in curvature of shell plates and frame due to inaccurate bending. The workers forcibly align the plates with frames and weld them together. This requires considerable hour of unnecessary

work, degrades accuracy of unit assembly and makes erection work difficult . When there will be discrepancies between jigs, plates and internal members like frames, of course, the jig should be the base. The accuracy of jigs is fundamental and vital for construction of hull units, which presupposes;

- Pin jigs of stable and tough structures
- To confirm that the data for jigs are fair and correct and to check the actual setting conditions of jigs with the confirmed data
- To assemble hull units in conformity with the confirmed jigs.

Nevertheless, if there exist discrepancies between jigs, curved plates and frames, accuracy of materials or calculation method by computer should be checked.

A computer program based on interpolation method such as for fairing of shell curvature, may commit errors in some cases and careful study and thorough understanding of the contents are necessary for adopting a new program. When discrepancies among jigs, plates and frames exist, they must be cleared by thorough probe into the reason thereof.

6-5) Three Dimensional Unit Assembly.

For better accuracy control, prior study should be carefully made as to selection of checking points or lines for right positioning of members or assemblies consideration of sequence of assembly work.

Planning of scaffolding should be made in connection with this study.

6-6) Straightening of Welding Deformation

Welding deformation at unit-completion is conspicuous. The deformation should be straightened at each phase of subassembly and assembly. Total deformation at completion of a hull unit and reforming man-hour will be minimized if the deformation caused at each phase is straightened before next phase even though another deformation will be caused at the next phase. Straightening at each phase ensures easy accuracy control and minimizes erection manhour, which should be the first target for improvement of productivity.

6-7) Cable Wiring on Board -

Electric cables wired in the machinery space of the ARCO tanker under outfitting did not appear neatly wired because they snaked at random. Introduction of wiring winch for electric cables is studyworthy.

6-8) Piping in the Machinery Space

Piping in the machinery space was not so well organized because one system of pipes are installed independently from other system regardless of outfitting sequence. Pre-erection or unit outfitting will improve this condition to much extent.

6-9) Painting

Painting is very good. However the paint to

be welded after erection ^{of units such as block} joints or foot parts of pillars under the girders of machinery flat etc. should be protected by masking tapes.

We learned that NASSCO was studying introduction of weld through shop primer and would like to mind you to pay attention to the demerits of the primer as undermentioned as well as its merits.

Usually, clients are very nervous about painting and many troubles are expected about touching up of damaged primer

- Gas cutting speed should be lower for the primer coated steel plates and, in case of fillet welding of high tensile steel, blow holes are liable to remain in the deposit metal.

Removal of fume generated by gas cutting or welding must be considered because modern primer has tendency to contain zinc.

Our frank opinion recommends NASSCO to conserve the conventional surface treatment by sand blasting which is very effective for the time being while leaving introduction of the shop primer to future study.

7. CONCLUSION

We pointed out several items for your improvement in the production system in previous chapters. We believe that these items are all important and applicable to: NASSCO by themselves but we do not think that these improvement should be started simultaneously because they right bring you some troubles or confusions, at the beginning, by: the people who have not been used to the new method. We, therefore, recommend you to start the improvement from very few items which are essential for reducing manhour, as explained in the preceding chapters.

Note :. So far as we studied in NASSCO, the total production manhour of ARCO tanker is approximately twice or three times as much as that of IHI. We notice that some of manhour would be easily reduced if some of the major points are successfully implemented. Since the cost accumulation classification and method between NASSCO and IHI had many differences, a manhour comparison in detail was not easy.

7-1) Hull Production

In the hull production, the improvement should be concentrated to the unit assembly stage at the beginning.

In an attempt to improve the whole shipbuilding productivity, an improvement for the hull production is more effective than for the outfitting, because the hull production consumes a great deal of manhour in whole for the shipbuilding.

And also rationalization of a hull production system is easier than that of an outfitting system because the hull system is not complicated such as the outfitting system which contains several number of sub-systems and is only a single system. Especially, the improvement should be concentrated to the unit assembly stage because it calls inevitably for improvement of the preceding and following stages ie, the fabrication and erection stages.

The most of Japanese shipyard made improvement successfully by the same way. Their experiences emphasize the points such as :

- A feed back system shall be established for self-improvement of system.
- The implementation shall not be rushed.
- All the relevant people shall be well educated for new system.

Outfitting

In tile outfitting, the improvement should be concentrated to the unit outfitting in engine room primarily and the zone outfitting method secondarily.

Through our observation of the destroyer tender in NASSCO, we noticed that the unit outfitting method is applicable to this kind of sophisticated engine room. It means that the unit outfitting method is probably applicable to all engine rooms which NASSCO constructs. You can repeat the outfitting of the same zone (engine room) by the same

method so that NASSCO people may be easily used to it and expand its application to the other zone. It is also a merit for this recommendation that the units such as a pump unit, a purifire unit, a pipe unit etc. can be assembled in less dependent to the hull construction schedule. Therefore it gives hull production less damage even though we have some troubles upon new outfitting method.

The implementation for on-block outfitting method should be started only after the hull unit assembly stage under being improved becomes steady. Because it is very dependent on the hull unit assembly schedule and has fears to get the hull production into trouble.

In connection with punctual material preparation which must be very serious problem in U.S.A., IHI has total material supply system which prepares materials to a shipyard in package and with the schedule to meet with their construction schedule. It has been applied successfully to several foreign shipyards. It must also be helpful to better material procurement in NASSCO.

7-3) Feed Back System

For successful implementation of the above, a feed back system is indispensable. It shall provide the following functions.

- Defects and inconveniences in production site are to be reported surely and punctually to relevant organizations ie.

Design engineer, Material expediter,
Planning engineer etc.

- Proposals for improvement or creative idea for production are to be transmitted to the relevant organizations as a routine job.

They are corrected by and to a special group who make evaluation and decision for their acceptance and plan for realization for each item.

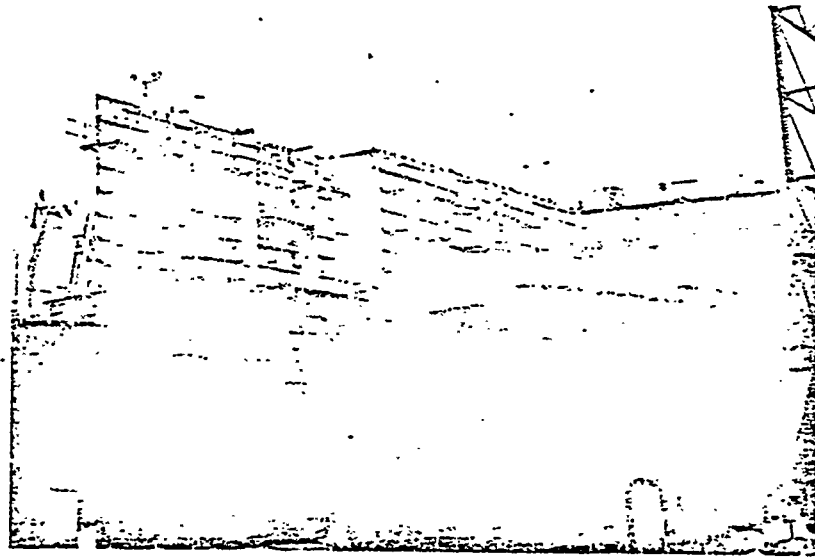
- "Result of each implementation is checked by the group and fed back to the relevant organizations.

This group composes two sub-groups; for hull and for outfitting. Each sub-group should be assembled by the members who belong to various sections in relation to hull production and outfitting. The Group should belong to Production Planning Group in Yard operation Department. If IHI has a chance to dispatch engineers to assist for the implementation of the accuracy control and palletization in NASSCO, they should join to this group.

At the end, we would like to inform you that we could make a recommendation for optimum productive capacity in each yard based on the data of your yard facilities which you gave us and an assistance for the future planning of whole NASSCO shipyard which you might have if you give us the request.

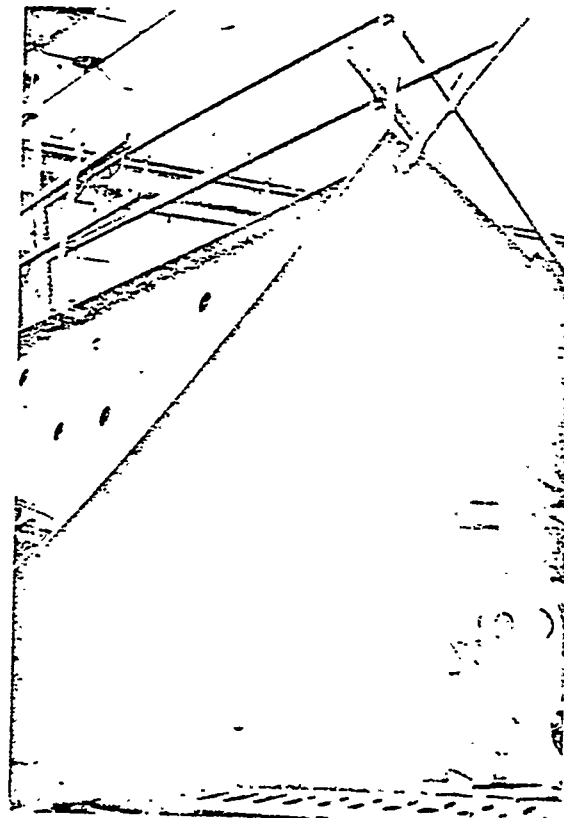
We appreciate your kind cooperation and hospitality given to us by Mr. French and the other members.

FUJICOLOR CO 79

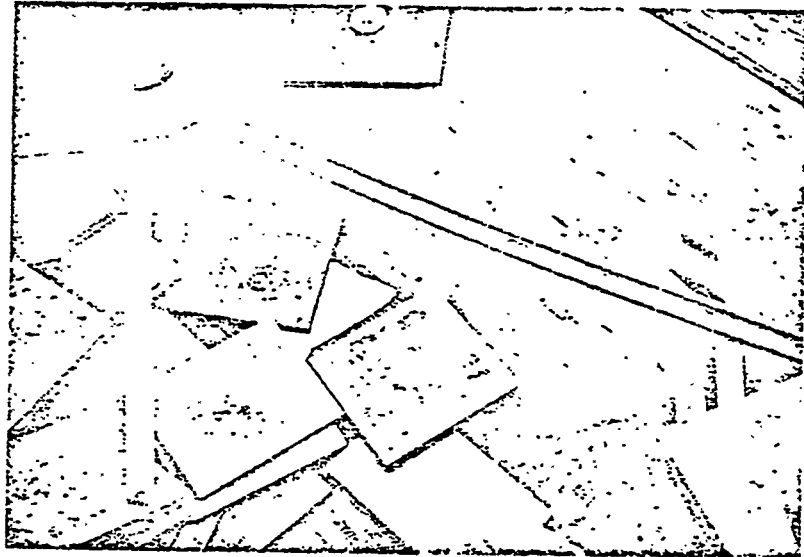


Small and many numbers of units require
more manhours at erection

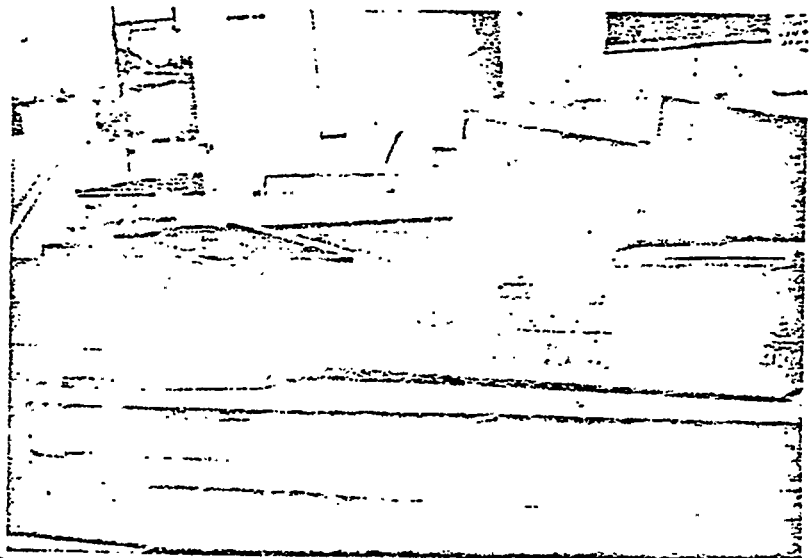
FUJICOLOR CO 79

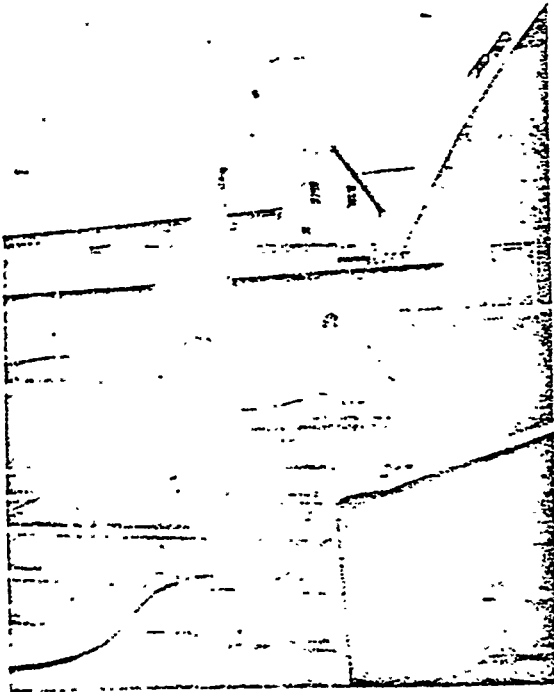


Smaller pieces of
curved shell plates
require more man-
hours to assemble
and weld at assembly



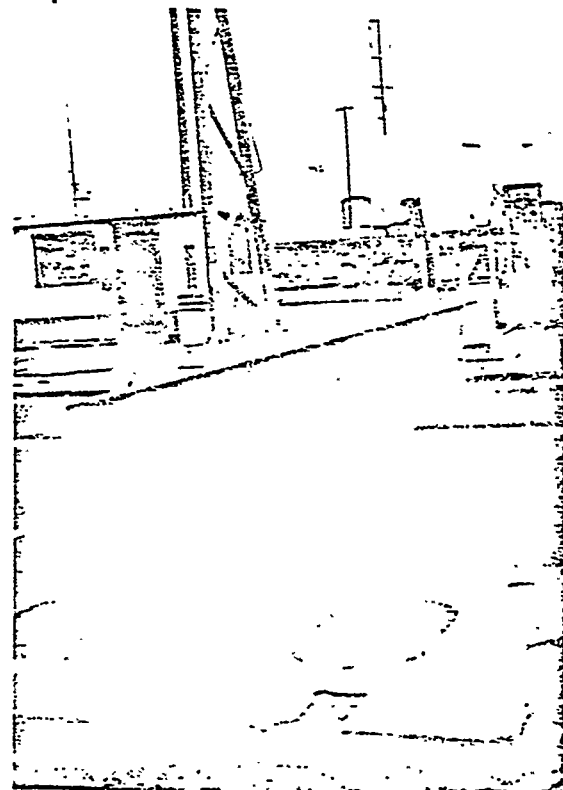
The parts code system is complicated.
(Number of digits of NASSCO's piece
mark is approximately three times of
IHI's one)





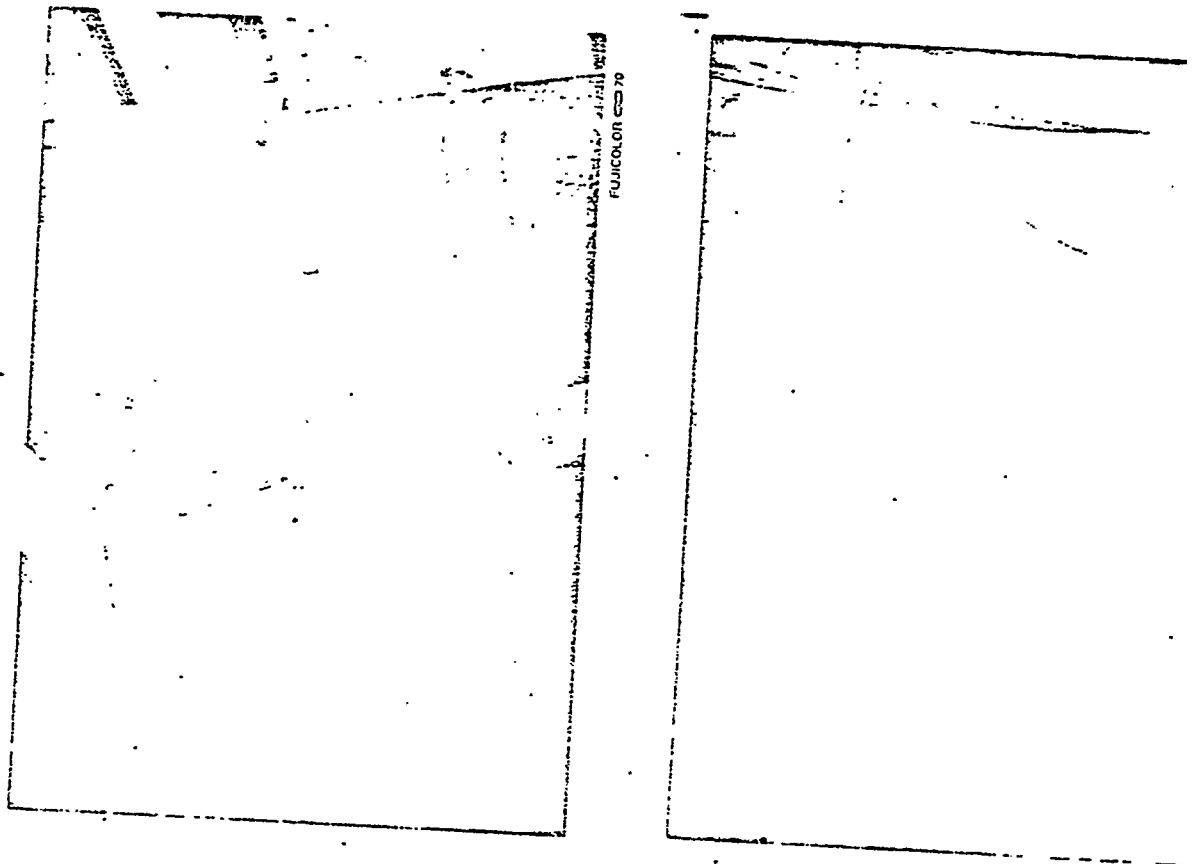
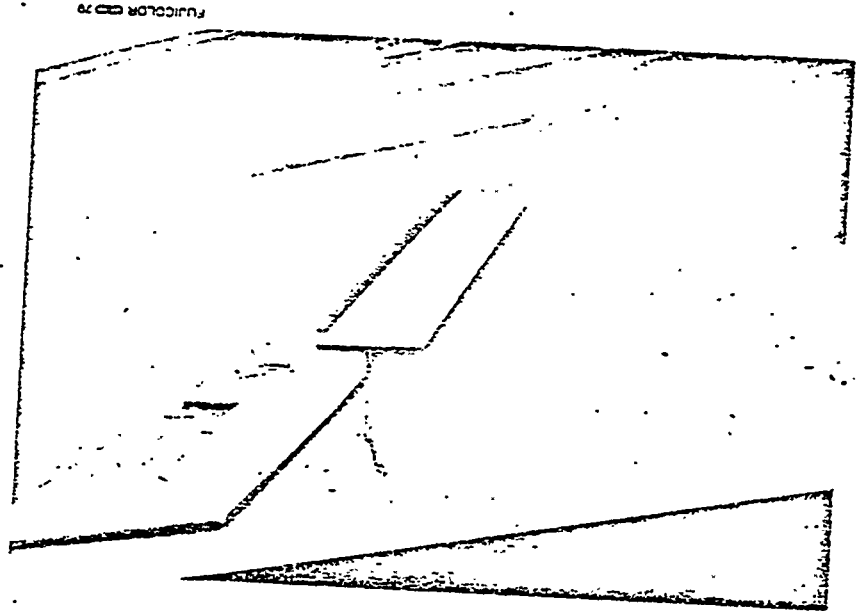
The idea of "Sub-assembly" stage should be established.
 Here "Sub-assembly" means "small assembly".
 The bracket in the picture can be welded in down hand at "Sub-assembly" stage on the flange web frame and then landed together at assembly.

Brackets and stiffeners on a flange web frame can be sub-assembled by down hand welding beforehand.
 Then the sub-assembled web frame can be landed and assembled.
 Thus most of welding can be easily performed by down hand welding through the establishment of "Sub-assembly" stage.

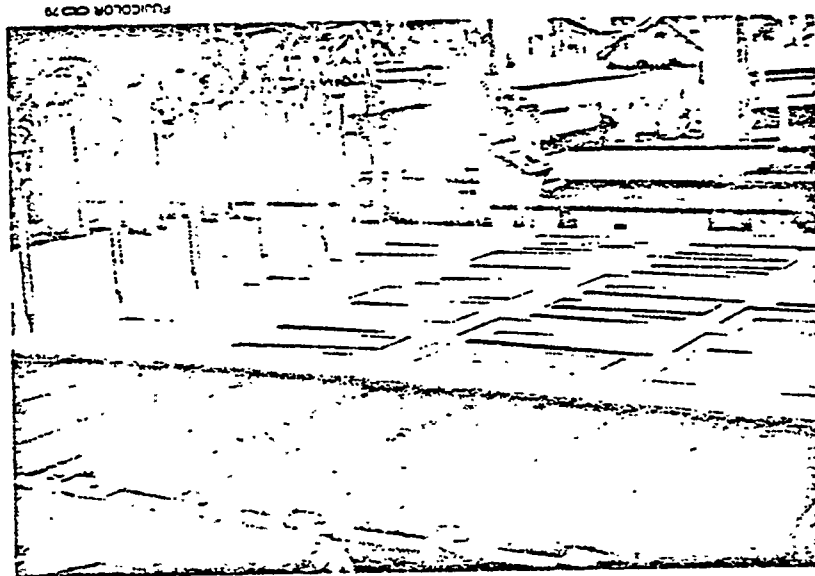


deck long

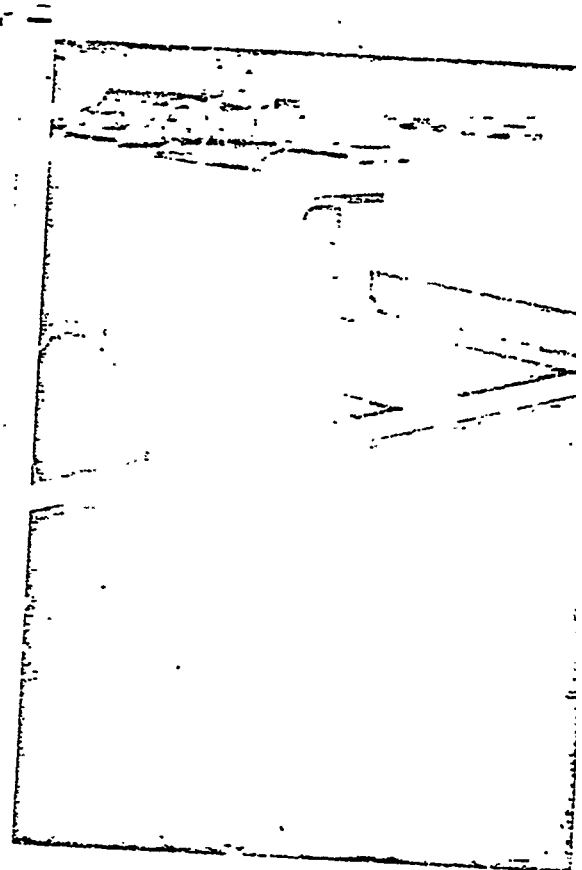
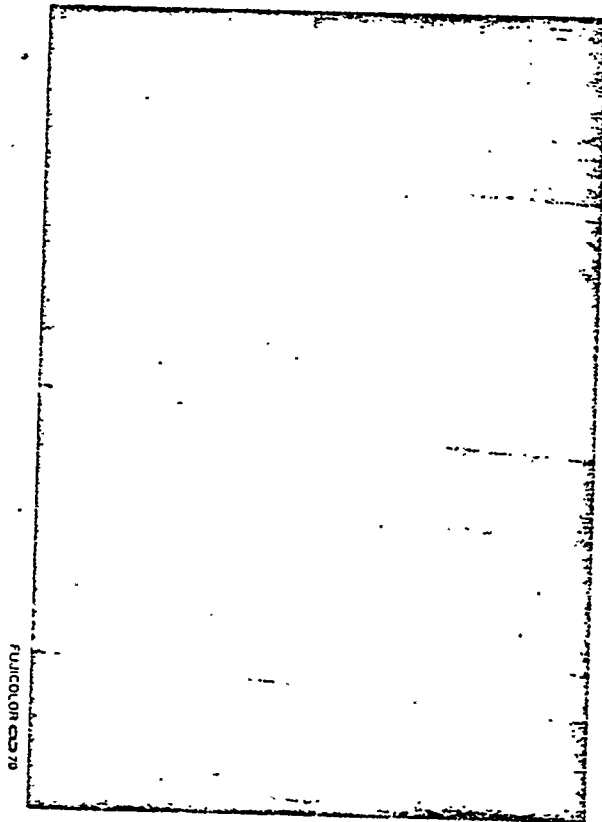
T-shaped carling is inconvenient to welding works.
Flat bar is recommended instead of T-shaped piece
since enough strength can be kept for the purpose.
(IHI adopts flat bars for carling even in 250,000 DWT
tankers)



Cutting small pieces by the optical tracer from a large plate as shown in the pictures may bring high productive gas cutting, however this kind of small pieces. is recommended to De cut from scrap plates to save material.

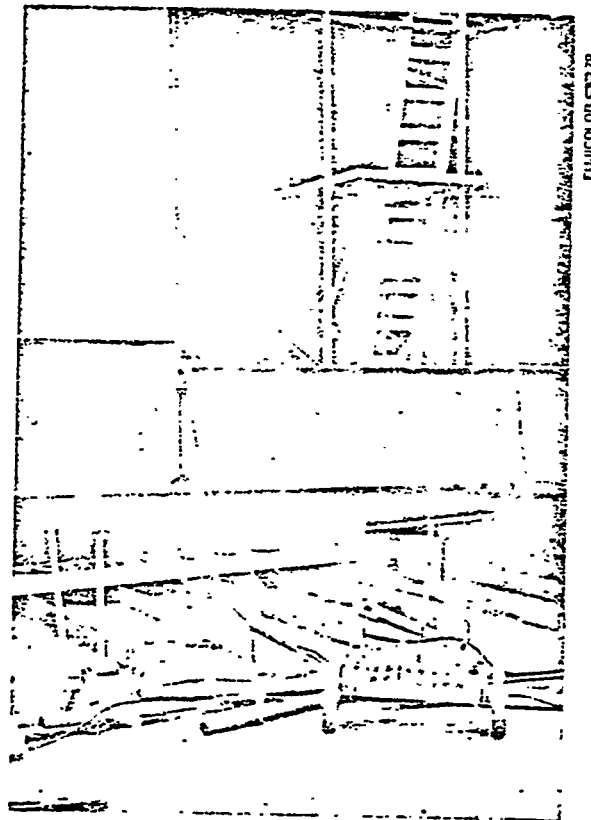


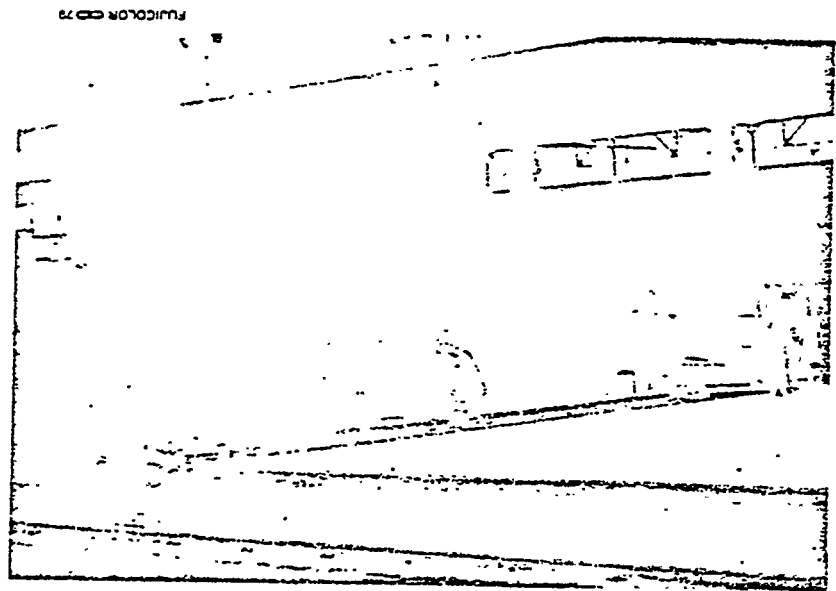
Insert work at erection is very difficult.
In order to prevent insert work, the curtain
plate (margin plate) of the bulkhead should
be included in this unit. (Design change)



The problem around the connecting part between
two flange frames can be solved by the change
of the flange direction and/or the change of the
position of the erection joint.

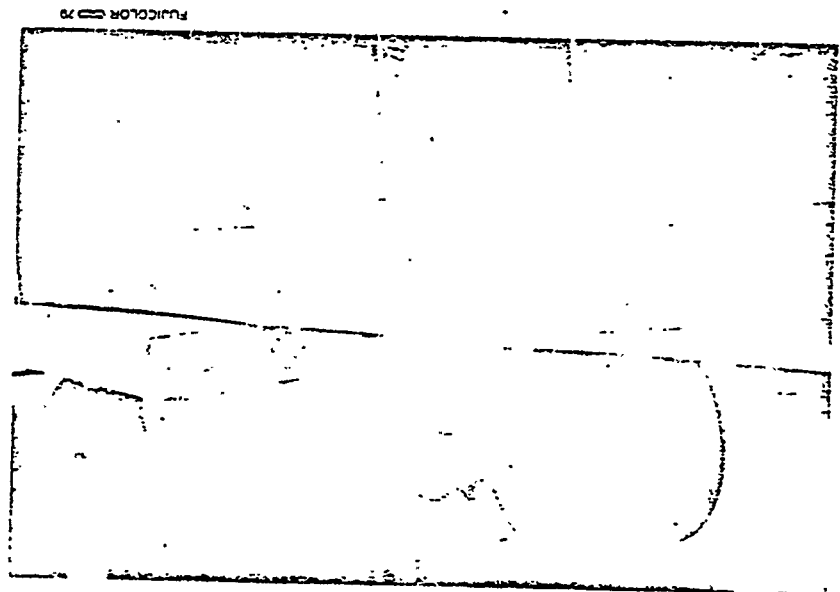
The position of the erection joint
should be shifted.





Insufficient engineering

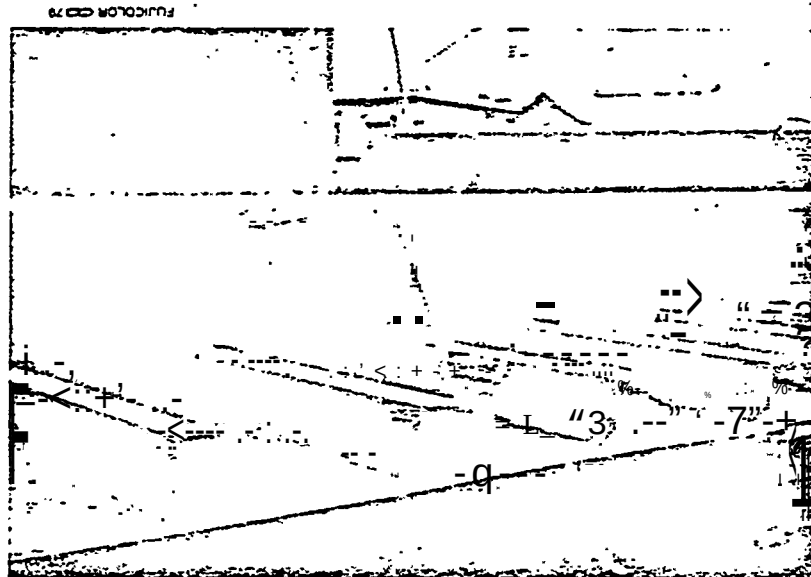
Brackets and that bars are obliged to be gas cut and the parts gas cut of piece are temporarily put near ther After erection, those are rewelded. This kind of reworks were caused by poor engineering. If the stiffeners are fitted to the opposite side of the web plate, the vain reworks can be prevented.



Necessary scallops are not opened. (Poor engineering)
Scallops for erection welding should be opened at the flange webs.

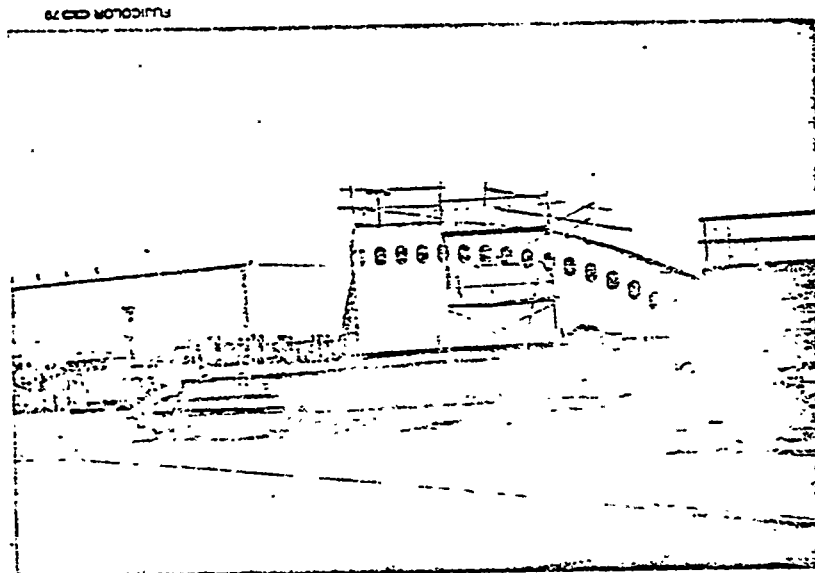
Cutout mis-opened. (Engineering)

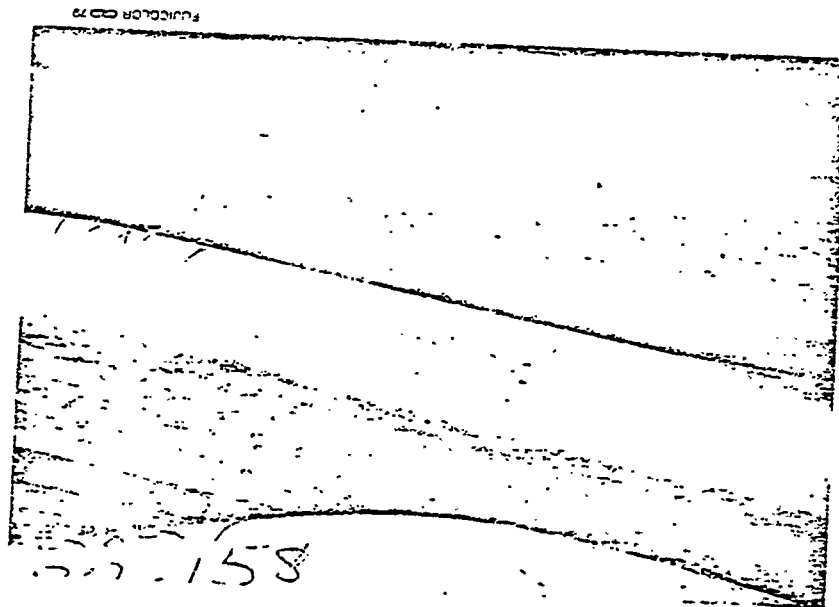
If the bracket is sub-assembled to the flange web, the wrong cutout could be checked by match mark for fitting BKT at the cutout before gas cutting.



Position of access holes (Engineering)

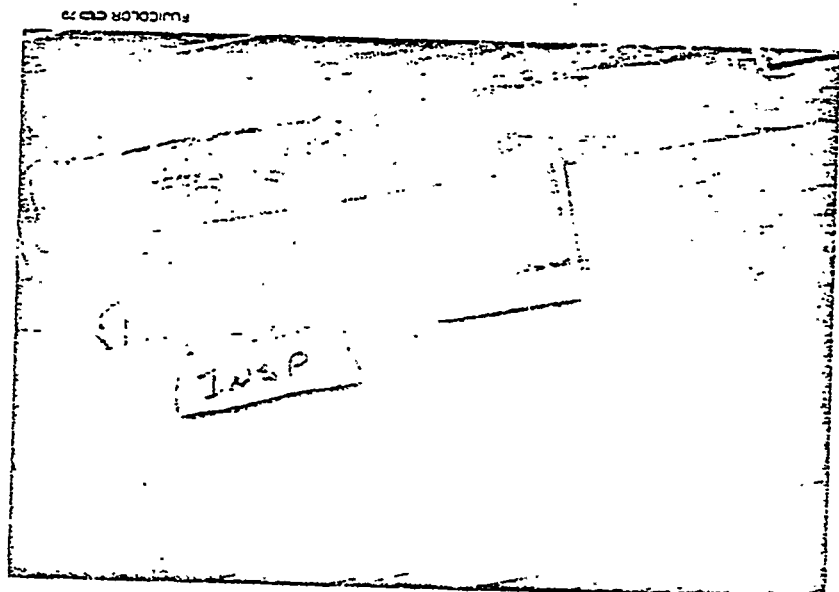
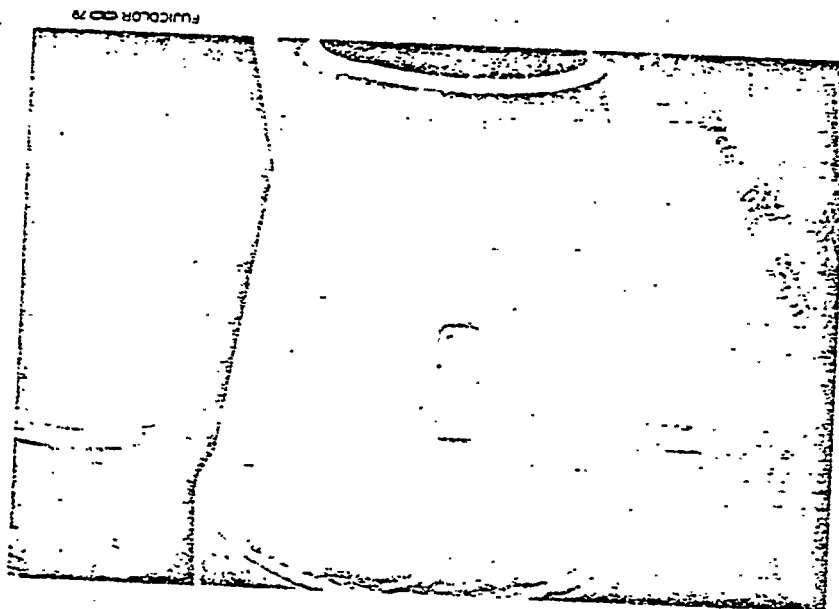
If the position of the access holes are in zig-zag arrangement (the one is near the bottom, the next is near the T.Top), it is more accessible for assembly workers and scaffolding is not necessary.





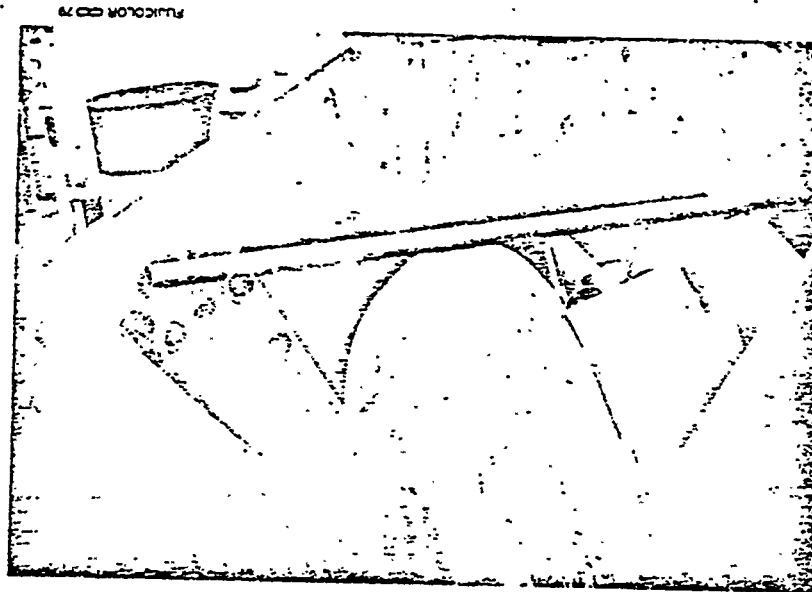
Long pipe pie
code

It is trouble
some to weld
name plate to
each pipe pie



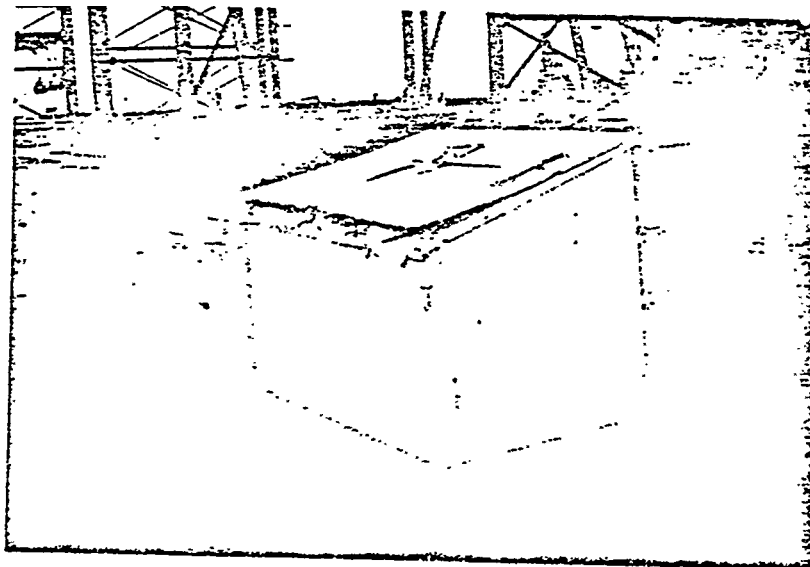
Wasted material (Pipe)

By install of the pipe piece drawing system and pipe fabrication system, pipe scraps can be decreased.



Much computer output sheet

Through improvement of distribution of computer output sheet, output sheet and computing time can be saved.



Wasted material (Electric wire)

