LSCo Report No. - 2X23-5.1-4-I

TECHNOLOGY TRANSFER PROGRAM (TTP)

FINAL REPORT

QUALITY ASSURANCE SYSTEM

Appendix A

Accuracy Control System

QUALITY ASSURANCE

VOLUME 2 APPENDICES

Prepared by:

Livingston Shipbuilding Company
Orange, Texas

March 3, 1980

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Appendix A

Accuracy Control System

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VOLUME 2 APPENDICES

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APPENDIX A

ACCURACY CONTROL SYSTEM

ACCURACY CONTROL SYSTEM

ATTACHMENT:

1) PLANNING OF VITAL POINTS OF ACCURACY
   (HP-122)
2) BASE LINE FOR ACCURACY
   (HP-123)
3 ADDITIONAL MATERIAL PLANNING
   (HP-124)
4) ACCURACY CHECK SHEET
   (HP-125)

PREPARED BY:
K. HONDA
IHI MARINE TECHNOLOGY INC,
OCTOBER 9, 1979

ACCURACY CONTROL SYSTEM

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A. Introduction

I. Preface

II. Purpose of Accuracy Control

III. Accuracy Control System in IHI

I. Preface

A study on the activities of accuracy control system at LSCO. has been now continued along the building process of Hulls 751 and 752 from January 1979.

The study is being developed through "The A.C. Meeting" which was established to review the present method of accuracy control and to introduce the development of Accuracy Control Activity. All IHI's engineers have directly or indirectly co-operated with LSCO'S A.C. Group for developing of Accuracy Control System at LSCO.

II. The Purpose of the Accuracy control

For better understanding, it seems to be significant to remind the purpose and the meaning of the Accuracy Control

IHI considers that Accuracy Control is a system to be supported by all organizations to the shipyard from Engineering, Mold-Lofting, Marking, Gas Cutting, Bending, Welding, Sub-assembly, Assembly and Erection. Accuracy Control system is a series of activities to realize the aim which is given to the shipyard how to construct 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".

Even though there may 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 phase, various kinds of hard works shall be caused by an inaccurately constructed unit. Almost all of these works shall be obligated to be performed on the scaffolding on high position, therefore the working condition is neither safe nor inconvenient for every work.

It has to be recognized that the accuracy at erection comes as the total result of preceding steps to erection such as marking, cutting, bending, fitting and welding. Moreover survey and engineering to realize concrete activities and methods for Accuracy Control should be prometed by all related departments involved from Engineering to Production field. What is more important, is that all the activities for Accuracy Control should be continued systematically without stopping.

III. Accuracy Control System in IHI

Concerning with this theme, the report was presented to LSCO by our Mr. M. Hatake in March 1979. Please refer to the report (FPC-III).

B. Total Scoope of Accurzcy Control Artivity in LSCo.

I. Planning Activity

a. Preliminary Planning

b. Accuracy Planning

c. Standardization

II. Field Activity

a. Preparation of Check Sheet

b. Measuring Activity

III. Feed Back Activity

a. Analysis

b. Improvement

In order that the development of Accuracy Control System be carried out smoothly in this shipyard, Accuracy Control Activities are concretely classified into three (3) kinds of activities as follows:

I. Planning Activity

II. Field Accuracy Activity

III. Feed Back Activity

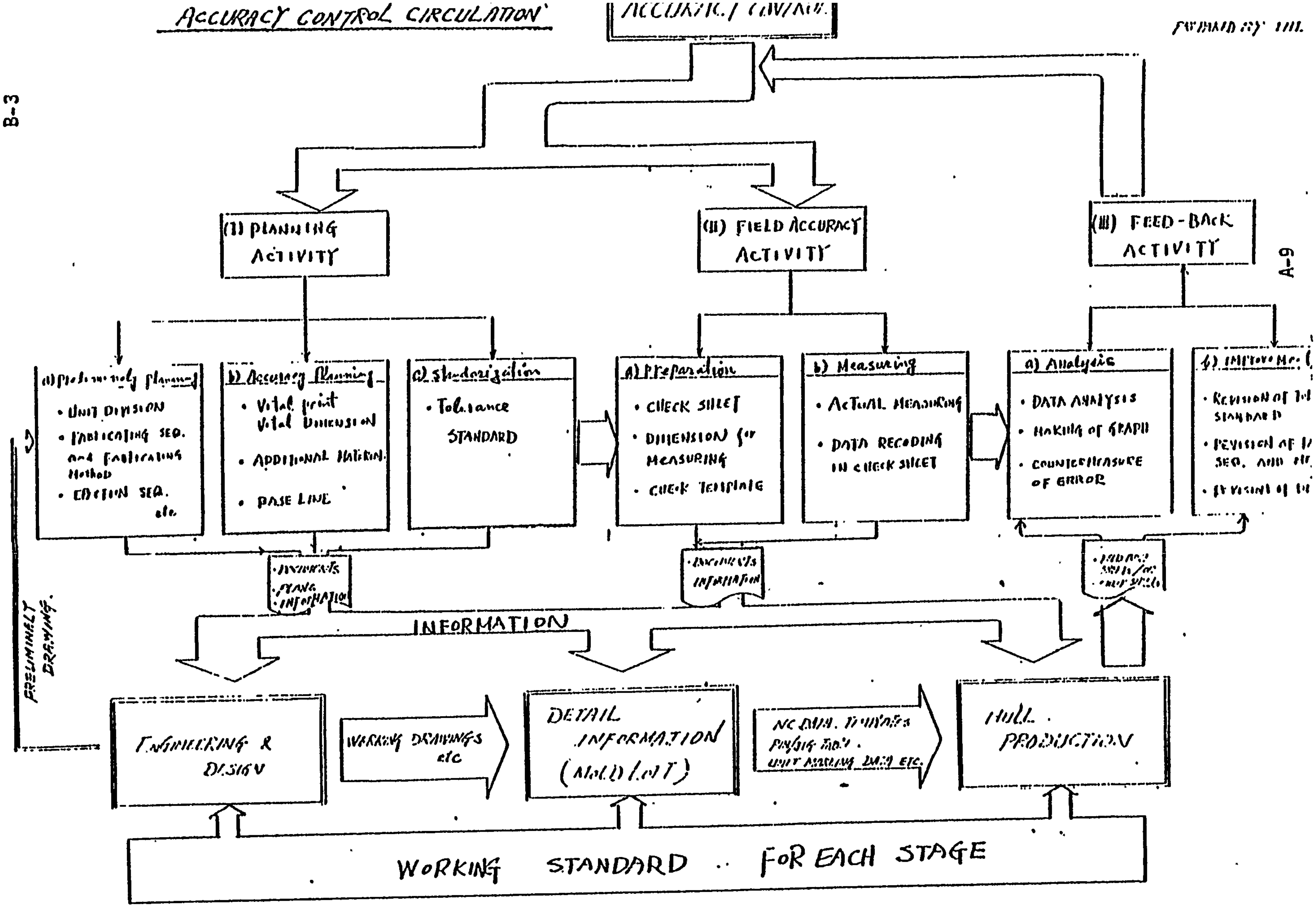
In addition, these activities should be carried out in harmony with almost all processes in shipbuilding hull procedure.

In other words, developing of Accuracy Control activities is related to almost all processes which are Engineering, Mold Lofting, Production Planning and Production Field.

This report displays hereafter the development of above activities, according to following flow chart.

B-3

ACCURACY CONTROL CIRCULATION



A-9

I. Planning Activity

Much territory of this planning activity is usually covered in common area of production planning territory.

In other words, this territory may be included in the production planning activity itself. However, from Accuracy Control point of view, this activity should be defined clearly the territory in Accuracy Control Activity.

From the above reasoning, this chaer displays concretely the developing of Planning Activity.

Planning Activity mainly consists of three (3) activities as follows:

(A) Preliminary Planning

(B) Accuracy Control Planning

(C) Randarization .

(A) Preliminary Planning

Preliminary planning begins as first planning activity in almost all of the plannings of the shipbuilding procedure. This planning involves the following factors:

1) To decide unit division and shell straking.

2) To decide preliminary assembly procedure.

This planning should be carried out at thought of following factors:

1) To consider the facilitation of shipwright with maintaining the accuracy unit shape.

2) To consider the shell straking to obtain accuracy bending plate at-thought of bending technique and facilities.

In order for the above studies to be carried out smoothly, the related sections should be supplied from Engineering, the preliminary drawings such as General Arrangement, Midship Section and Lines which has been planned the preliminary schemes of unit division and shel) straking.

As a matter of cause, Accuracy Control Planner, who is respon. sible to review the scheme with the view of obtaining the accuracy unit, should be supplied the above drawings in order to begin the study of Accurzcy Planning.

After studying the schemes of unit division, shell straking and preliminary assembly procedure, the related section personnel involved Accuracy Control Planner join the meeting to decide finally these above schemes.

Taking account of conclusion of above meeting, Engineering Department begins to develop the key plan such as shell expansion and structure lines.

(B) Accuracy Control Planning

Accuracy control planning is one of the important activities for developing hereafter accuracy control in the shipbuilding hull process.

Therefore, Accuracy Control Planner should have capability for improving production method in order to obtain higher accuracy products.

1. Planning Item

Accuracy control planning is how to decide the following iterns:

a) The vital points for the ship and each production stage.

b) The base line for each production phase.

c) Amount of additional material and the phase to be cut neat.

Detail explanations concerning above items are presented in the attached papers as follows:

1) Planning of vital points of accuracy.

2) Base line for accuracy

3) Additional material planning

In order to make the plan concerning above items, the most significant factor in this planning activity is to carry out the study from a view point of basis upon how to minimize erection works.

2. Information

In order to progress this planning activity effectively, Engineering section and Production Planning section must give information such as drawings and/or schemes involving the following functions to accuracy planners:

1) Structure Lines:

Scaled body plans including seam lines and longitudinal lines.

2) Shell expansion drawing

3) Structure section drawing:

Key plans

4) Assembly construction procedure

5} Erection sequence

On the basis of above informat,ion, A.C. planning activity prepares two kinds of new information to develop the following steps:

a) For working drawing development

The information consisting of amount of additional material and cutting neat phase from accuracy planners are given to Engineering section before drawing development work begins. This information is indicated in the working drawings in order to inform the mold loft and production field.

b) For Mold Lofting and Field Accuracy Activity

Other information such as vital points and base lines, are given to mold loft section and field activity group in order to prepare the mold loft output and check sheets which are included in above information.

II. Field Activity

Field Activity is to realize concretely the planning activity in harmony with actual production field.

Field Activity consists of two (2) kinds of activities as follows:

(A) Preparation of Check Sheet

(B) Measuring Activity

(A) Preparation Of Check Sheet

According to working drawings issued by Engineering and information of A.C. Planning, the check sheets are prepared by this activity.

A.C. Group designs measuring sheet in which checkpoints, checking method, responsible personnel for measuring and frequency of measurement are involved.

Preparation of check sheet should be classified according to production procedure as follows:

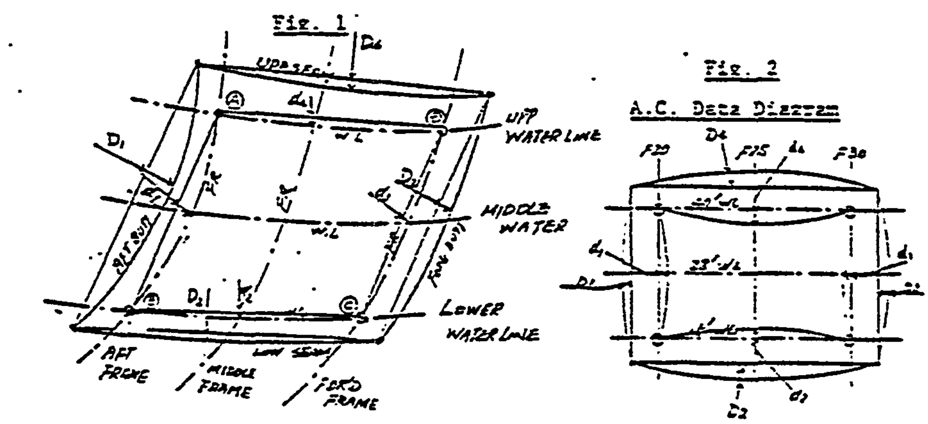
(1) Fabrication and sub-assembly

{2) Assembly

(3) Erection

In order to prepare the check sheet concerning curved shell unit, it is generally difficult to find out necessary measurements to be measured from dimension described in working drawing.

In a case like this, A.C. Group should request beforehand to mold loft to calculate the necessary dimension such as shown in figure below.



(B) Measuring Activity

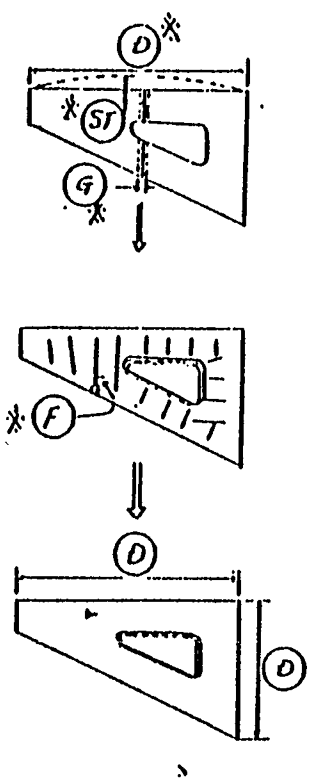
In this activity, actual measurement is mainly performed according to using check sheets. However, nobody can provide check sheets for all Hull Pieces. Therefore, ordinary checking is obliged to rely upon worker himself according to working process standard. This self-checking system, impossible in this shipyard, will bring many advantages for the progress of Accuracy Control System.

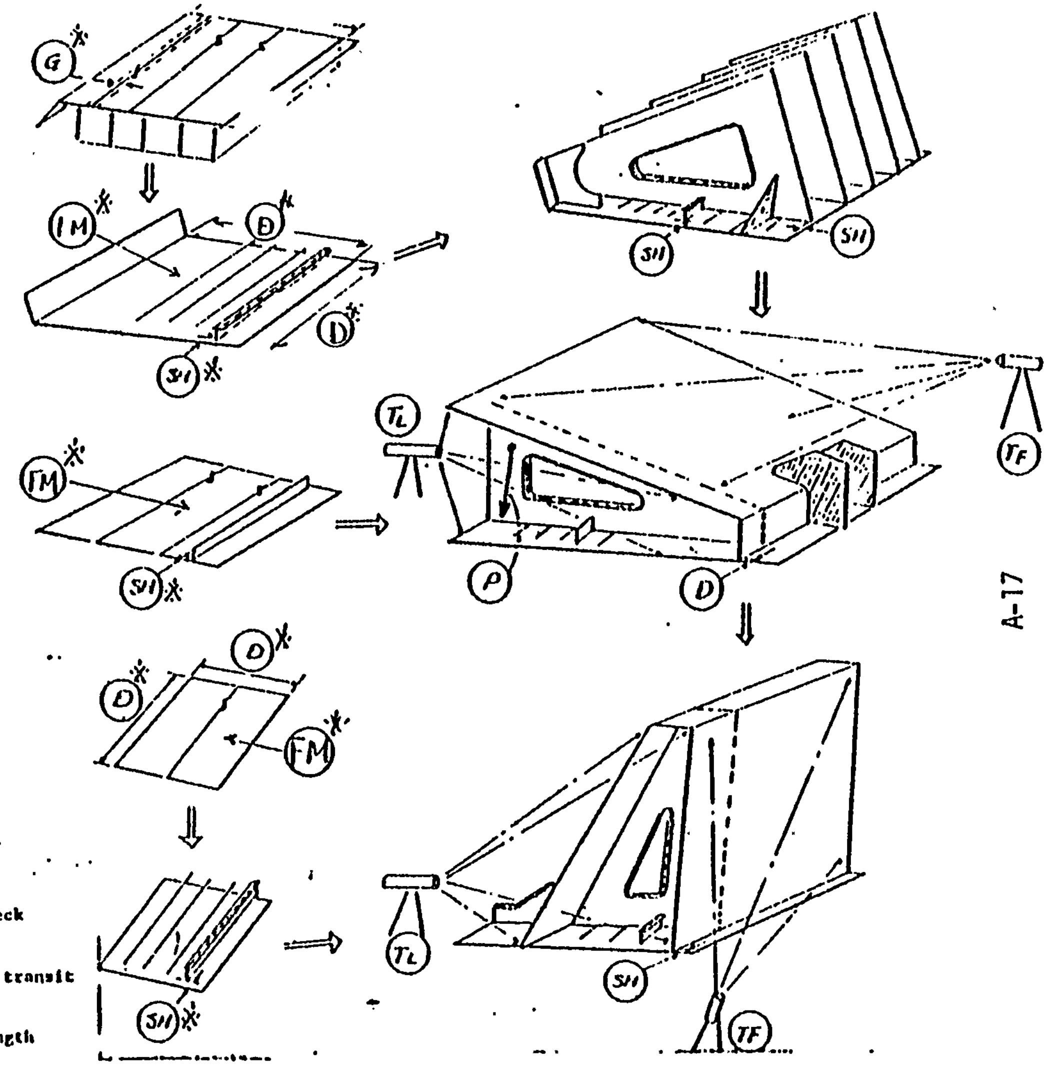
The following flow chart briefly illustrates the measuring steps in hull construction procedure.

The following phase displays briefly the measuring procedure for each stage.

UPPER WING TANK (PARALLEL PART) FABRICATION SEQUENCE AND ACCURACY CONTROL POINTS

MARK ※ Self-checking by worker.





D: Dimension Check

FM: Assembly Finished Marking

G: Check lines of gas cutting

F: Guide line for fitting stiffeners

ST: Check line for torsion by heat

SH: Check shift dimension

P: Perpendiculary check

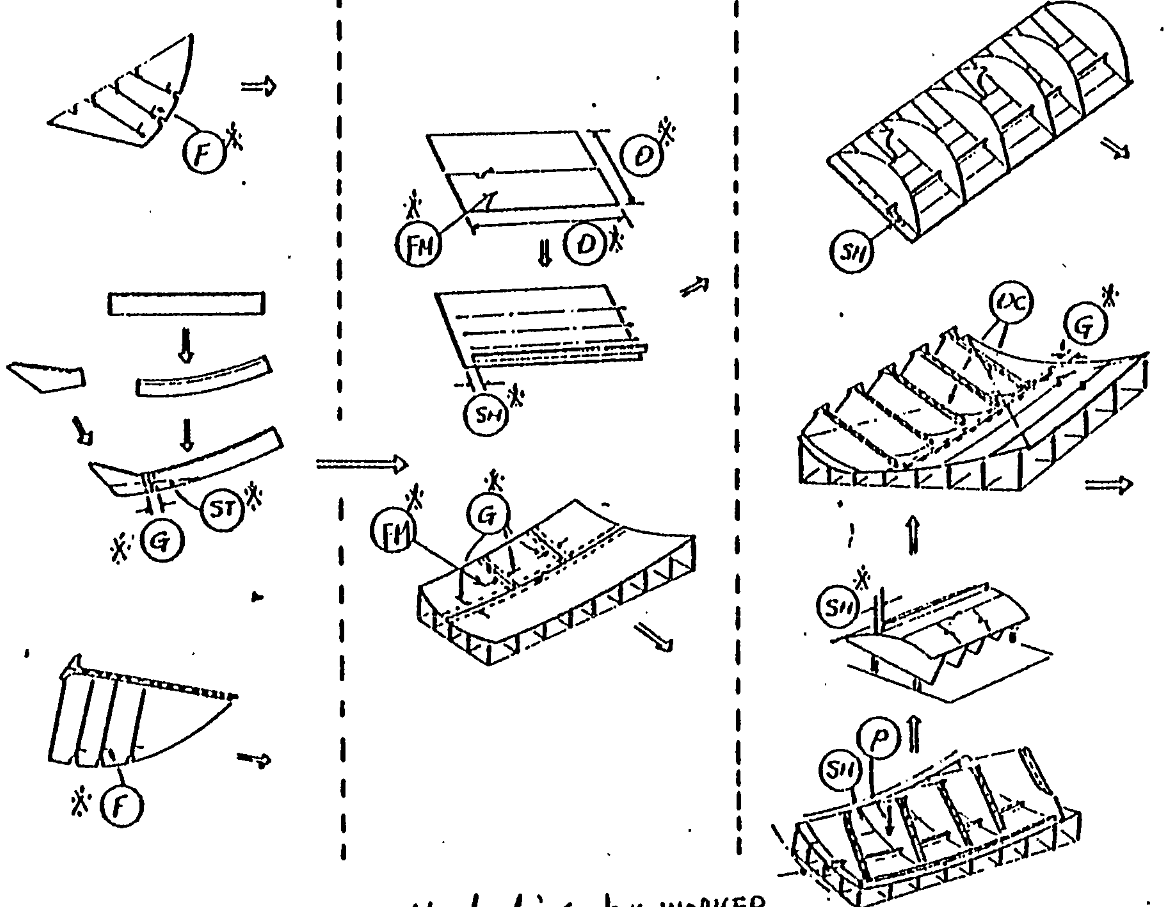
TF: Check flatness by transit

DC: Check diagonal length

TL: Check alignment at the end butt or end frame

Notice: End butts to be checked are all neat cut before erection.

BILGE SHELL UNIT (CURVED PART)
FABRICATION SEQUENCE AND
ACCURACY CONTROL POINTS



D: Dimension Check
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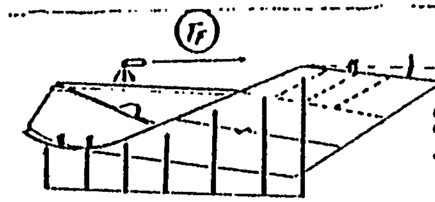


Notice: End butts to be checked are all neat cut before erection.

※ MARK self-checking by WORKER.

1. Fabrication

(a) Gas Cutting Phase

Several hull pieces are produced through this fabrication area as well known. In order to carry out high accuracy unit construction, all precise pieces must be supplied to next hull stage. However, no one can measure all dimensions of all hull pieces. Therefore, hull pieces should be chosen and changed periodically as objects of measuring in order to catch the tendency of their accuracy condition, except for special measuring objects such as girders being indicated by check sheet and curved trans webs being marked down the check line for deformation checking. Moreover, this fabrication stage has some machines such as N/C burning machine and flame planer. The maintenance of these machines is significant factor to obtain high accuracy hull pieces. Therefore, this maintenance activity should be carried out periodically in order to maintain machine accuracy.

(b) Bending Phase

As to curved unit pieces, the accuracy of curved shell plate is required in order to obtain high accuracy curved unit. After plate bending, all curved shell plate, even if bent by cold bending method, should be checked by the following items by using sight line template: (see next page)

i) A straightness of the sight line

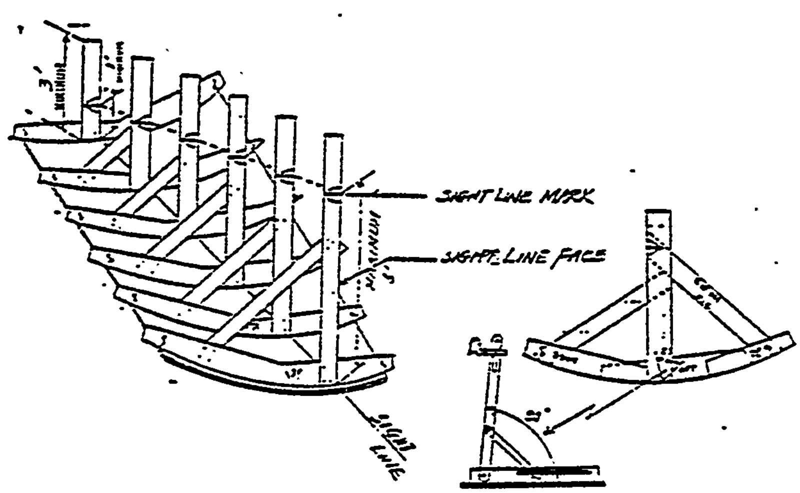
ii) The set condition of template

iii) The twist condition

iv) The transverse and longitudinal curved condition.

v) The inclined degree of template

vi) The plate ends form to meet with the seam points of template



As to sight line bending template, the reports presented by IHI are as follows:

i) Bending Template
(HP-098)

ii) Standard Position of Bending Template
(HP-117)

2. Sub-Assembly

In this area, from accuracy control point of view, significant factors are how to fit exactly the stiffners such as flatbar, bracket and face plate on the web plate, and how to prevent the deformation and shrinkage caused by welding.

From above reason, measuring activity in this area is concentrated as follows:

(a) To check fitting dimensions relative to stiffners and the web plate.

(b) To check deformation by using the base line and/or straight edge of the web plate.

(c) To measure dimension of sub-assembly unit which was indicated in check sheet.

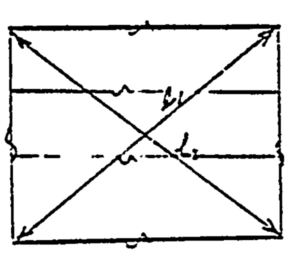
3. Assembly

From accuracy control point of view, assembly area is the most significant area in order to obtain the high accuracy assembly unit. Becasue all inaccuracy factors being included in hull component pieces realize some error on assembly unit.

a) Flat Panel Unit

in the case of flat panel unit, important factors are the following items in order to obtain accuracy unit:

(1) Assembly Finished Marking



After the seam welding, assembly finished-marking is done on the plates which had been cut by flame planer. Basically important measuring in this step is diagonal dimensions in order to confirm the squareness of the corners as shown in figure.

(2) Measuring

According to check sheet, vital points for each unit are mainly measured as following items:

i) Dimension of width and length on panel and diagonals

ii) Deformation caused by twist

iii) Relative dimension between panel and internal structures

b) Curved Shell Unit

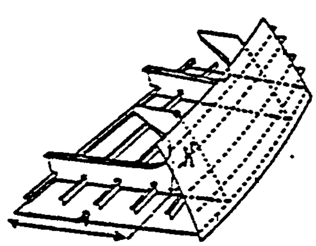
At present time, construction methods are classified as follows:

(a) Flat Panel Base (Conventional method in LSCo.)

(b) Curved Shell Base (Curved Unit Assembly Jig System)

(1) Flat Panel Base

This construction method is based upon internal structures. Curved shell plates are settled on the internal structures.



In the case of this method, vital points are mainly as follows:

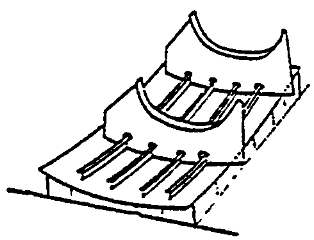
i) Dimension A

ii) Height Dimension H

(2) Curved Shell Base (Curved Unit Assembly Jig System)

This construction method is base upon curved shell plate on the pin jig.

In this case, vital points in this procedure are as follows:



i) How to put exactly the curved shell plates on the pin jig.

ii) How to carry out exactly the assembly finished marking using the marking tape method on the curved shell.

iii) How to set exactly the fitting angle for internal structure members on the shell plate.

iv) How to prevent the deformation caused by welding.

v) How to check the relative dimension between plate edge and internal structures.

In the curved unit assembly jig system, significant matter is how to carry out the neat cutting on the erection joint at assembly area in order to minimize the erection work.

As to this curved Unit Assembly Jig System, the reports were presented by IHI as follows:

i) Assembly Finished Marking Tape for Curved Shell (HP-111, August 16, 1979)

ii) Assembly Curved Jig and Necessary Information for Curved Shell (HP-113, September, 1979)

iii) Assembly Finished Marking Method for Curved Shell
(HP-115, September 25, 1979)

iv) Curved Unit Jig System
Implementation Schedule
(HP-116)

v) Curved Unit Jig System
Instructions (HP-120)

4. Erection

In this stage, the most significant factors are how to realize the actual ship on the ways with keeping ship's planned dimensions such as depth, breadth, length and straightness. The measuring activity in this stage is how to maintain the vital point into check sheet. Vital points in this stage are measured periodically and recorded by A.C. Group until the ships launching.

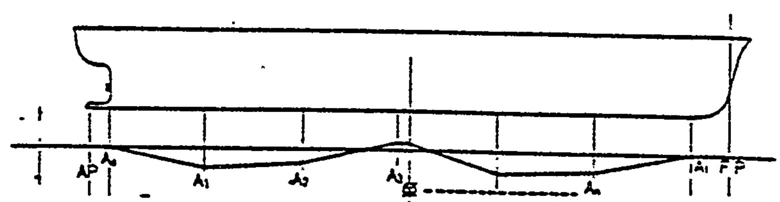
The following items are significant factors:

a) To keep the planned dimensions

b) To prevent the distortion of ship

Final measurement in this stage are done with Owner's attendance.

a) Bottom Alignment



b) Ships Dimension

c) Draft Mark Position

III. Feed Back Activity

Feed Back Activity will make some improvements on the production procedure and all planning activities which are not only A.C. Planning but also production planning through analyzing inaccuracy problems which occured in shipbuilding construction.

All results of check sheets and all inaccuracy problems which occured at production field are gathered to A.C. Group in. order to feed back all relative sections. This feed back activity is significant factor to progress the improvements for following ships accuracy construction.

Tnis activity appraises the results of Planning Activity and Field Activity.

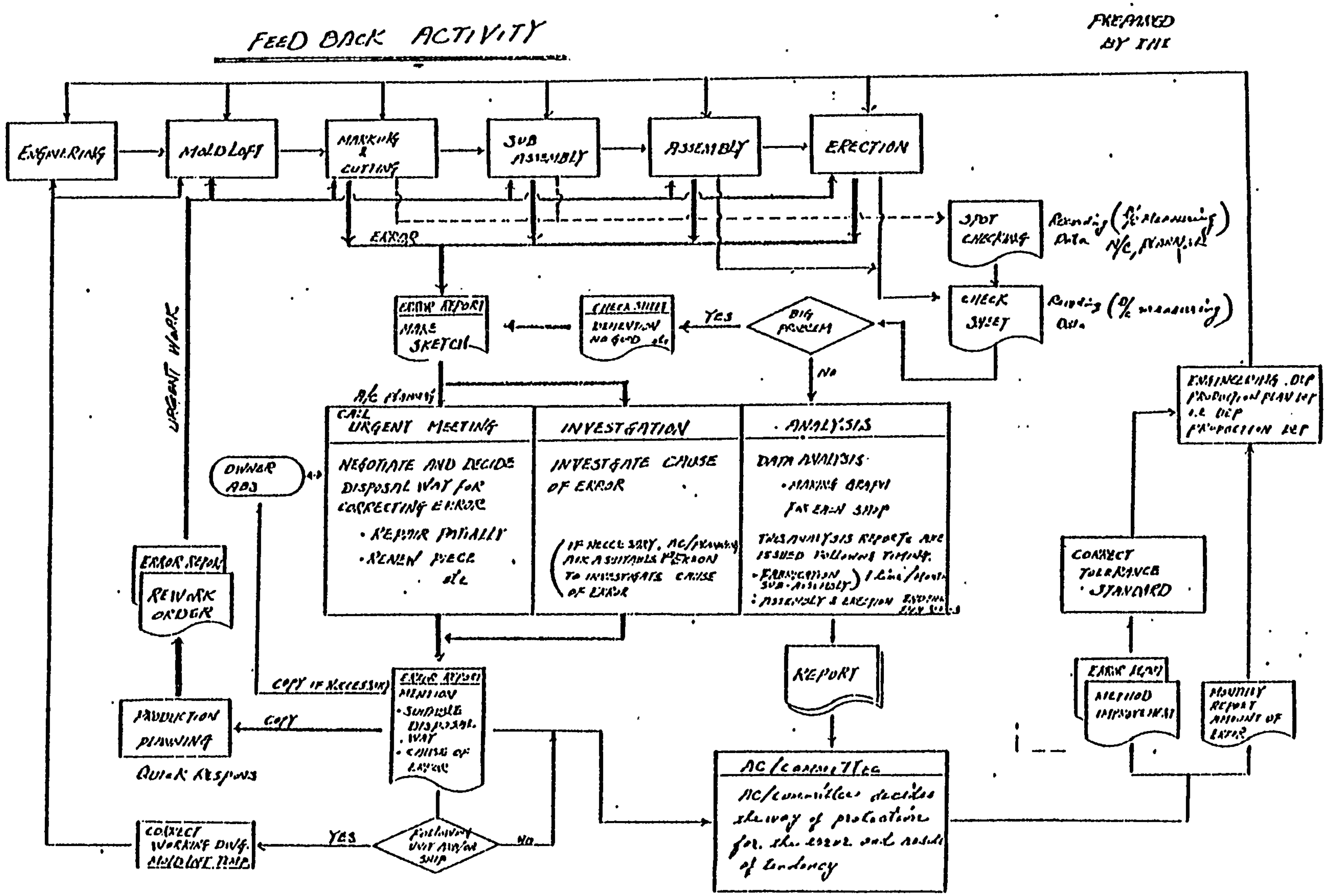
Feed Back Activity includes the following functions:

(A) Analysis

(B) Improvement

The following flow chart illustrates the Feed Back Activity.

FEED BACK ACTIVITY



(A) Analysis

From Accuracy Control point of view, analysis can be classified as two kinds of functions:

(a) Urgent Analysis Function

(b) Ordinary Analysis Function

(a) Urgent Analysis Function

No one can prevent completely any errors during the period of ship construction. The errors often disrupt the productive project itself. For this reason, the temporary countermeasure against such an urgent problem should be planned promptly by all related personnel in order to repair an inferior part.

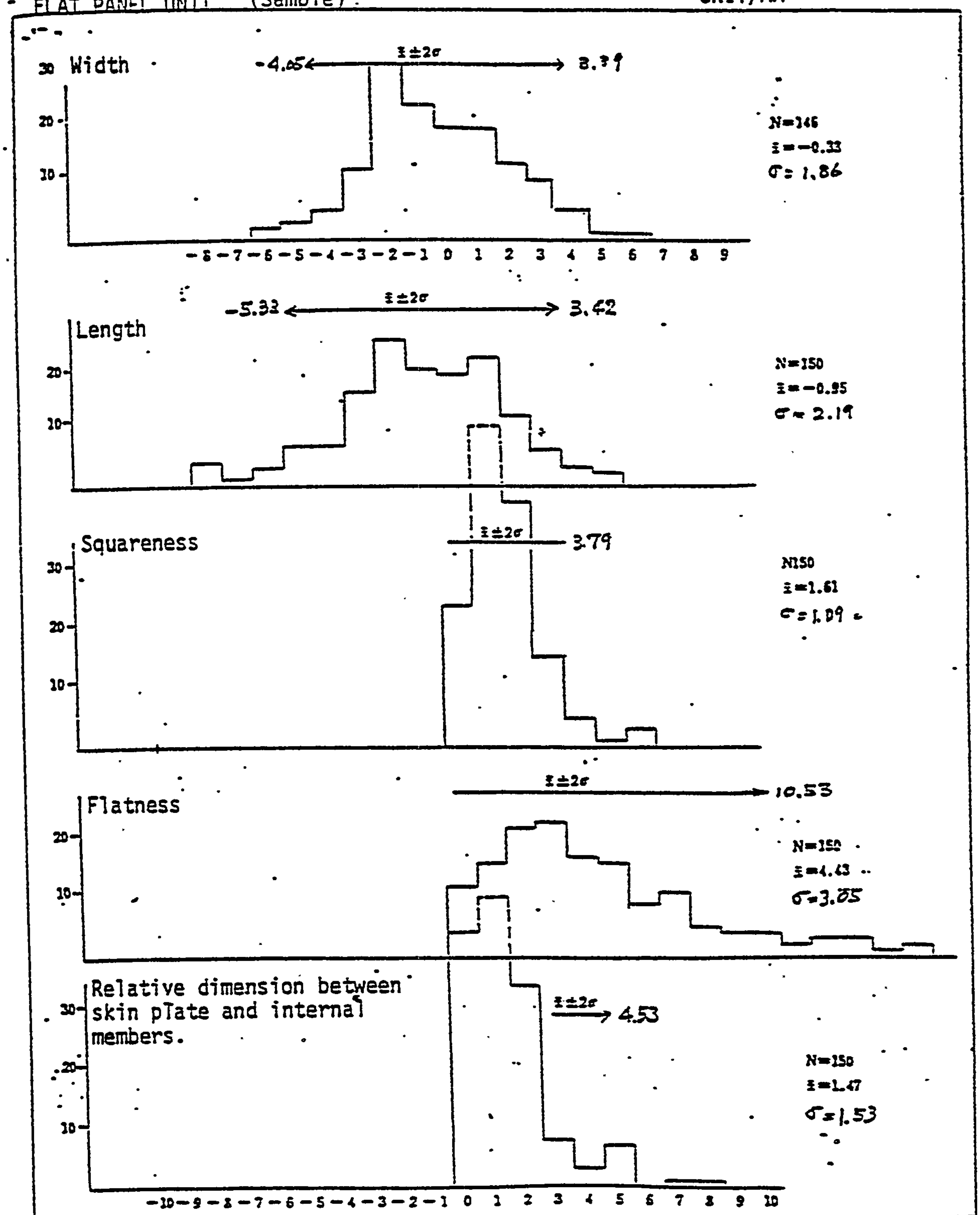
After the above temporary countermeasure is carried out, the permanent countermeasure is also provided by deep investigation of the cause in order to prevent the same errors. The permanent countermeasure will demand to review the working standard such as checking procedure and necessary information. This countermeasure promotes some preparation of working standard based upon accuracy control point of view.

(b) Ordinary Analysis Function

Concerning this phase, the report of Accuracy Control in IHI had been presented by our Mr. Hatake in March, 1979. (Ref. No. FCP-111)

This phase briefly displays how to use the result of analyzed data in order to review the tolerance standard.

FLAT PANEL UNIT (Sample) UNIT/MM



As previously mentioned in the chapter of Standardization in Planning Activity, it is very significant to review the allowable amounts in the tolerance standard taking account of the result of actual data analysis.

For an example, dimensions of flat panel are shown in diagram on provious page.

steps:

1) To make histograms of same kind of data.

2) To calculate the mean value and the standard deviation.

3) To compare both amounts of above calculated standard deviation.(8) and the amount of allowable tolerance.

If the amount of 28 is more than allowable tolerance range, the following actions should be taken:

1) To make the countermeasure of how to obtain the allowable tolerance.

2) To check the allowable tolerance whether suitable amount in this shipyard.

(B) Improvement

All results of analyzed inaccuracy factors are fed back to Planning Activity in order to take account of following ships planning.

As ‘he result of Feed Back Activity, the following items should be mainly revised based upon Accuracy Control point of view:

1) The planned scheme such as additional material, vital points and base line were either optimom or not.

2) The planned assembly procedure was either optimum or not.

3) The planned unit division and shell straking were either optimum or not.

4) The present working process standards for each stage were suitable or not.

5) What kind of information, which is included in working drawing or mold loft out-put, should be given to production field.

Such improvements as the above mentioned items-should be carried out for the progress and development of Accuracy Control System in this shipyard.

C. Recommendation for Accuracy Control from IHI

Recommendation for Accuracy Control from IHI

(1) In order to carry out Accuracy Control Activity smoothly, the most significant factor is how to establish the information flow concerning the Accuracy Control System. Therefore, it is recommendable to establish the information flow chart which involved all accuracy control activities. In addition, it is very important matter that the above flow chart define clearly what kind of information should be supplied by whom.

(2) As before mentioned, the Accuracy Control Planner will be required to have capability for improving the production method. Therefore, it is recommendable to define clearly the responsible department for Accuracy Planning Activity in this shipyard. It is also recommended to define clearly who is responsible for each accuracy planning item.

(3) Engineering

In order to inform to related section, some kind of drawings are necessary as information media. The following items are recommendable:

(a) To issue early as possible, from Engineering to related department, the preliminary scheme such as unit division and midship section in order to begin the preliminary planning.

(b) To inform early as possible from Engineering to related department, the preliminary drawings involved functions such as structure lines described, the shell straking, shell expansion and key plan (section plan) in order to carry out the Accuracy Planning which will decide the vital point, the additional materials and the base line.

(c) To indicate in the working drawings necessary information such as neat cutting phase and amounts of additional material which are fed back by A.C. Planning Activity.

(4) Mold Loft

Mold loft should be the nucleus for realization of planning activities results by its nature, because most of output used in actual production field are generated at mold loft. It is recommendable that necessary Accuracy control information, such as base line and match mark, should be included in mold loft output.

(5) Fabrication (Bending Phase)

Curved unit requires precise curved shell plates. It is recommendable that all curved shell plate after bending, should be checked by using sight line template even if this curved plate was bent by only cold bending method.

(6) Assembly

After seam welding on the plate joint, final neat cutting on erection joint should be done at assembly area by using the assembly finished marking method in order to minimize the erection work. Also, final neat cutting of longitudinal member on erection joint should be done at this area".

(7) Erection

As to shipwright on the ways, IHI recommended at A.C. meeting that absolute base line of the ship should be marked on the ways. The absolute base line on the ways is significant line in order to obtain the accuracy ship. For this reason, IHI recommends again to set the absolute base line on the ways and the shipwright works should be carried out by referring to this line at erection.

Conclusion

Accuracy Control Activity in LSCo has been continuously operated well by A.C. Group. However, from Accuracy Control System point of view, it seems that the activity of A.C. Group at present time is limited mainly to field activity.

Therefore, it is important to establish the Accuracy Control organization which involved all related departments such as, Engineering, Production Planning, I.E. and Production including the Mold Loft. This Accuracy Control organization, involving Accuracy Planning Activity andFeed Back Activity, will support the A.C. Group Activity.

IHI expects that Accuracy Control Activity in LSCO will promote the Productivity in shipbuilding construction and also will promote continuously the development of Accuracy Control System without stopping.

LSCo. Report No. - 2123-5.1-4-1

TECHNOLOGY TRANSFER PROGRAM (TTP)

FINAL REPORT

QUALITY ASSURANCE SYSTEM

Appendix B

Planning of Vital Points Of Accuracy

QUALITY ASSURANCE

VOLUME 2 APPENDICES

prepared by:

Livingston Shipbuilding Company
Orange, Texas

March 3, 1980

APPENDIX B

PLANNING OF VITAL POINTS OF ACCURACY

HP-122

PLANNING OF VITAL POINTS OF ACCURACY

(A.C. Planning Activities)

October 5, l979

Prepared by: Osamu Togo
IHI

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PLANNING OF VITAL POINTS OF ACCURACY

1. How to Decide the Vital Points

   A. Basic Ideas

   The vital points of accuracy must reflect enough of the idea that will be the most important points to keep the high quality of the ship. Therefore the steps to decide the vital points should be started from At Erection Condition to At Fabrication's, Just like a reversed Steps of Production Flow.

   B. Total View of the Vital Points

   The vital points to keep the accuracy of ship must be decided by the parts of vital points of each stage, as keeping the steps.

   The parts of vital points for each stage will be classified as follows:

   1. At Erection Stage

      1) Hold Part

      2) Curved Part

      3) Stern Part

   2. At Assembly Stage

      1) Straight Unit

      2) Curved Unit

         i) Units based flat panel.

         ii) Units based curved plates.

   3. At Fabrication Stage

   C. Detail Descriptions for each Part

   1. At Erection Stage

      I) Hold Part

      This part is the main part to decide the high quality of the ship. Because this part has, not only the mid-ship part, but also every hold tank. The hold part is the biggest part of the ship. Since it is the biggest, the most parts of all vital points of the ship will be depended on this part practically.

The vital parts of Hold Part can be separated into 2 parts generally as follows:

a. Tank Top Part

b. Top Side Tank Part

Descriptions will be next.

a. Tank Top Part

This part is the basic of Hold Part. So the following items should be controlled as the vital points.

i. Center Line of the Ship.

ii. Relativity between each Double Bottom Unit.

iii. Level of Tank Top.

The detail will be shown in (Appendix - 1.)

b. Top Side Tank Part

This part will decide the final dimensions of the actual width and actual depth of the ship. Then the following items should be controlled as the vital Points.

i. Straightness of the Base Line.

ii. Width of the Ship at Main Deck.

iii. Height of the Ship at Main Deck.

iv. level of Main Deck.

The detail will be shown in {Appendix - 2.)

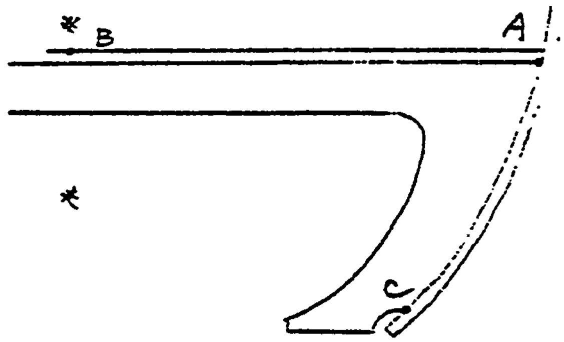
Depending on these items, the vital points of each unit to set on the ways will be clear. Then the vital points of each unit on the ways should be noted on the shipwright guidance. (See Appendix -3.)

2) Curved Part

The vital points of curved part on the ways will be depended on Hold Part, Because the erection order of each unit will be started from hold part to curved part usually. But there are special points of curved part as follows:

i. The Vital Points to set the Curved Unit.

To set the curved unit, it is necessary to catch the suitable point of the unit. Usually the following points will be effective.

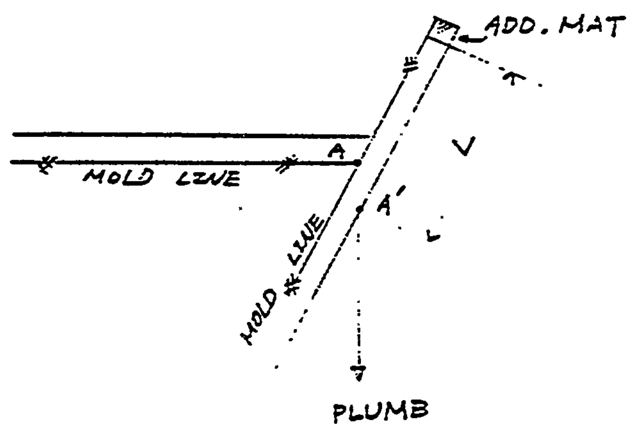


Point A: Use for setting the width.

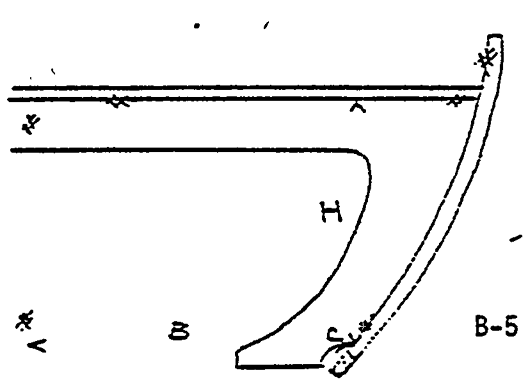
Point B: Use for keeping straightness.

Point C: Use for setting the height, and checking the width at lower part.

Notice-1: To catch the point A′, it is necessary to prepare the dimension (L) to layout the precise point on the shell plate as shown below.



Notice-2: To catch the point C, it is necessary to prepare the dimension (H) and (B) by Mold Loft.



: Mold Line

3) Stern Part

The accuracy of this part will influence on the powers of the ship directly. Then the following items will be the vital points of stern part.

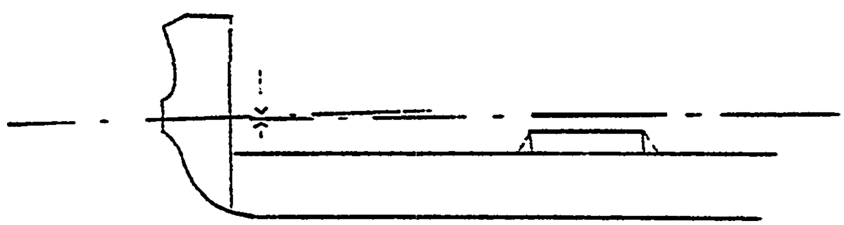
a. Accuracy of Shaft Line

i. Accuracy of Center of Stern Tube

Centering

Height

ii. Relationship between center of stern tube and shaft line depended on the main engine sheet.



Notice: Especially this relationship will be hard to keep precisely. Because usually the initial hogging will be applied for this part. Then the greatest possible care has to reapplied for this part.

b. Relationship between shaft center and rudder center.

Usually this relationship should be fixed on slabs in one unit. But still now it is difficult to set both of them in the right position on the ways. Especially at the timing of welding for the plate joints located at front of Aft peak tank bulkhead, the greatest possible care must be prepared for this part.

2. At Assembty Stage

1) straight unit

This type of unit is located at Hold Part and contains several typical kinds of unit depended on their positions. Therefore it is convenient to understanding the vital points to study and decide the points by typical kind of unit.

a. Basic Ideas to Decide the Vital Points.

In order to decide the vital points of units, there are two kinds of items to be considered.

i. Which points will be the most important for the ship?!

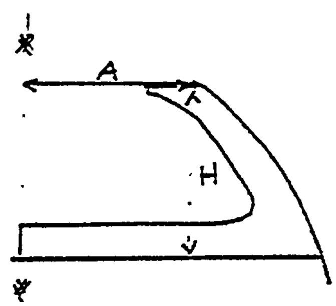
ii. Which points will be the most difficult to keep the drawing dimensions on slabs?!

Depending on these item, the samples will be shown in the check sheets by each typical unit. (See Appendix-4)

Notice: The more precise descriptions about these items will be shown on "Additional Material Planning."

2) Curved Unit

i) Unit Based Flat Panel



This construction method is based upon internal structures. Curved shell plates are set on the internal structure.

Therefore, vital points are how to keep the dimensions such as H and A as shown in figure.

Edge alignment between shell plate and Internal structures is also vital point.

Depending. on these items, the vital points of each unit are decided. The detail will be shown in (Appendix - 5.)

ii) Unit based Curved Plates

This construction method is based upon curved shell plate on the curved unit jig.

Internal structure members are set on the curved shell.

One of the vital points is how to keep the shape of the curved unit during assembly.

As to this method, the deteil will be shown in (Appendix - 6.) and other reports as follows:

i) Curved Unit Jig System
Instruction (HP-120)

ii) Curved Unit Jig System
Assembly Curved Unit Jig and
Necessary Information (HP-113)

3. At Fabrication Stage

In this stage, the basic idea is how to choose important pieces which will influence the inaccuracy factor of unit.

Impor'@nt pieces to keep their accuracy are as follows:

*Bottom Girder

*Bottom Side floor

*Hopper Side Tank floor

*Hold frame

The detail of vital point will be shown in (Appendix - 7.)

Appendix - 1.

THE VITAL POINTS TO KEEP THE ACCURACY AT ERECTION STAGE

(For Tank Too Part at Zone 1)

THE VITAL POINTS TO KEEP THE ACCURACY AT ERECTION STAGE

(For Tank Top at Zone 1)

To check and keep the accuracy of tank top at erection stage, there are three (3) kinds of checking methods originally as follows:

1. Center Line Check

   Check the shift of center line a each unit on tank top.

2. Relativity Check

   Check the relativity of three (3) kinds of units (center double bottom, center side double bottom, and bilge unit) at every hold length on-tank top.

3. Level Check

   Check the level at each unit on tank top and bottom.

Description

1. Center Line Check

   When: 2 times, once before fitting and once after welding.

   Who : worker and AC before fitting.
   AC after welding.

   Where: At the front of each unit on tank top.

   How: By transit. (allowance max. 1/8″)

2. Relativity Check

   When: Every unit before fitting and 1 time after welding at hold length.

   Who : Worker and AC before fitting and AC after welding.

   Where: At the front edge of each unit.

   How: By transit. (Allowance max. 1/8″ at each target)

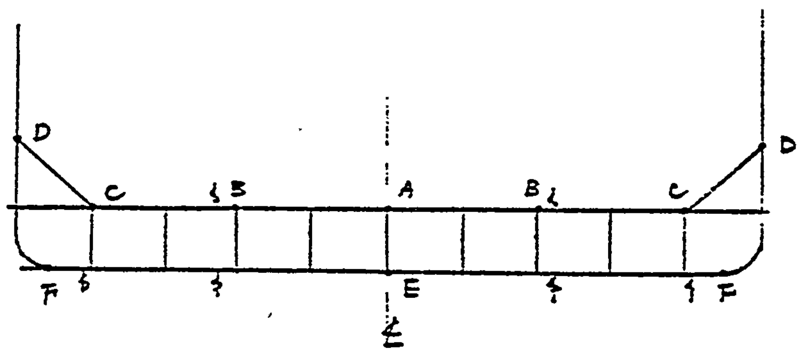
   Notice: If the relativity is larger than allowance and that amount is less than 1/4″, there is no use to correct. It is enough to correct the relativity at each hold length finally.

3. Level Check

when: Every unit before fitting and after welding.

Who : Worker and AC before fitting and AC after welding.

Where: These points (A, B, C, and D) at front *frame* of each unit on tank top. After welding, the level of these points (E and F) at the bottom must be checked.



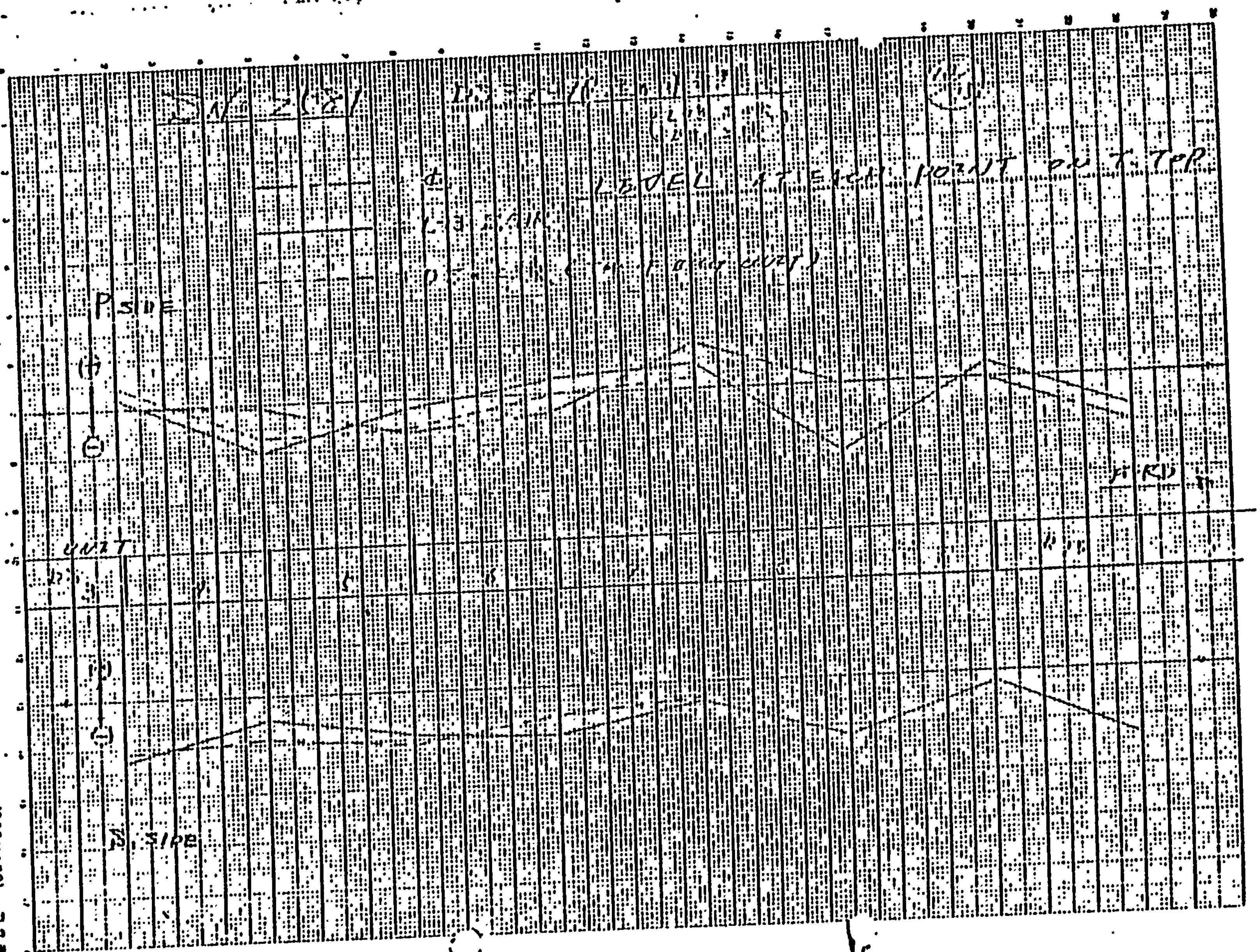
Appendix

The samples of the records for those checking methods will be

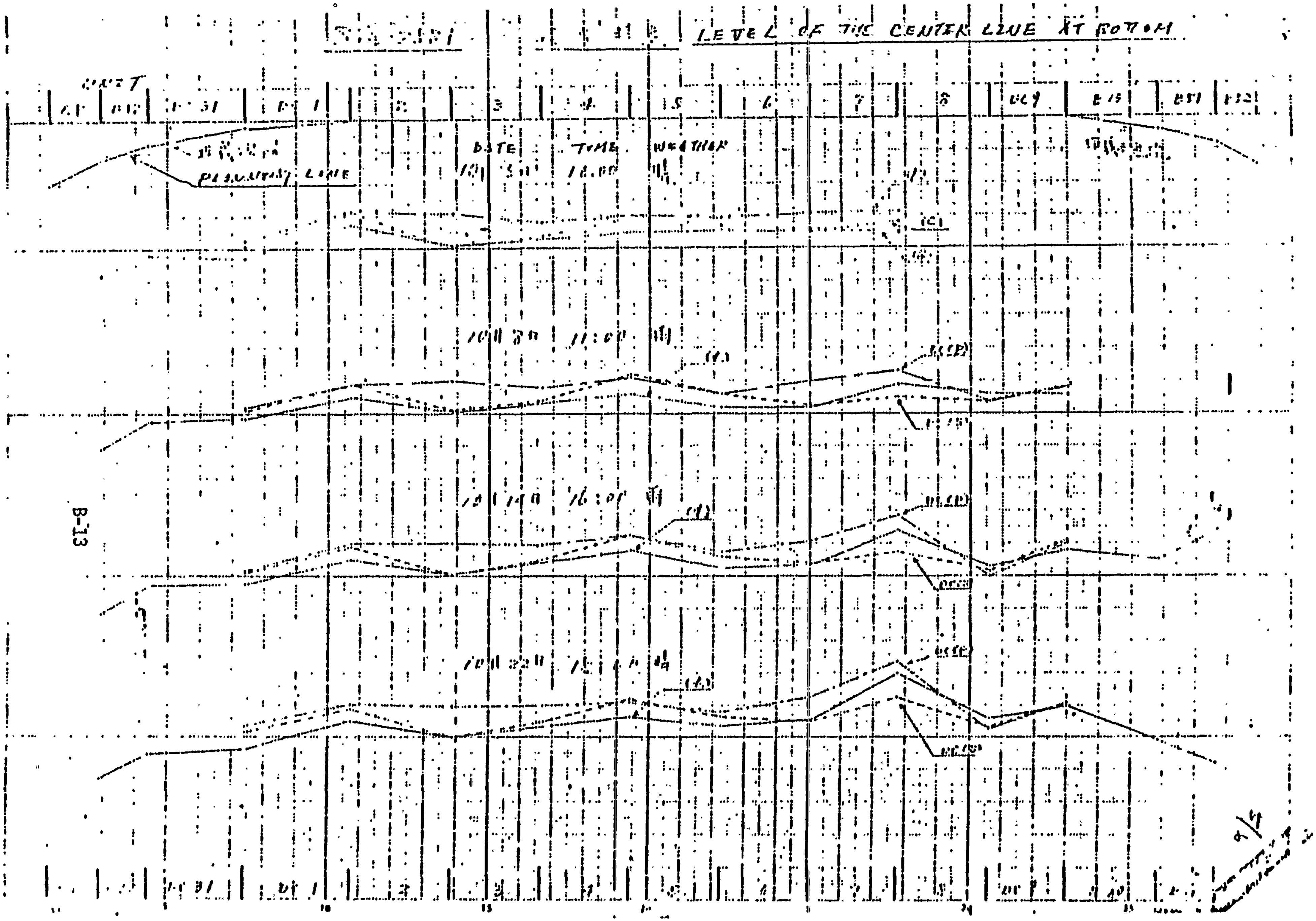
The data checked by those said methods must be recorded and arranged *in* simple style (picture, graph, chart, etc.). These graphs will be helpfull to recognize and decide the way *of* accuracy control at erection stage.

Notice: Each record must be shown with the date, time, and temperature.

The attached graphs show one of the recording styles of IHI.

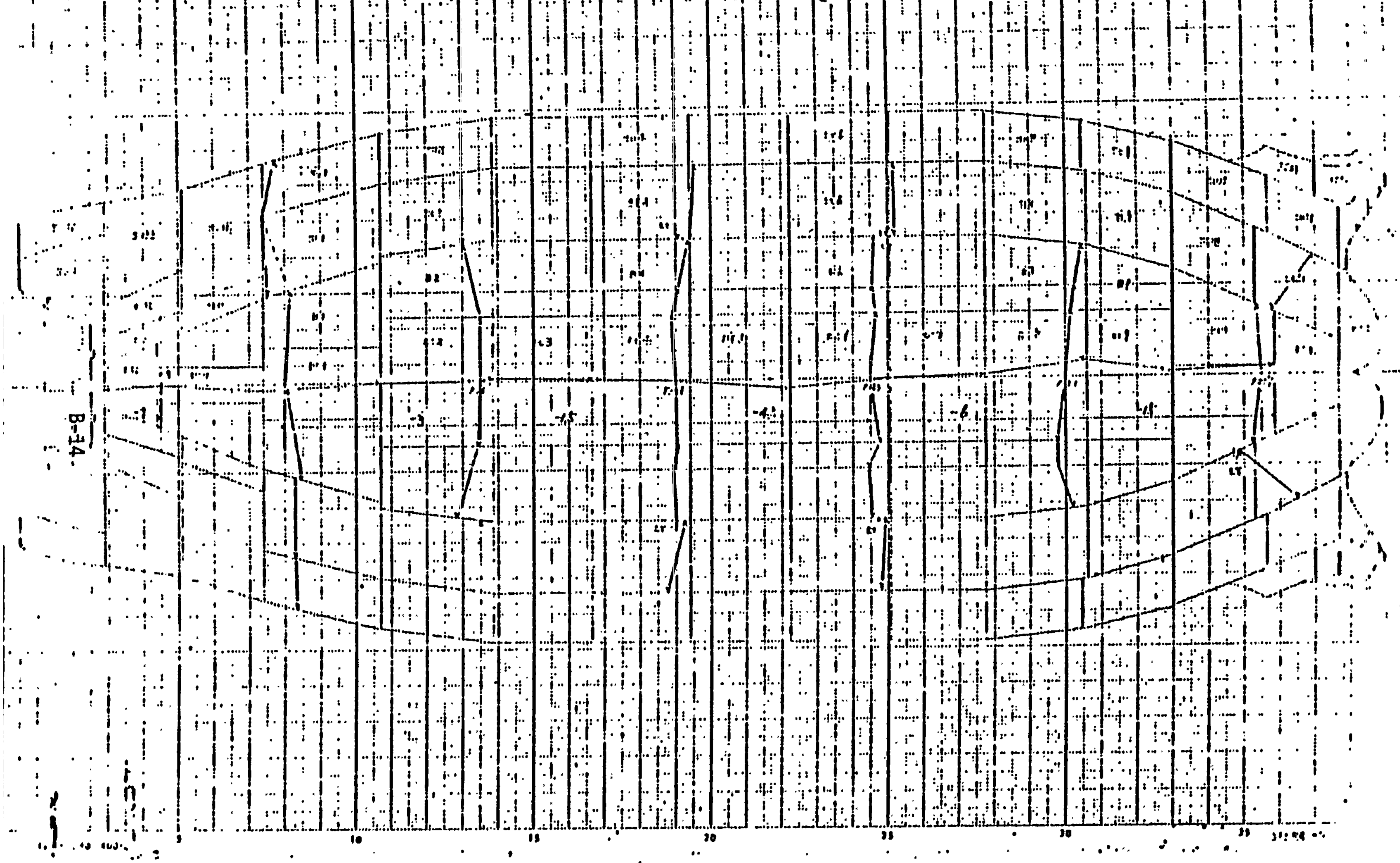


4/8


LEVEL OF THE CENTER LINE AT BOTTOM
DATE
TIME
WEATHER

RELATIVITY to CENTER LINE CHECK

(AT EACH HOLD LENGTH)



Appendix - 2.

THE VITAL POINTS TO KEEP THE ACCURACY AT ERECTION STAGE

(For TOP Side Tank at Zone 1)

THE VITAL POINTS TO KEEP THE ACCURACY AT ERECTION STAGE

(For Top Side Tank at Zone 1)

1. Kinds of Items

   To check and keep the accuracy of top side tank part, there are four (4) kinds of items as follows:

   1) Straightness of the Base Line

   2) Width of the Ship at Main Deck

   3) Height of the Ship at Main Deck

   4) Level of Main Deck.

2. Detail Descriptions

   1) Straightness of the Base Line

      When: 2 times, once before welding and once after welding at each erection joimt.

      Who : Worker and AC (before welding)

      AC (after welding)

      Where: At the baseline (see figure l.)

      Notice: This bake line must be marked on slabs before erection

      How: By transit.

   2) Width of the Ship at Main Deck

      When: 2 times (before and after welding)

      Who: Worker and AC (before welding)

      AC (after welding)

      Mhere: At the base line of tie front part of unit. (See Figure 1.)

      How: By measure

   3) Height of the Ship at Main Deck

      when: 2 times (before and after welding)

Who: Worker and AC (before welding)

AC (after welding}

Where: At the point supported by pillar. (See Figure J.)

How: By measure.

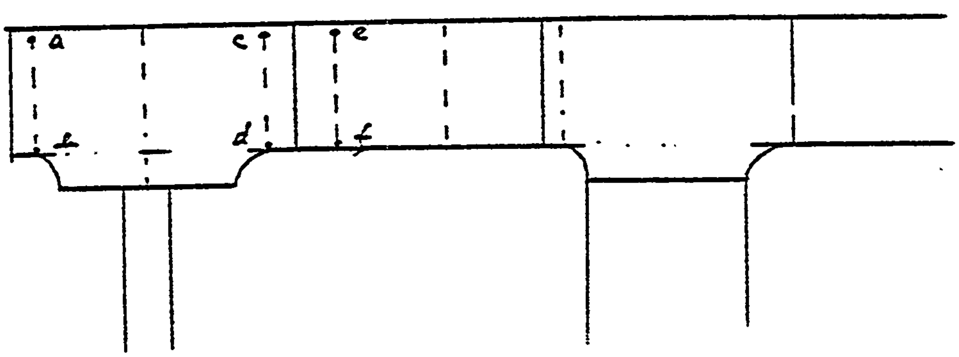
4) Level of Main Deck

When: 2 times (before and after welding)

Who: Worker and AC (before welding)

AC (after welding)

Where: At least 6 points

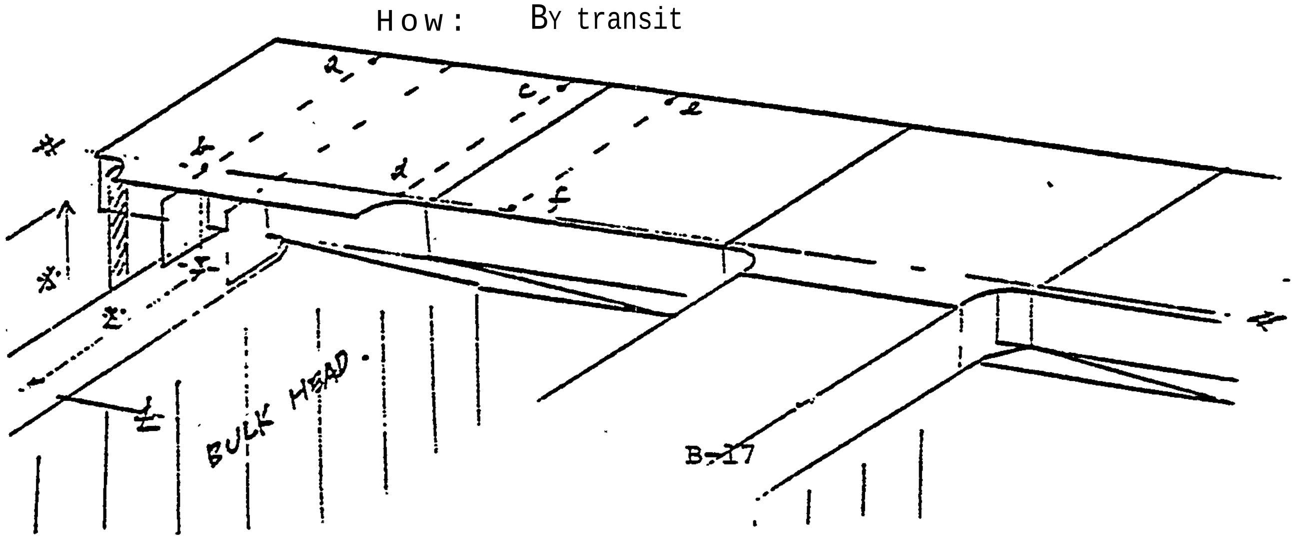


Notice: Points a, bat fwr'd end

Points c, d at aft end

Points e, f at fiw'd part of preceded unit

How: BY transit



Appendix - 3.

ACCURACY CONTROL

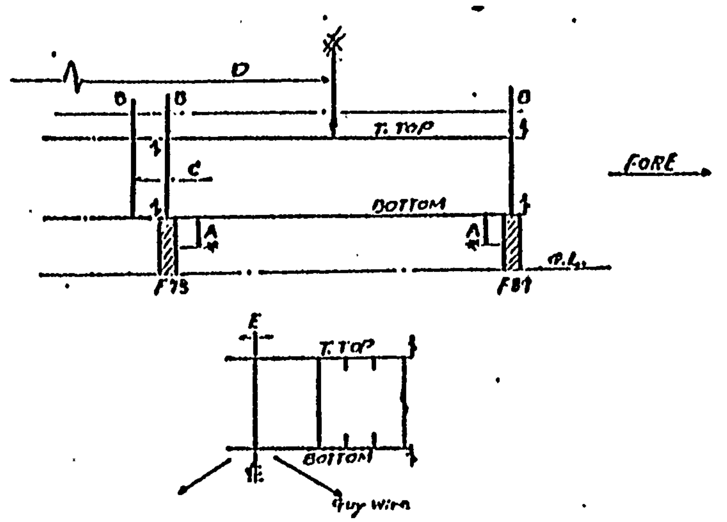
CHECK POINT, CHECKING DIMENSIONS. CHECKING METHOD

AT ERECTION

BASED ON ERECTION SEOUENCE

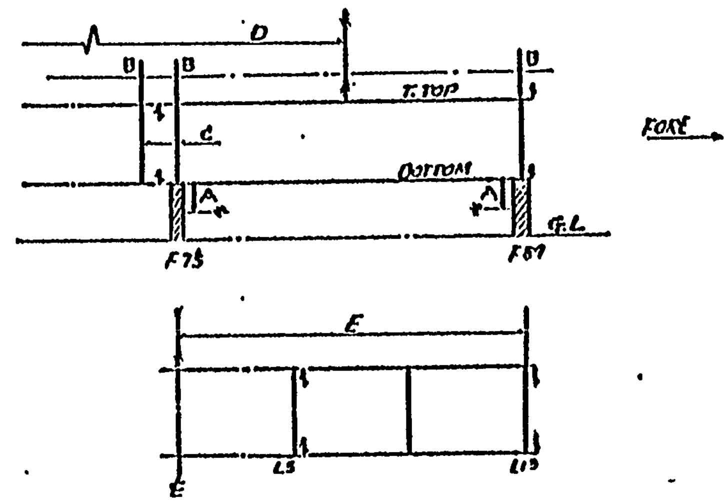
PREPARED BY IHI

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



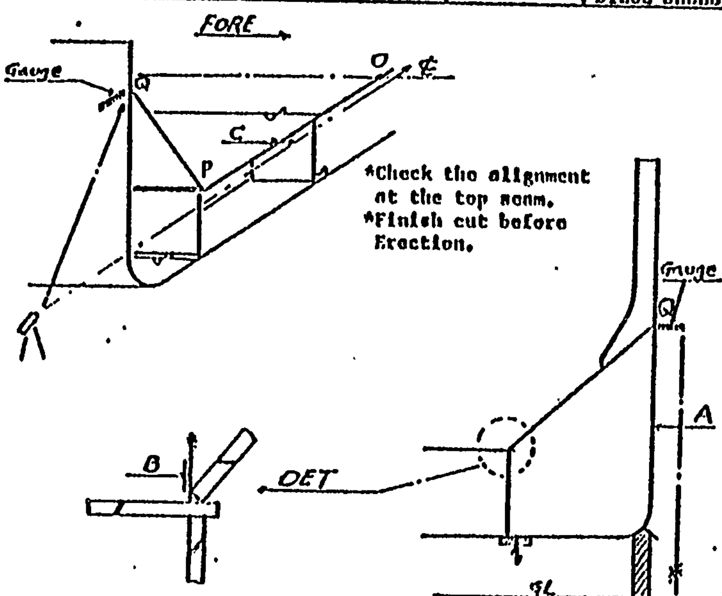
MARK	DESCRIPTION	DIMEN-SIONS	TOLER-ANCE	CHARGE	NOTICE
A	Bottom Height			Worker	Measure at C.CTR by special gauge
B	Level			Worker AC	Measure at 4 corner points by Transit
C	Space Check			Worker	Measure by ruler
D	Space Check from Bhd. to Bhd.			Worker AC	Measure by ruler
E	Center line check			Worker AC	Adjust at foreend by guy wire. Measure by Transit

HULL 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 Bhd. to Bhd.			Worker AC	Measure by ruler.
E	Width from C. line to L13.			Worker	Measure at fore & aft end by transit.

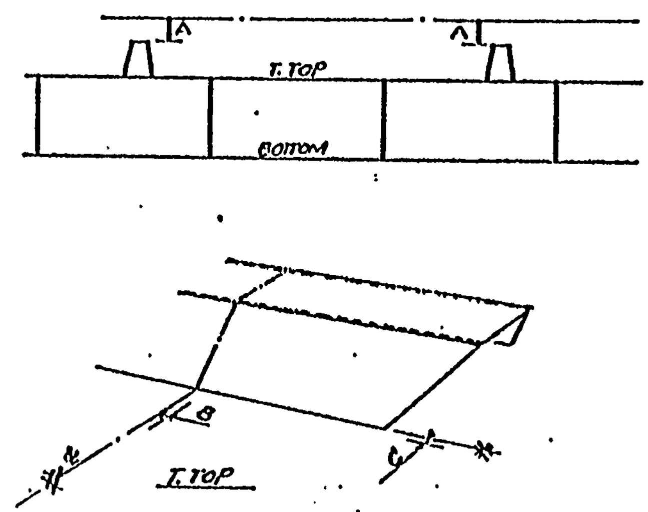
HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
			-	BILGE SHELL.



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

MARK	DESCRIPTION	DIMENSIONS	TOLERANCE	CHARGE	NOTICE
A	Width & Perpendiculary			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	

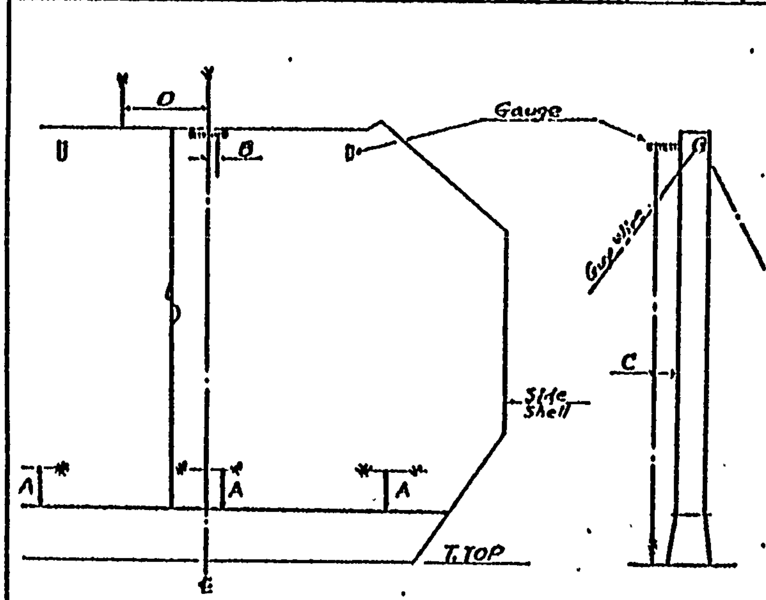
HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				STOOL.



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					

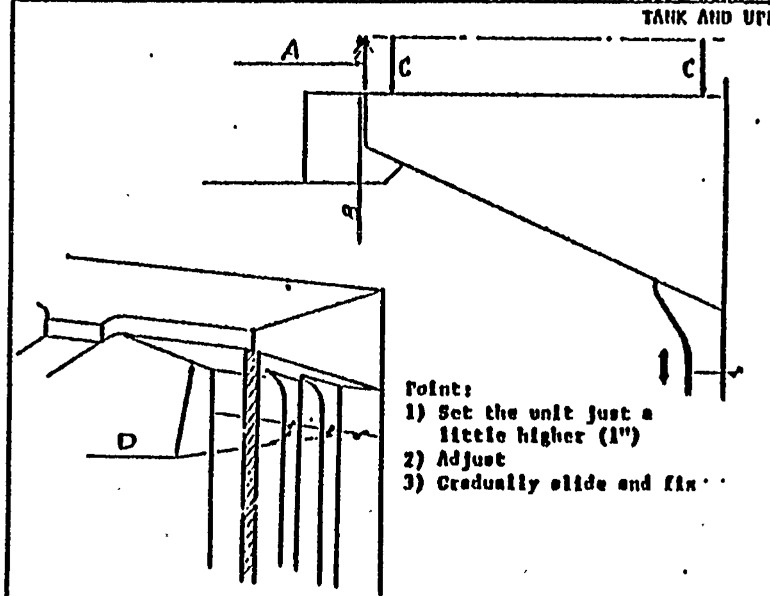
The unit is most vital to keep precise level and height of Bhd. and Upper deck.

HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				CORR. MID.



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

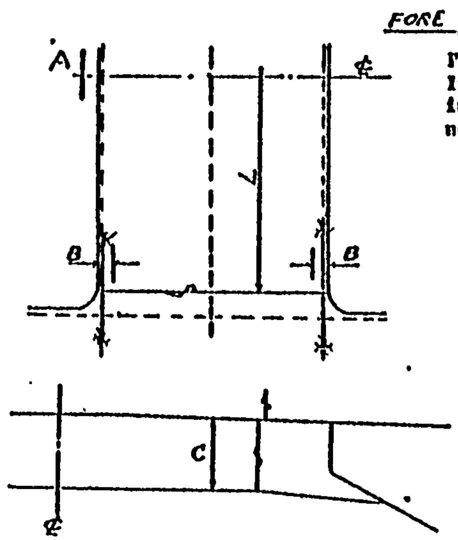
HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				UPP. WING TANK AND UPP. DK.



MARK	DESCRIPTION	DIMEN-SIONS	TOLER-ANCE	CHARGE	NOTICE
A	Width			Worker AC	Measure from center line by ruler
B	Height			Worker AC	Measure from T. Top by ruler.
C	Level			Worker AC	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. DK. CENTER



Point:
In case of the unit to be inserted: Check "L" and neat cut. (at Assembly)

MARK	DESCRIPTION	DIMEN-SIONS	TOLER-ANCE	CHARGE	NOTICE
A	Center line			Worker AC	Check discrepancy by transit
B	Alignment of the joining part			Worker	
C	Height			Worker	Before erection, check the dimension and neat cut
D					

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

MARK	DESCRIPTION	DIMEN-SIONS	TOLER-ANCE	CHARGE	NOTICE
A					
B					
C					
D					

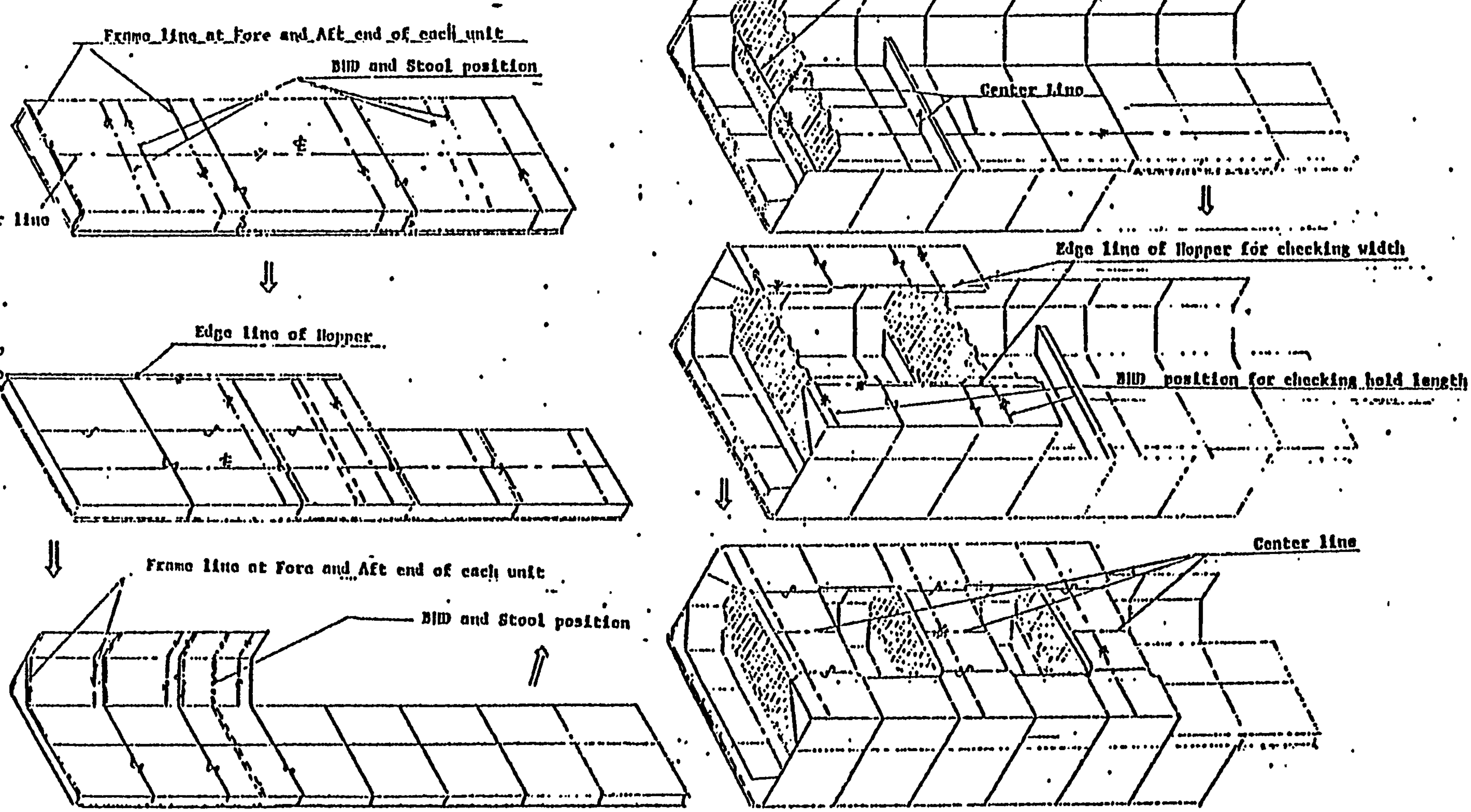
ACCURACY CONTROL

HOW *TO* DO SHIWRIGHTIN

BASED ON ERECTION SEQUENCE

PREPARED BY IHI

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



Appendix -4.

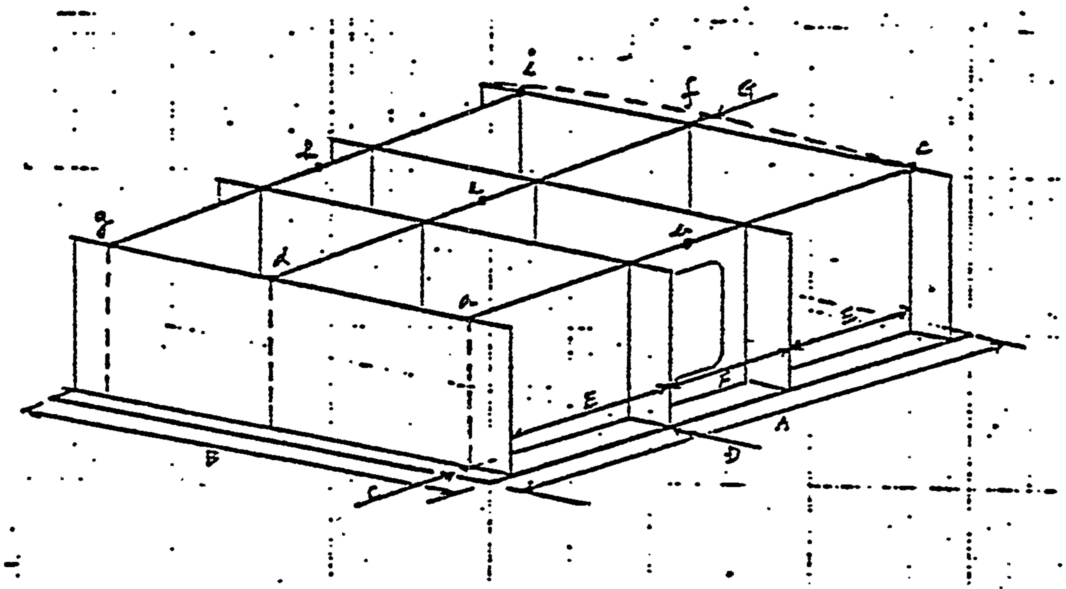
THE VITAL POINTS OF UNITS

(For Zone 1)

THE TOTAL POINTS OF UNITS
(SAMPLE FOR ZONE 1)

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Before combined with bottom plate

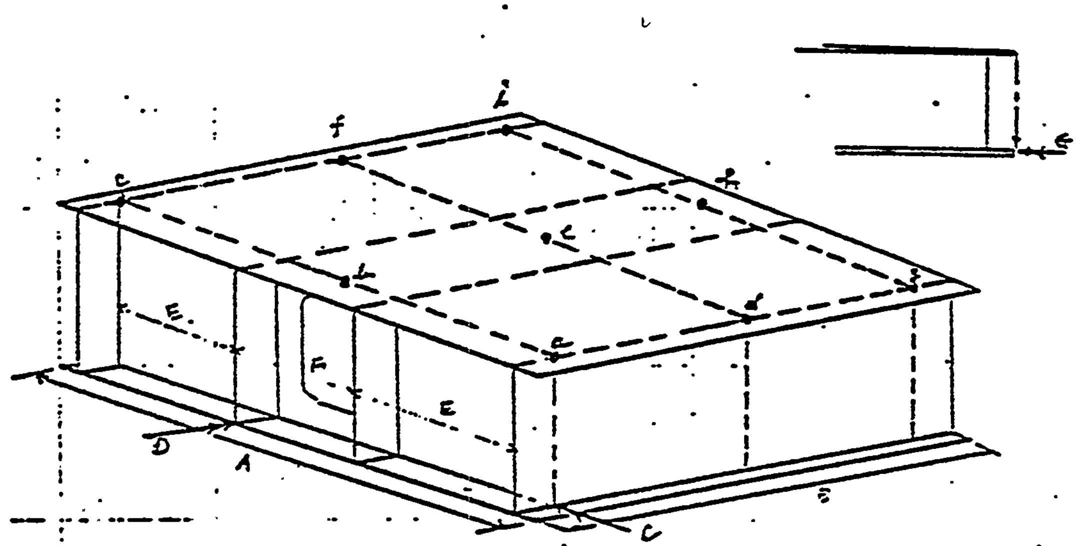


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
C			P / S		Worker AC	Both side (P.S)
D	Edge' Alignment		F / A		"	Every Girder Both Side (F.A.)
E	Girder Spacing		P / S		"	Every Frame
F	"			FORE / AFT	"	Both side (F.A.)
G	Straightness				"	Each girder show maximum.
H	Level			a b c d e / f g h i j	"	9 points a - i

Notice: After fitting, welding

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Final Unit Assembly

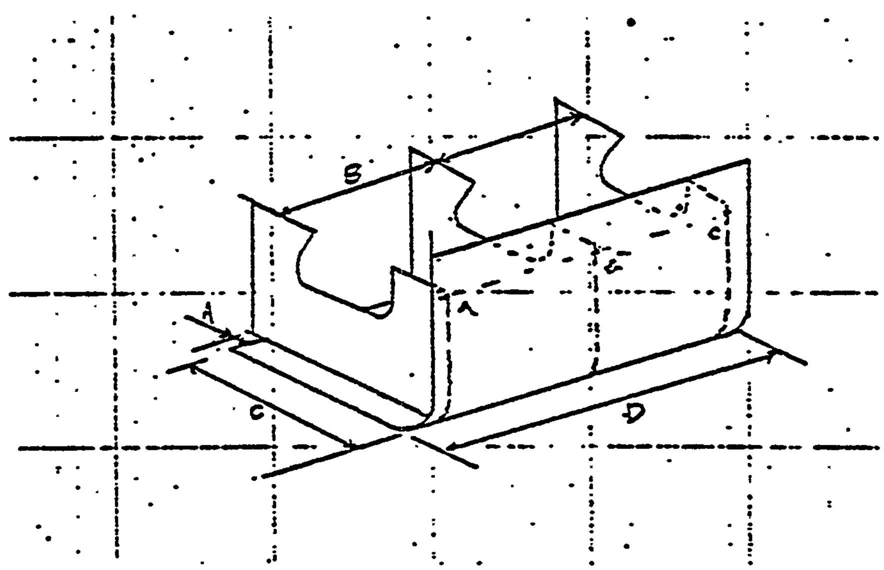


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
C			P S		Worker AC	Both side (PSI) Each Frame
D	Edge Alignment		F A		"	Every Girder Both side (F.A)
E	Girder Spacing		P S		"	Every Frame
F	"				"	Both Side (F.A.)
G	Relativity				"	2 points each edge
H	Level			a b c d e f g h i j		9 Points (a-i)

Notice After fitting, welding

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Before combined with side shell

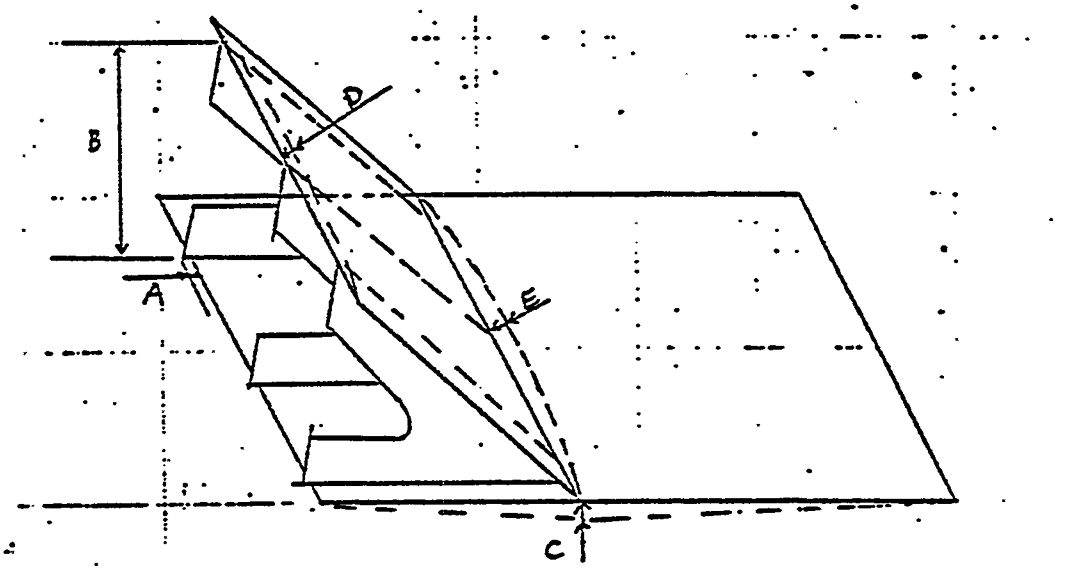


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension				Chg.	Notice
A	Edge Alignment							Worker AC	Every Trans Web.
B	Transv. Spacing							"	"
E	Deformation			a	b	c		"	3 points (a,b,c)
C	Width							AC	
D	Length							AC	

Notice: After welding, fitting

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Before combined with bilge unit

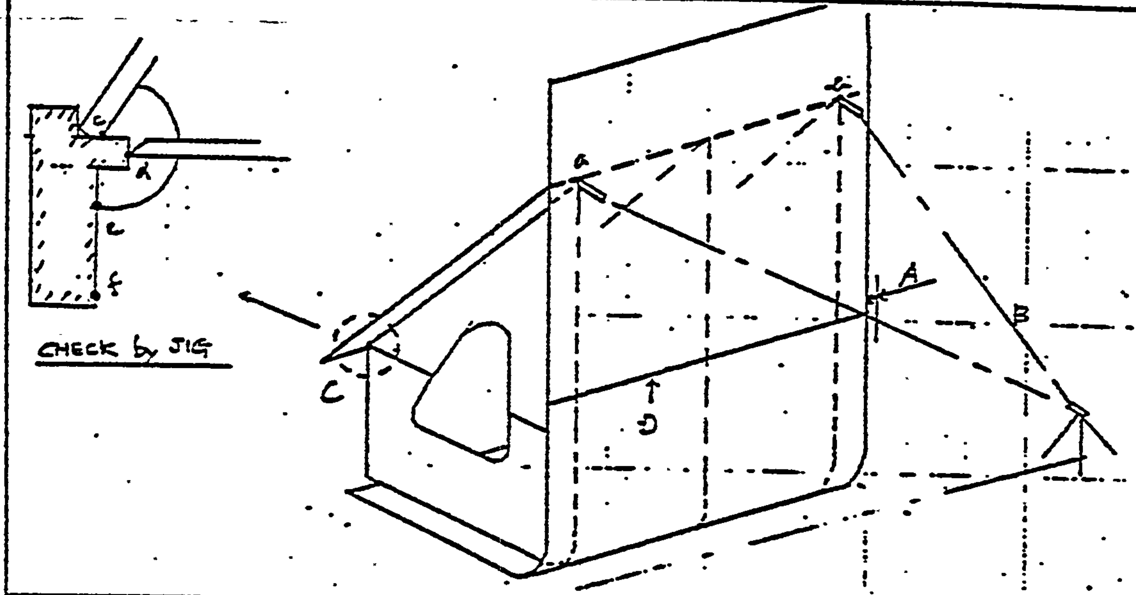


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Edge Alignment				Worker AC	Every Transv. web
B	Width at Slant Plate				AC	"
C	Knuckle at Side Shell				AC	"
D	Bending at Slant Plate				"	"
E	Bending at Side Shell				"	"

Notice After fitting, welding

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Unit to Unit

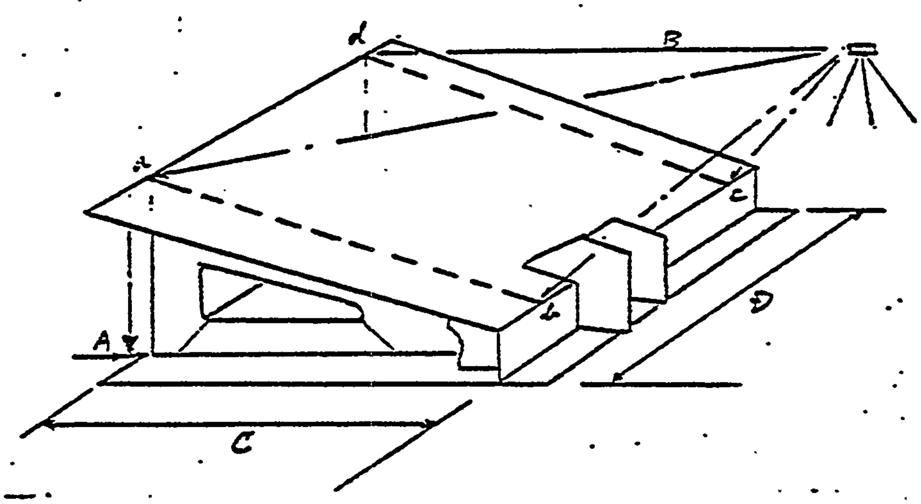


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension				Chg.	Notice
				FORE		AFT			
A	Butt Alignment							Worker	Both side (A.F.)
				FORE		AFT			
B	Inclination							Worker AC	(a,b)
				c	d	e	f		
C	Alignment							"	Check by special jig.

Notice
1. After fitting and welding
2. Top seam at bilge should be checked and finished up before setting side shell unit.

ACCURACY CHECK SHEET

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

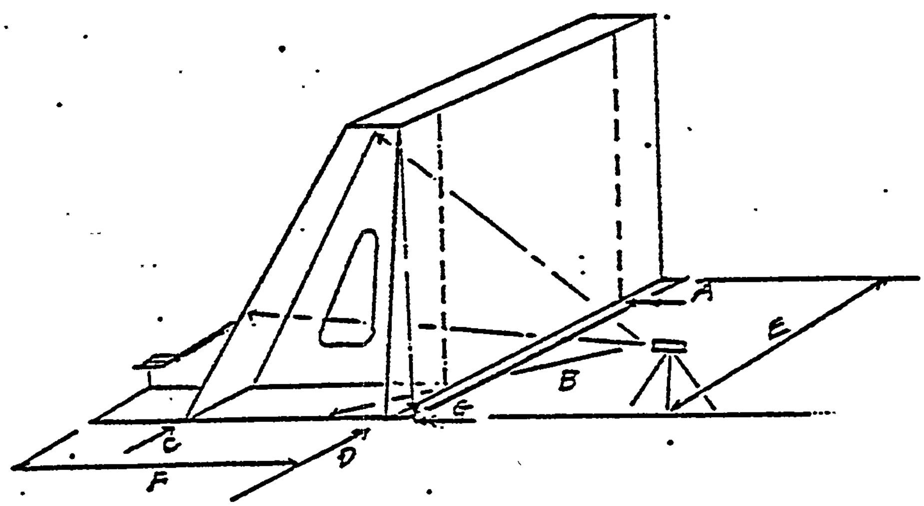


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Shift between U.Dk. & Top Side				Worker AC	Every Frame
B	Level				"	4 points (a-d)
C	Width				"	
D	Length				"	

Notice: After fitting, welding

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Final Unit Assembly

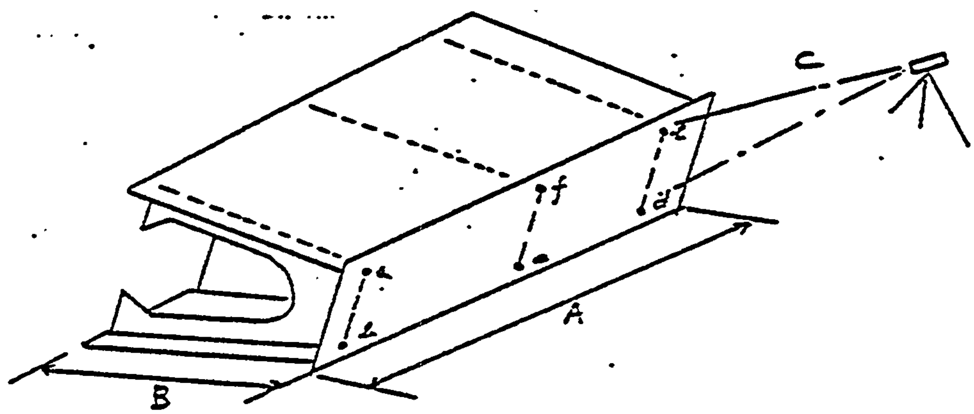


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension				Chg.	Notice
A	Shift							Worker AC	Every Frame
B	Edge Alignment			AFT		FORE		"	Both end (aft. fore)
C	Straightness							"	
D	Straightness							"	
E	Length							"	
F	Height							"	
G	Inclination			AFT		FORE		"	Both End

Notice : After fitting.welding

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Final Unit

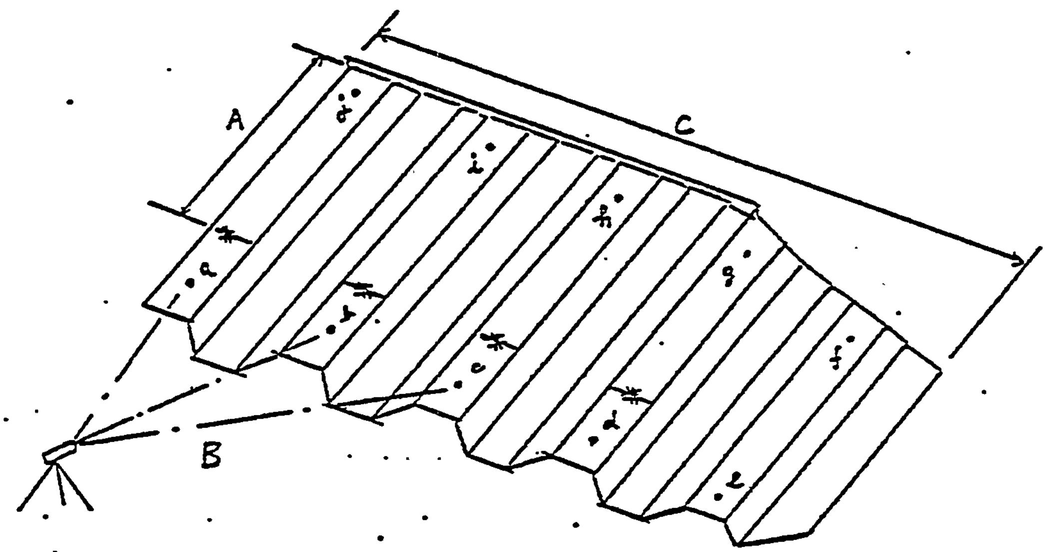


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Width				AC	
B	Height				"	
C	Flatness				"	2 points at each frame

Notice: After fitting, welding

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Final Unit Assembly

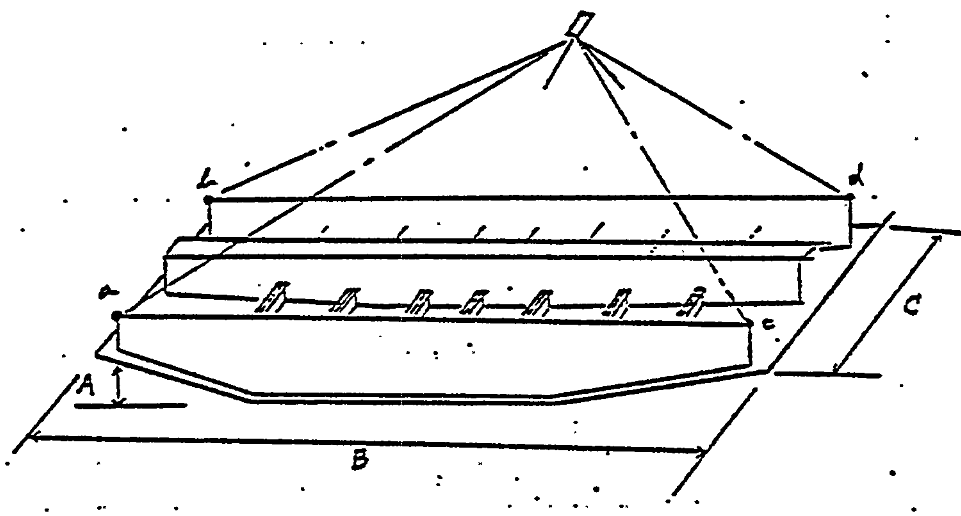


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Height				Worker	Mark check line for shipwright
B	Level				"	After checking level fix by temp. beam
C	Width					

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

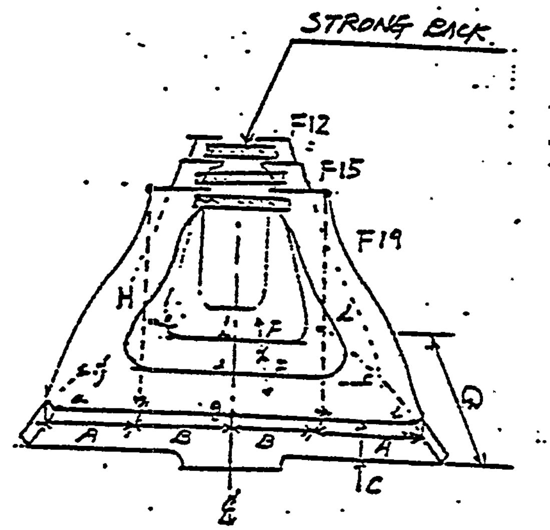
Appendix - 5

THE VITAL POTNT OF UNIT

(Curved Unit Based Flat panel)

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
	232 (233)-1/2		Lower Engine Flat Base

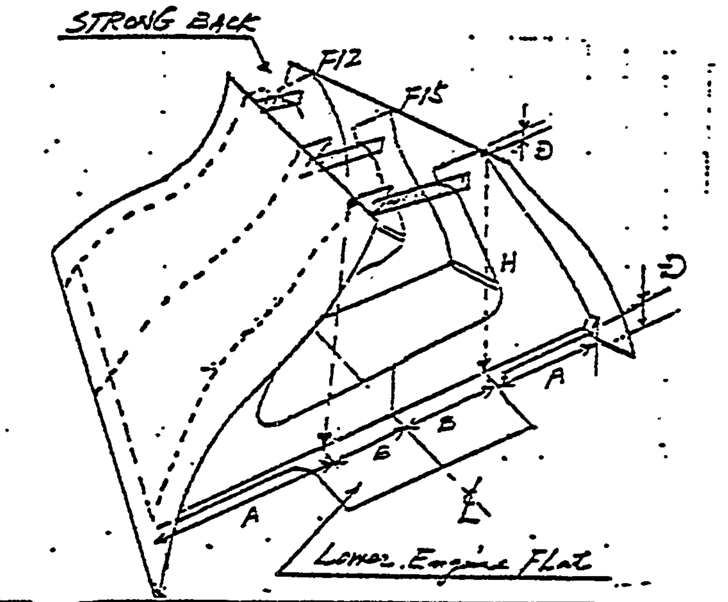


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
G	Lower Eng. Flat Level				AC Worker	a~i 9 points Keep horizontal plane
A B	Width				AC Worker	Plumb at every frame
H	Vertical Height				AC Worker	Plumb at every frame Check the vertical
C	Edge Alignment				"	Aft & Fore
F	Space				"	Each space at frame web
D	Length				"	

Notice
1) Keep the level and fix the flat panel.
2) Need support and strong back.

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
	232(233)-2/2		Final Assembly



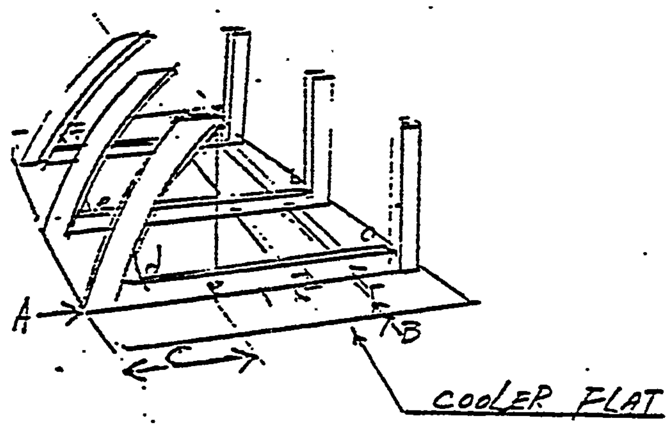
Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A B	Width				AC	Plumb Keep horizontal plane
D	Shift				AC Worker	
H	Height				AC	Plumb

After fitting and after welding.

Notice

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
	222(223)-1/3		Cooler Flat Base

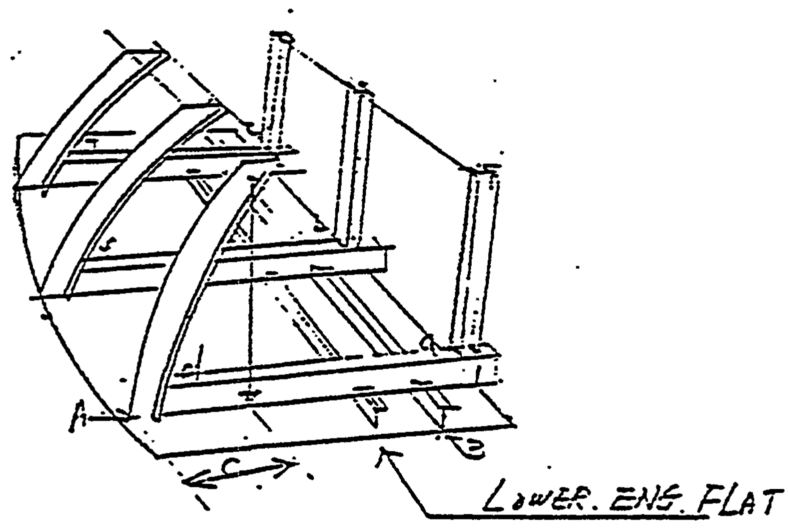


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Edge Alignment				Worker	At each frame
B	Shift				Worker	At each long'l
C	Inclination				Worker AC	At each frame with plumb
D	Level				Worker AC	a~f

Notice

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
	222(223)2/3		L. E. F. Base

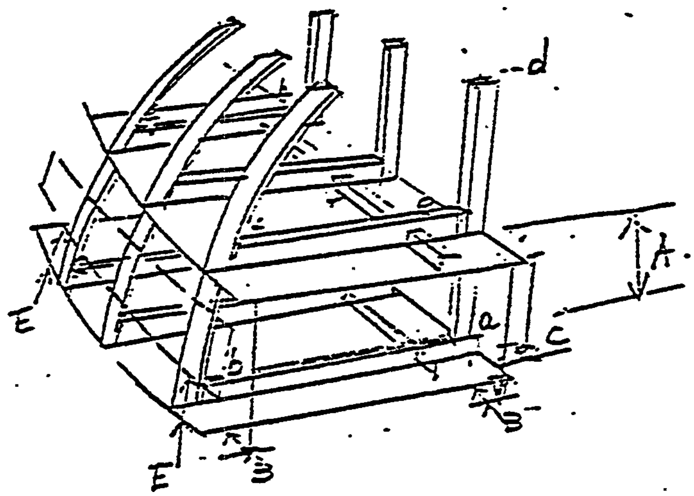


Mark	Item	Dim's Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Edge Alignment				Worker	At each Frame
B	Shift				Worker	At each long'l
C	Inclination				Worker AC	At each frame with plumb
D	Level				Worker AC	a~f Transit

Notice

ACCURACY CHECK SHEET

Ship No.	Unit No. I Shop	**Condition**
	222(223)-3/31	**Shell** Plate to be put on



Mark	Item	Dim's Drawings	**Allow. Tol.**	**Actual** Dimension		Chg.Notice
A	**Height**				**Worker** **AC**	
B **C**	**'Shift**				**Worker** **AC**	**Plumb** **at** four corners
D	Level				Worker	**a~d** **e~h Transit**
E	ShiftI	**I**	**I**		Worker	At fore and aft frame positions
I		**I**			-	

Notice

THE VITAL POINT OF UNIT

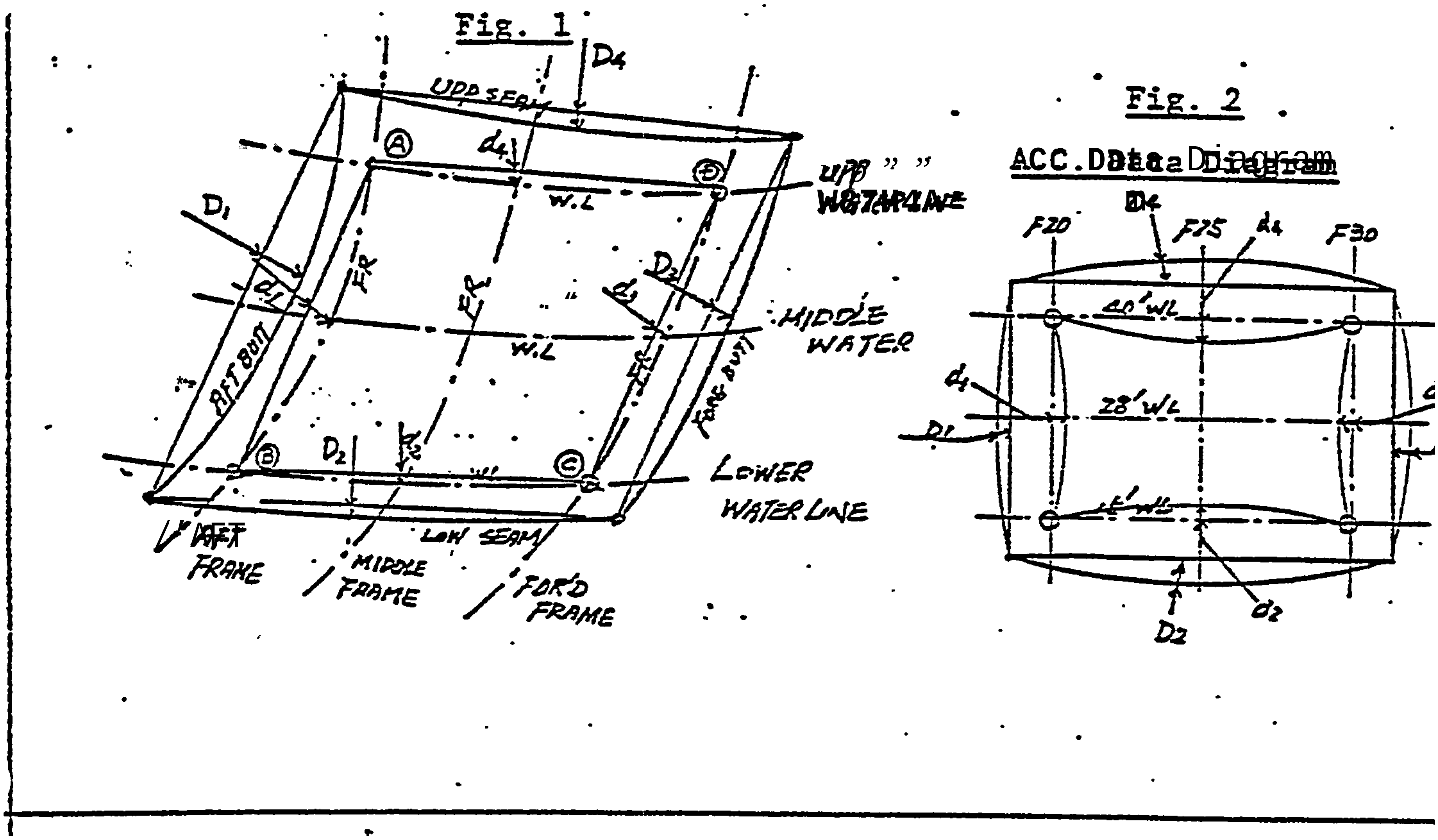
(Curved hit Based Curved Plate)

C. ACCURACY CONTROL INFORMATION

1. A. C. Data Diagram
2. A . C. Checking Procedure

C. ACCURACY CONTROL INFORMATION

1. A.C. Data Diagram



1. A.C. Data Diagram

It is generally difficult-to check deformation of the curved unit shape. However, from the point of view of *accuracy* control, it is necessary to **check** deformation of the curved unit shape **during** assembly work procedure.

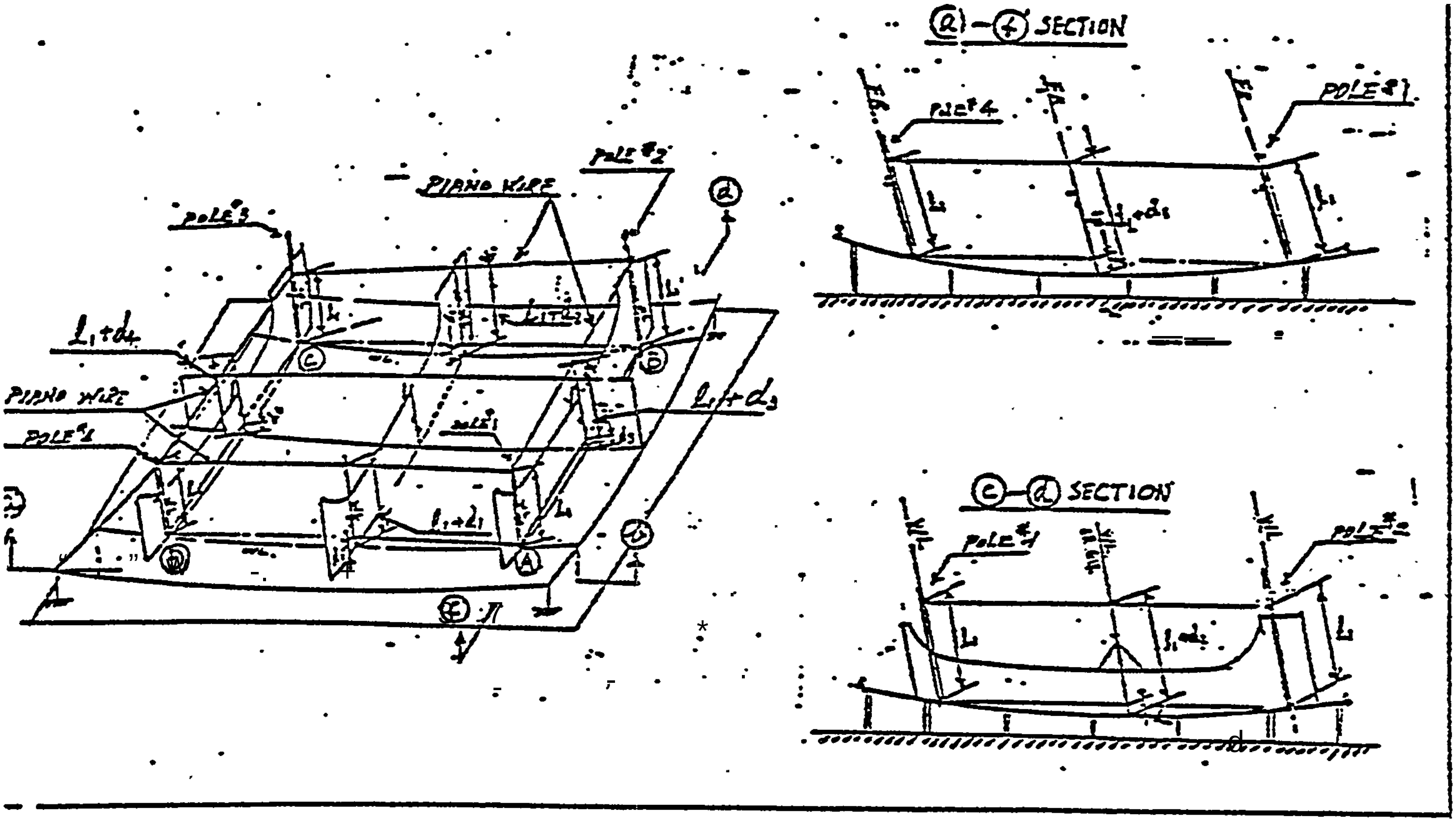
Then, the deformation checking data of the curved unit should be prepared by the mold *loft* before they begin the *assembly work.*

Calculate the maximum curvature depths at the aft butt, for'd butt, upper erection seam and the lower erection seam. Join (A) (D), (B)(C), (A) (B) and (C) (D) as shown in Fig. 1.

Calculate the upper waterline section's depth and the lower waterline section's depth at the middle frame. And also calculate the aft frame section's depth and for' d frame section's depth at middle waterline.

Using the results of the above calculation, draw the checking data diagram as shown in Fig. 2.

2. A.C. Checking Procedure



2. A. C. Checking Procedure

Using the checking data diagram, accuracy control activity is carried out as. follows:

(1) After plate joining, check the curvature depth at the aft butt, fore butt, upper seam and lower seam.

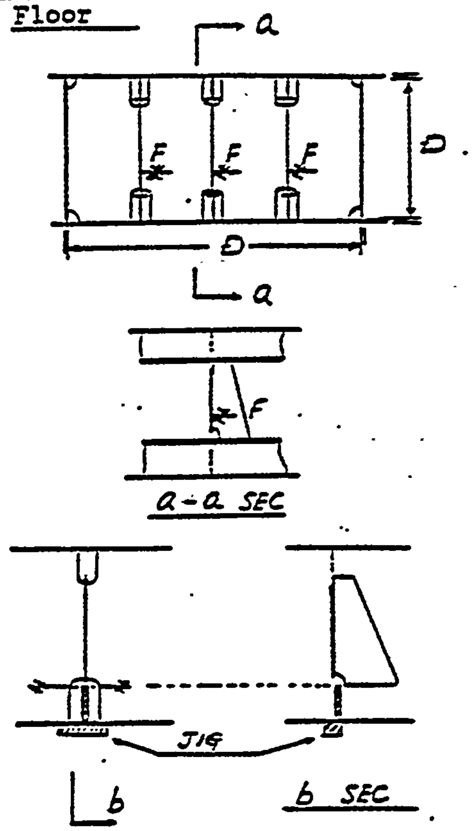
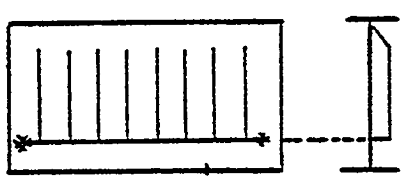
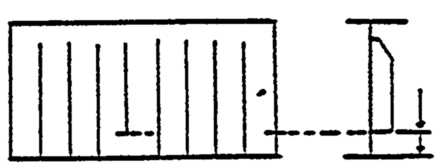
(2) Before welding of the internal structures. set the poles at four (4) points (A, B, above Fig. 3. Me checking point on the shell plate. Mark down te level mark on. each pole for deformation checking.

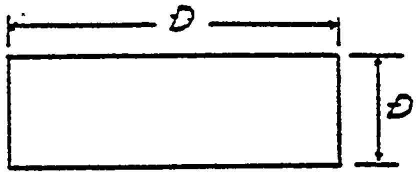
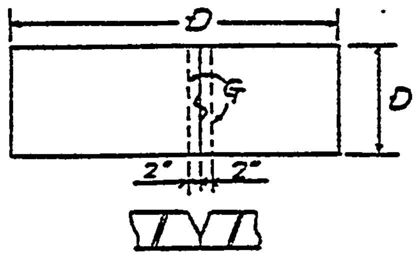
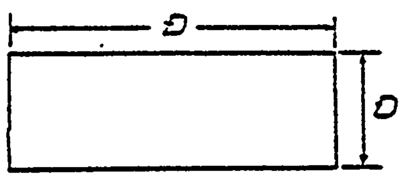
(3) After the welding of. internal structures, again set the poles at the same ‘points, and check the” distances in the same way as mentioned above.

Check the level mark on each pole for deformation of the unit.

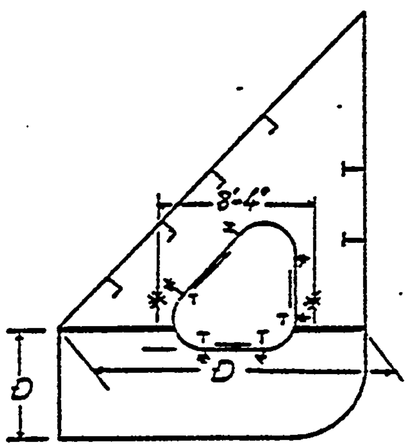
VITAL POINTS FOR FABRICATION

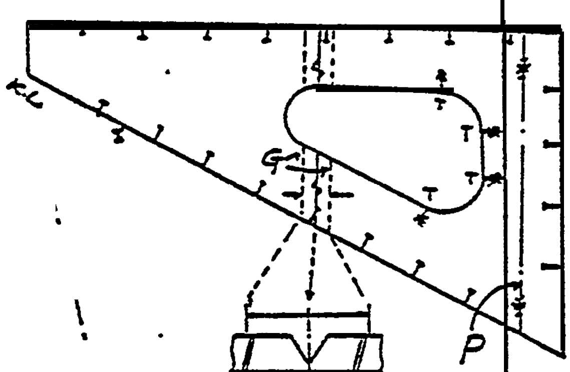
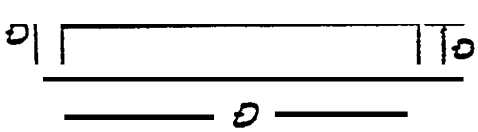
(sample)

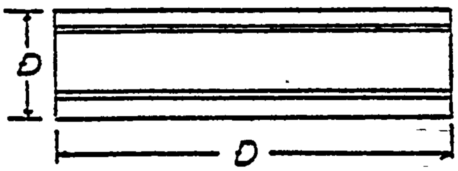
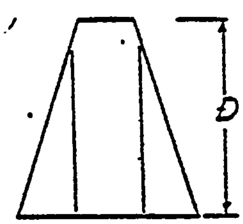
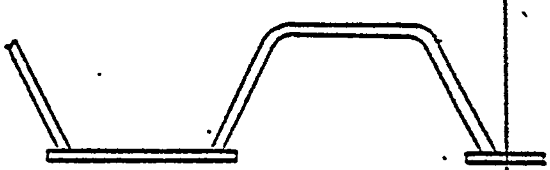
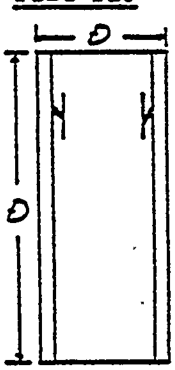
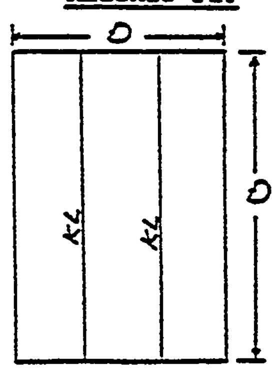
MEMBER & ITEM	MEANING & PURPOSE	NOTES
Bottom Floor 	D : Dimension to be checked *The dimension is marked by NC operator and measured after cutting and sub-assembly. F : Guide lines for fitting stiffeners. *To be marked by NC burning machine . *To be used for fitting stiffeners at sub-assembly *Two methods 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.
Tight Floor & Wall 	*To be marked at the end of stiffeners.	
	*The dimension should be indicated in case that only one stiffener is different from others.	

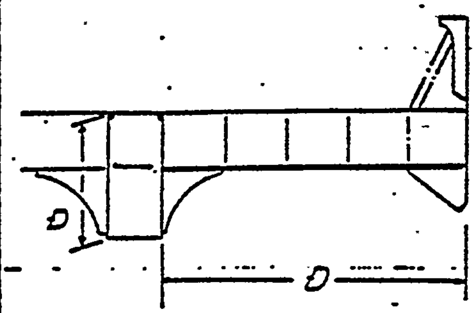
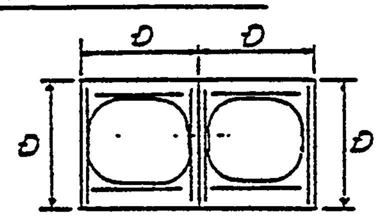
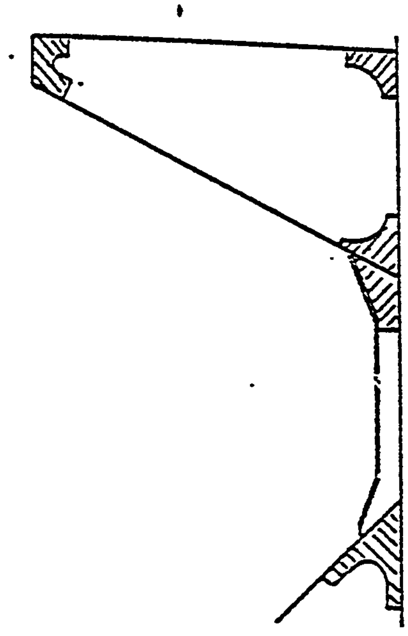
MEMBER & ITEM	MEANING & PURPOSE	NOTES
Girder		
	D : Dimension to be checked	
	G : Check lines of gas cutting	
Joined at Sub-Assembly		
Bottom & T. Top Plate		
		

HULL 751 (Zone-1) BASE LINE & CHECK LINE FOR VITAL POINTS

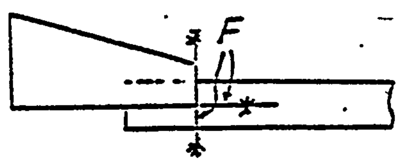
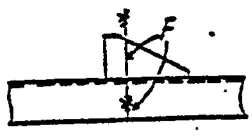
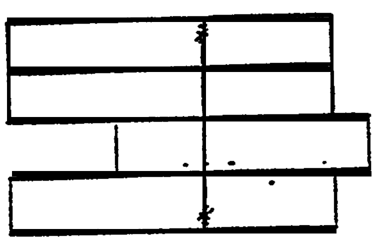
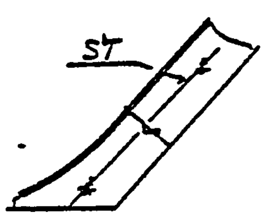
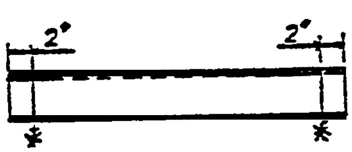
MEMBER & ITEM	MEANING & PURPOSE	NOTES
<u>Bilge Part</u>	D : Dimension to be checked	
	8'-4" : Check lines to be marked by NC machine for checking deformation by heating through gas cutting and welding T : Tangency to be marked by NC machine for fitting of face plate	

MEMBER & ITEM	MEANING & *PURPOSE*	*NOTES*
Side Shell T S T .	D : Dimension to be checked ST: Check line for deformation by heat. To be marked by NC machine or by hand.	
Upper Wing Tank  Knuckled Place  	G : Checkline of *gas cutting* . P : Check line for perpendicular to be marked by NC machine. T : Tangency To be marked by NC machine.	

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

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

HULL 751 (Zone-1) BASE LINE & CHECK LINE FOR VITAL POINTS

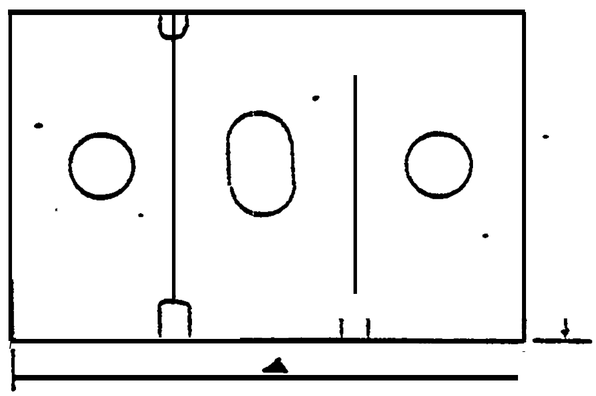
MEMBER & TEM	MEANING & PURPOSE	NOTES
Sub-Assembly (Angle)		
  	F : Guide line for fitting to be marked by NC machine or by hand.	
	Guide line for plate joining: In case that some ends of plate are different from others, a base line should be marked for plate arrangement.	
	ST: Check line for deformation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

VITAL POINTS ▲ : MARK

ACCURACY CHECK SHEET

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

BOTTOM CENTER UNIT FLOOR



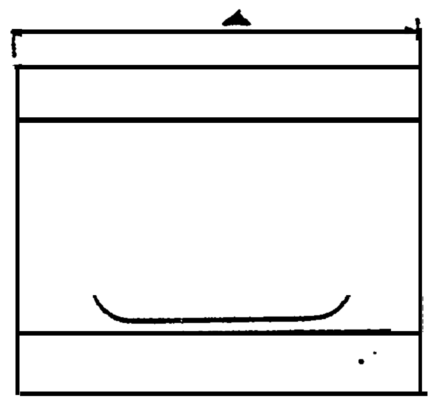
WRITER

PIECE NAME	HEIGHT	WIDTH

ACCURACY CHECK SHEET

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

BOTTOM CENTER UNIT FLOOR



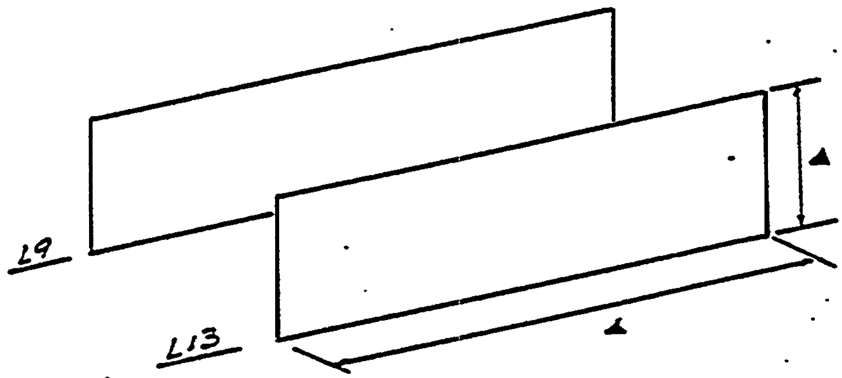
WRITER

PIECE NAME	HEIGHT	UPPER SIDE WIDTH	LOWER SIDE WIDTH

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Cut. Sub.As.	All pieces to be checked

BOTTOM SIDE UNIT GIRDER



WRITER

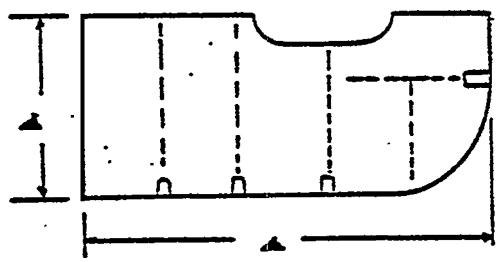
UNIT NO.	PIECE NAME	LENGTH	UNIT NO.	PIECE NAME	LENGTH

a

ACCURACY CHECK SHEET

Ship No.	unit No.	Shop	Condition
		Cut. Sub-As	Sampling check 2 pieces/plate

Bilge Shell Unit Floor



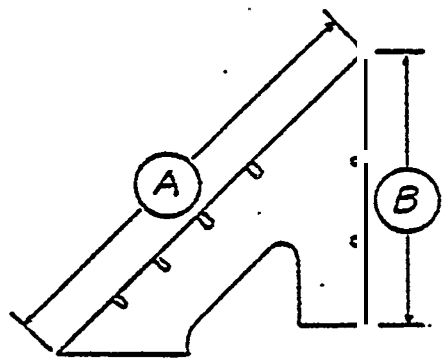
WRITER

PIECE NAME	HEIGHT	WIDTH

ACCURACY CHECK SHEET

Ship No. unit No.	Shop	condition
	Cut. Sub-As Sampling check: 2 pieces\plate	

Hopper Side Tank Unit Floor



(INCLUDING WATER TIGHT BHD.)

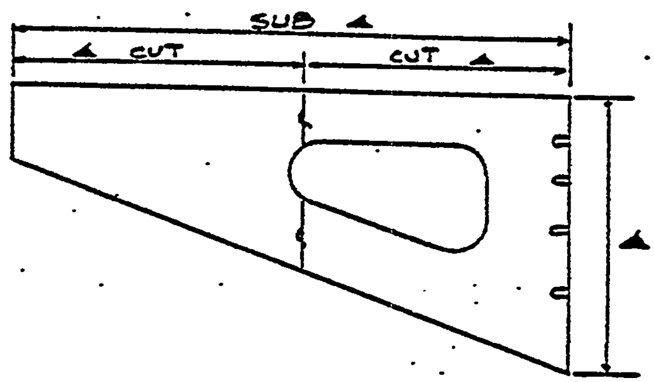
WRITER

PIECE NAME	HEIGHT A	HEIGHT B

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Cut. Sub.As	Cutting: Sampling check Sub : AU piece check.

TOP SIDE TANK UNIT FLOOR



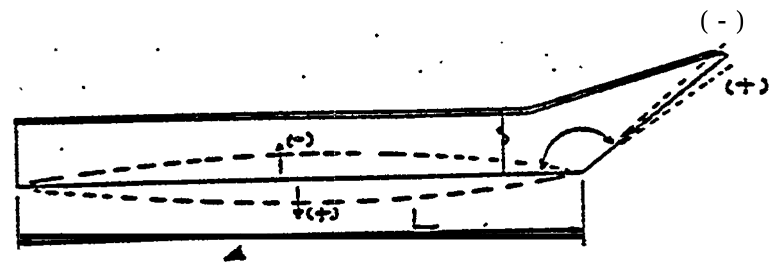
WRITER

PIECE NAME	WIDTH	HEIGHT

ACCURACY CHECK SHEET

S ship No.	Unit No.	Shop	Condition
		Sub-Assembly	All pieces to be checked

H O L D   F R A M E



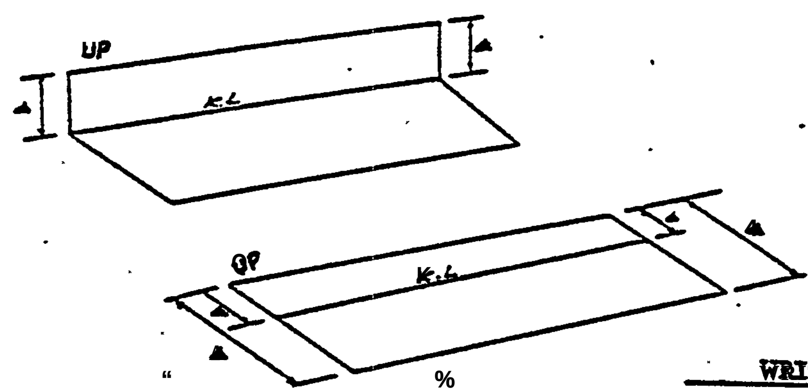
WRITER

PIECE NAME	LENGTH (L)	DEFORMATION	ANGLE

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Cut.-Bending	All Pieces Check

TOP SIDE TANK UNIT THE KNUCKLED PLATE



WRITER

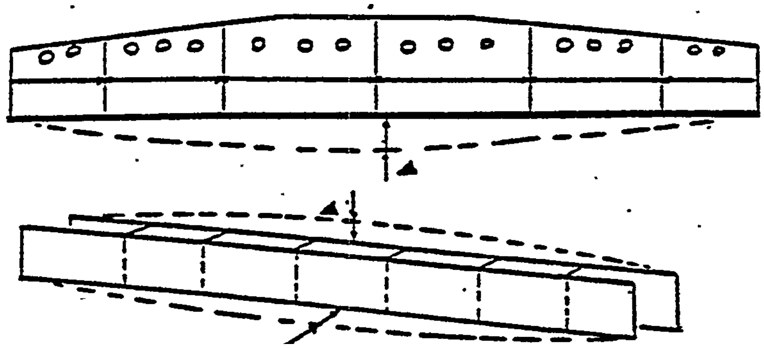
UNIT AND PIECE NAME	AT FORE END		AT AFT END	
	WIDTH	Distance from kl to edge	WIDTH	Distance from kl to edge

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Sub-Assembly	All pieces checked

UPPER DECK CENTER UNIT HATCH END

BEAM BOX BEAM



WRITER

PIECE NAME	DEFORMATION OR DISTORTION

LSCo. Report No. - 2123-5.1-4-1

TECHNOLOGY TRANSFER PROGRAM (TTP)

FINAL REPORT

Appendix C

Base Line for Accuracy

VOLUME 2 APPENDICES

prepared by:

Shipbuilding

‹as

March 3, 1980

APPENDIX C

BASE LINE FOR ACCURACY

BASE LINE FOR ACCURACY

(A.C. PLANNING ACTIVITY)

Prepared by
Osamu-Togo
I,H.I.
Sept. 6, 1979

C O N T E N T S

Base Line for Accuracy

I.. TOTAL VIEW OF BASELINE

To maintain the accruacy of each construction step of shipbuilding, seine types of base lines which are dependent on the purposes should be prepared. Usually base lines are separated into three (3) types as follows.

Type l--Check Line to Maintain Accuracy of Burning

Type 2--Check Line to Maintain Accuracy of Shaping the Materials

Type 3--Check Line to Maintain Accuracy of the Relationship of the Materials

The planning for every type must be separated into two (2) kinds as is other planning.

One is preliminary planning and the other is implement planning .

Basically the preliminary planning should be prepared by the A.C. planning and the implement planning should be prepared by the Mold Loft.

The preliminary planning shows the precise guides by material to put the information mainly into the N/C tapes.

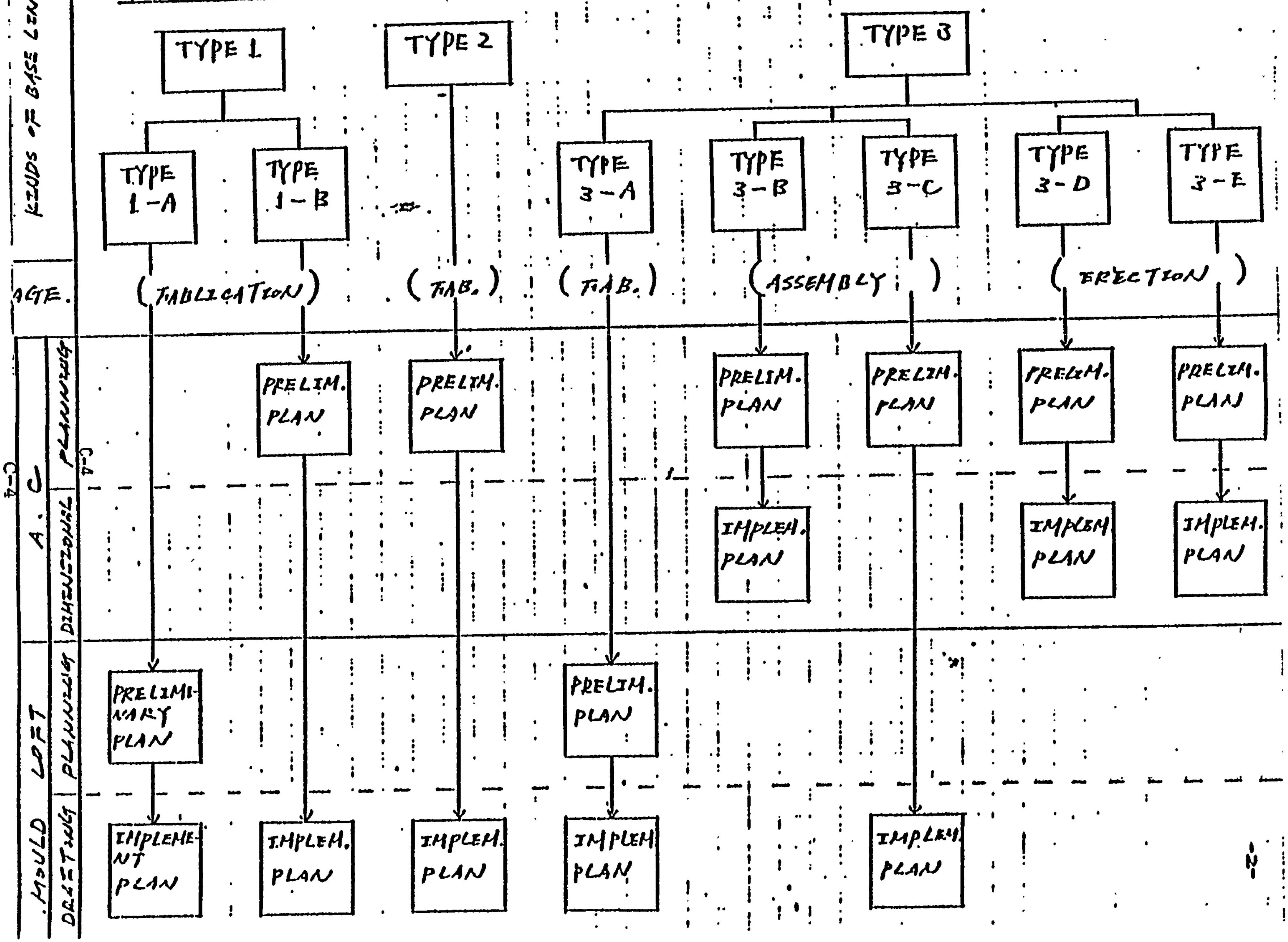
The total view of the base line planning will be shown on the next page.

This view shows these items as follows:

- Kinds of Base Lines
- Reserved Stages
- Charged by Who & What

SEPT. 10. '69

TOTAL VIEW OF BASE LINE PLANNING



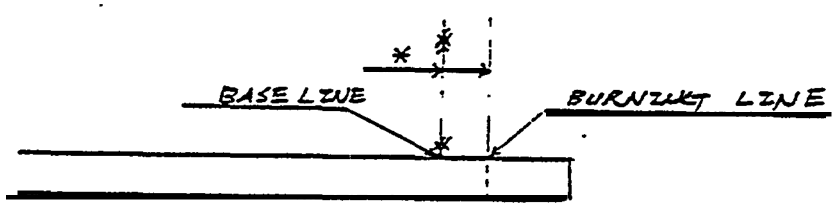
II. DESCRIPTIONS BY TYPE

A. Type l-- Checd Line to Maintain Accuracy of Burning

It is very effective to confirm or check the dimensions after burning materials.

1. Standard Format

Mark the dotted line at the suitable place in keeping some constant distance from the edge with some specific marking method such as the N/C burning machine or some type of jig.



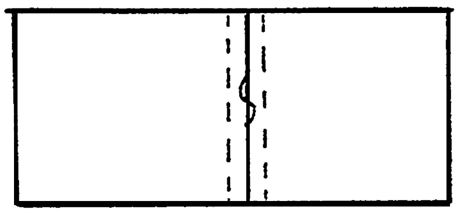
* Usually keep 2" as constant dimension.

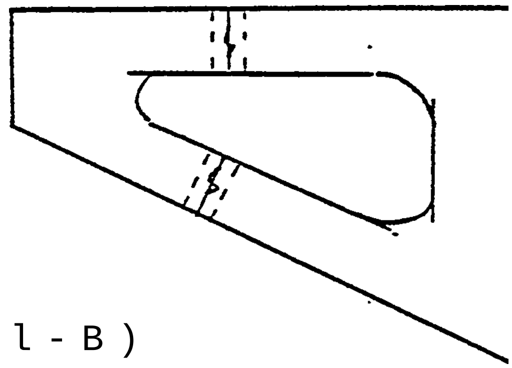
2. Application

Usually this check line should be divided into two (2) types of lines. One is the line to check the straightness and the other is the line which checks the curved line after burning.

(a) The Straight Part (Type I-A)

Usually this checking line should be planned by the Mold Loft planning for materials which have a straight joint. For example, the flat joints of the internal structures need this base line which should be marked by the N/C burning machine as illustrated on the following page.





(b) For the Curved Line (Type l - B)

This base line usually should be applied to the curved part (such as engine flats and curved web frames) which is burned manually. This should be done because the manual burning applied to the curved part makes it very difficult *to* maintain accuracy. The preliminary plan will be prepared by the A.C. planning in this case.

At the present **time,** the N/C burning machine will be prepared *as usual* for the curved part like this. Then the case of using the N/C burning will not require any type of base line like this.

B. Type 2--The **Check** Line to Maintain Accuracy of Shaping Materials -(**SEE APPENDIX PAGE 2)**

This base line should be marked and in the dotted *line* at the middle part of the material and the length of the line should be kept long enough to be checked. This check line should be marked by the N/C burning machine or some kind **of** jig.

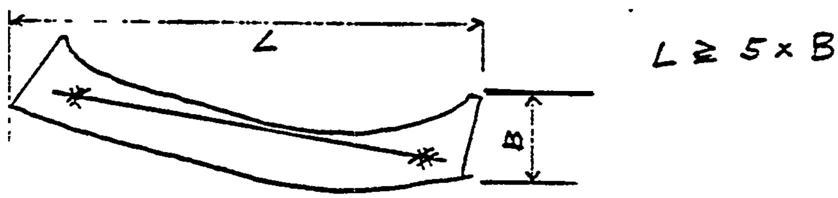
The preliminary planning for Type 2 should be prepared by the Accuracy Control **group. Depending** on the plans, the **actual planning for each material will** be done **by the** Mold **Loft** .

1. Application

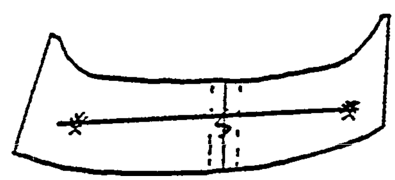
For the internal structure which is long and has no straight line (such as the curved web), it is necessary to set some kind of check line to maintain the shape after welding. Materials which require Type 2 are listed below:

(1) In the shape of the material, the straight line as the base line is not included such as the curved web frame, side stringer, etc.

(2) The ratio of length to width should be 5 times greater.



(3) EspeciallY for the materials that have sub-assembly joints in them.



C. Type 3--The Base Line to Maintain the Accuracy of the Relationship of Materials

This base line is very effective in confirming or checking the relationship of materials (shift, alignment, straightness, parallel, etc.) at each step of shipbuilding.

This type can be classified by its purpose at each stage as follows:

(a) At the Fabrication Stage (Type 3-A)

This base line is usually used at the sub-assembly stage. It is especially effective to set stiffeners, face plates and brackets on the trans frame or girder. These base lines should be prepared by the Mold Loft planning. (See appendix, Page 1).

(b) At *the Assembly* Stage (Type 3-B) (Type 3-C)

This base line at the assembly stage is usually separated into two (2) types of base lines .

(1) **One** is the base line called "Back Side Marking" which is very convenient in maintaining the alignment between materials separated from each other by a wall or girder. (Type 3-B) (See appendix, Page 2).

(2) The other is the base line to affect the relationship of materials, especially for the curved unit (Type 3-C) (See appendix, Page 3).

(c) At Erection Stage (Type 3-D) (Type 3-E)

The **base line** *at* the *erection stage* is usually separated into two (2) types as follows:

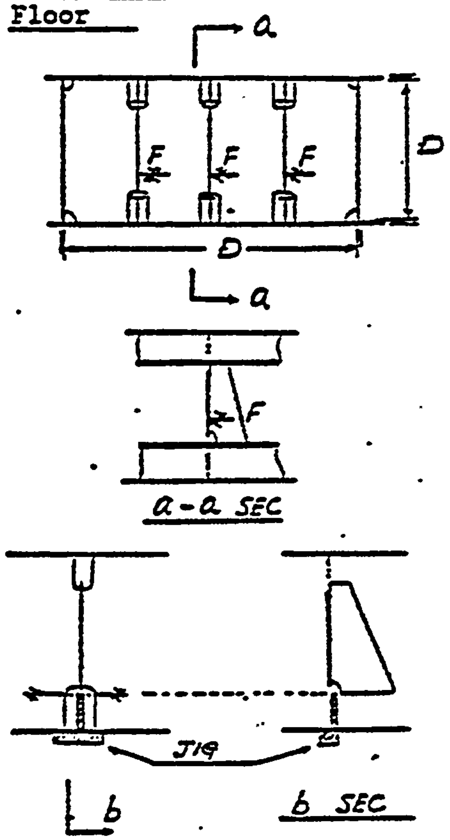
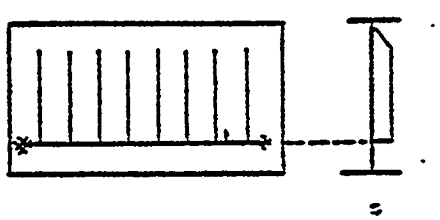
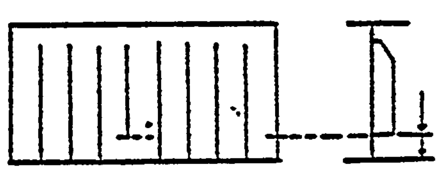
(1) The absolute **base line** which will be marked on **the** ways for the ship. (Type 3-D)

* Marking Items
  Centerline of ship, aft butt position of start unit .
  For'd end frame position of each unit for Zones 1 & 3, aft end frame position of each unit for Zone 2, watertight bulkhead position, aft perpendicular point. For'd perpendicular point.

* **Timing & Charging**
  These-items should be figured on some type of marking guide by the A.C. planning before the keel lay. Usually the guide plan should be described in the cribbing plan. Depending on the guide, actual. layouts have to be done by the A.C. group.

(2) The Check Line for Shipwright (Type 3-E)

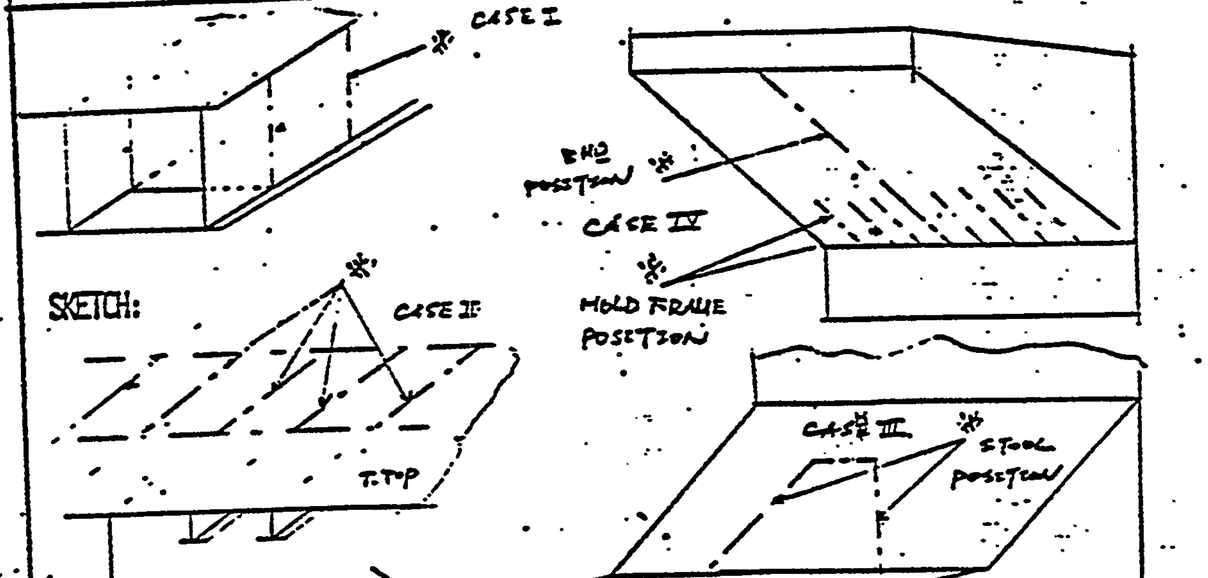
This is very important and effective to set units on the ways. Basically, this line should be marked on the unit before erection. There are many types of base lines, depending on the types of units. The necessary base lines are shown in figures marked
(See appendix, Pages 4-8) . These basic lines should be planned preliminarily by the A.C. planning. Depending on this plan, the implementing plan will be prepared by the A.C. group. After completing the units, the actual layout will be set by the A.C. group on the slabs .

MEMBER & ITEM (TYPE 3-A)	MEANING & PURPOSE	NOTES
Bottom Floor  	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.
Tight Floor & Wall 	*To be marked at the end of stiffeners.	
	*The dimension should be indicated in case that only one stiffener is different from others.	

[redacted] (TYPE 3 - B) CHI'S ENGINEER FIELD REPORT 2/8

PREPARATIONS TO ERECT UNITS	DATE Jan. 25, '77	REF. NO. 12
ITEM o BACK SIDE MARKING	ENGINEER'S NAME OSAMU. TOGO	

SKETCH:



<RECOMMENDATIONS>

~~COMMENTS~~: IT IS VERY EFFECTIVE TO REDUCE THE MAN HOURS ON THE WAYS THAT THE BACK SIDE MARKING MUST BE DONE ON THE SLABS AS SHOWN IN FIGURES. BECAUSE ONE OF THE BIGGEST JOBS TO WASTE THE TIMES ON THE WAYS IS TO MAKE THE ALINEMENT IN NARROW, DARK, DANGEROUS PLACES. SO TO DO THE BACK SIDE MARKING ON THE SLABS WILL BE MORE HELPFUL TO DECREASE LIKE THAT JOBS.

~~RECOMMENDATIONS~~: <SAMPLE CASES>

CASE I : BACK SIDE MARKING ON GIRDERS BETWEEN DOUBLE BOTTOM UNITS. (Ex. 121 ↔ 122, 122 ↔ 124, ALSO CURVED DOUBLE BOTTOM UNITS)

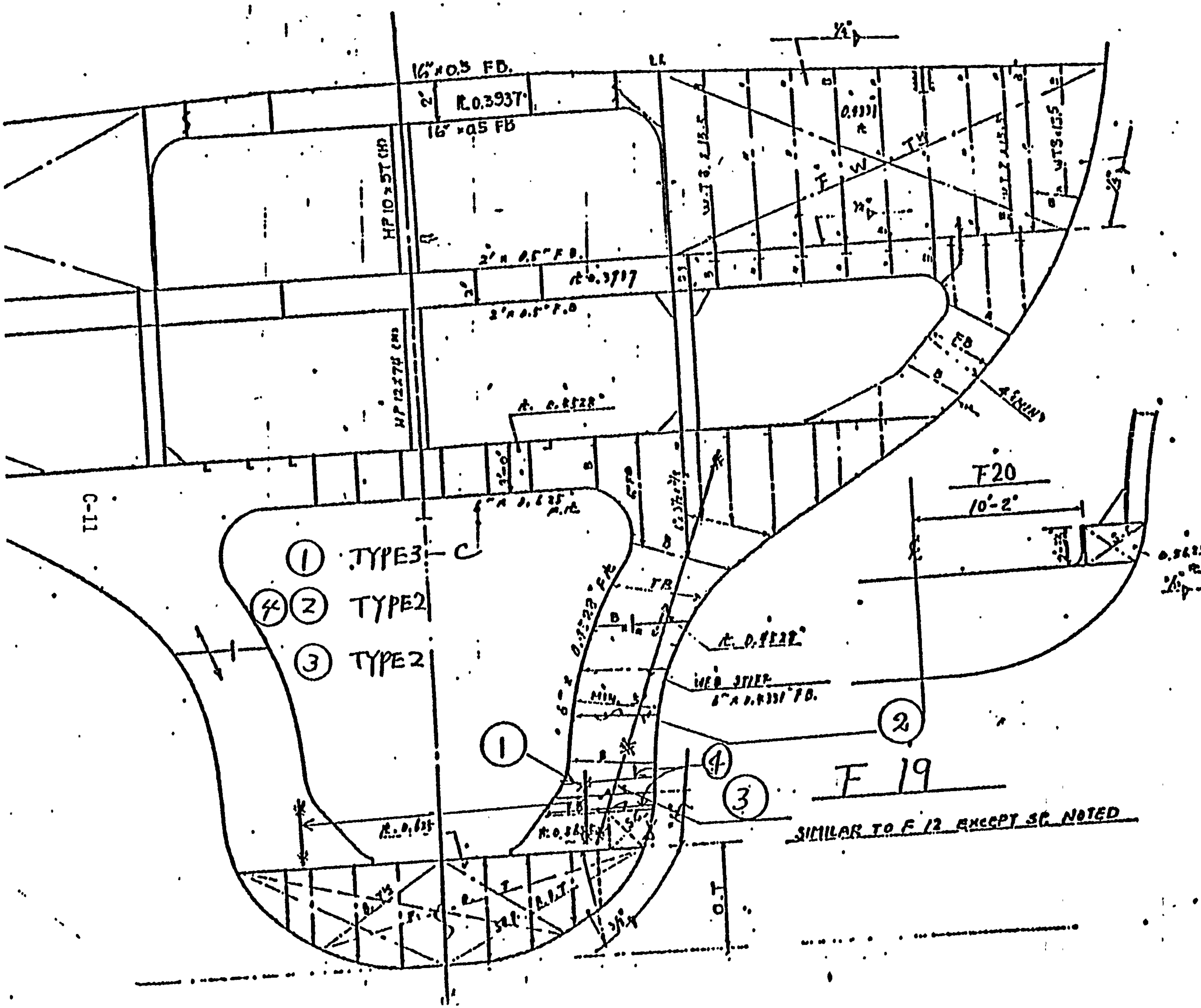
CASE II : BACK SIDE MARKING ON T-TOP. BETWEEN STOOLS AND D.BOTTOM UNITS (Ex 121, 122, 123 ↔ 183)
AS SAME BETWEEN STOOLS AND BHDS (Ex 183 ↔ 124)

CASE III : BACK SIDE MARKING ON SLANT PLATE (Ex 123 ↔ 124)

CASE IV : BACK SIDE MARKING ON TOP SIDE TANK BOTTOM PLATE (Ex 184 ↔ 126)

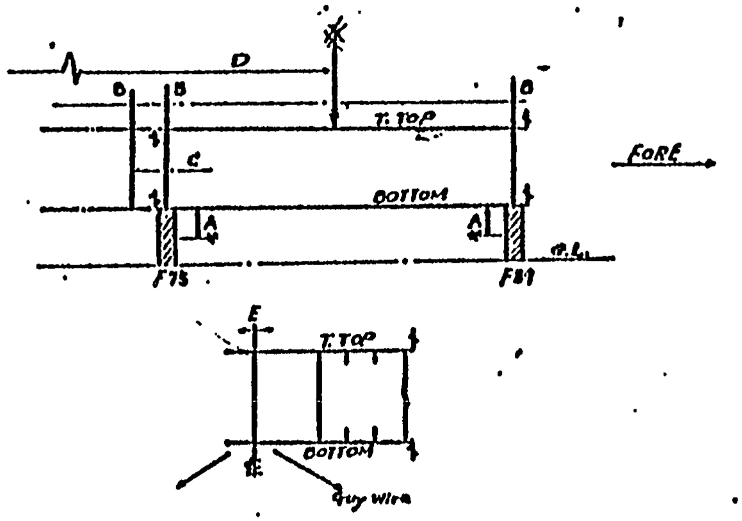
LSCO'S VIEWS:

TYPE 2, TYPE 3-C



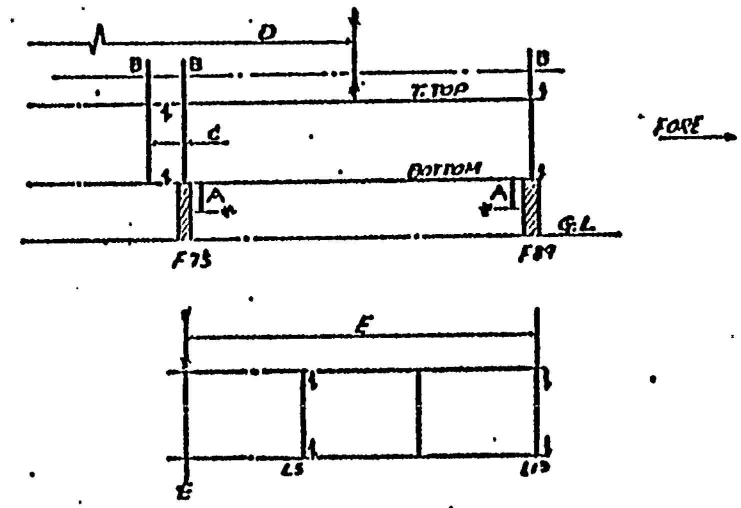
(TYPE 3 - E')

HULL NO.	UNIT	ERECTION SEQ.	HEIGHT (T)	SHIPWRIGHT
				BOTT. CENTER



MARK	DESCRIPTION	DIMEN-SIONS	TOLER-ANCE	CHARGE	NOTICE
A	Bottom Height			Worker	Measure at C.GIR 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 Bhd. to Bhd.			Worker AC	Measure by ruler
E	Center line check			Worker AC	Adjust at foreend by guy wire. Measure by Transit

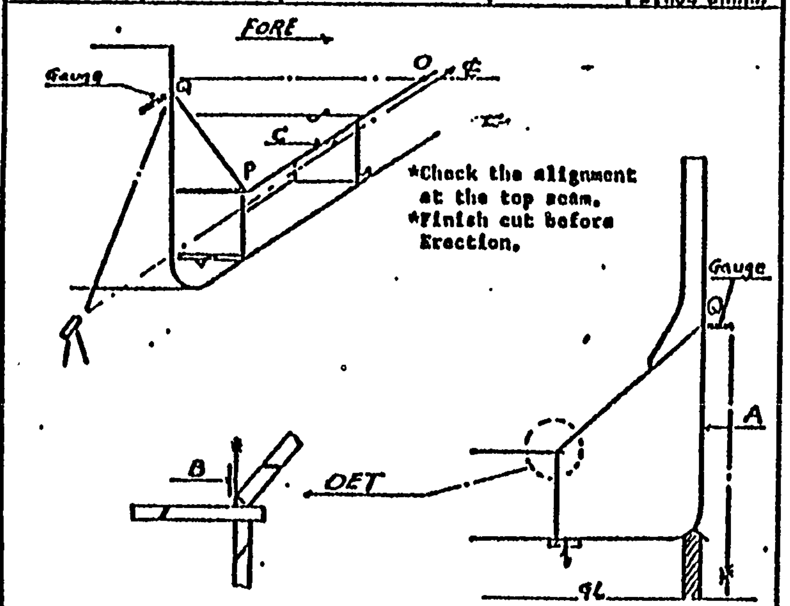
HULL NO.	UNIT	ERECTION SEQ.	HEIGHT (T)	SHIPWRIGHT
				BOTT. SIDE



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 Bhd. to Bhd.			Worker AC	Measure by ruler.
E	Width from C. line to L13.			Worker	Measure at fore & aft end by transit.

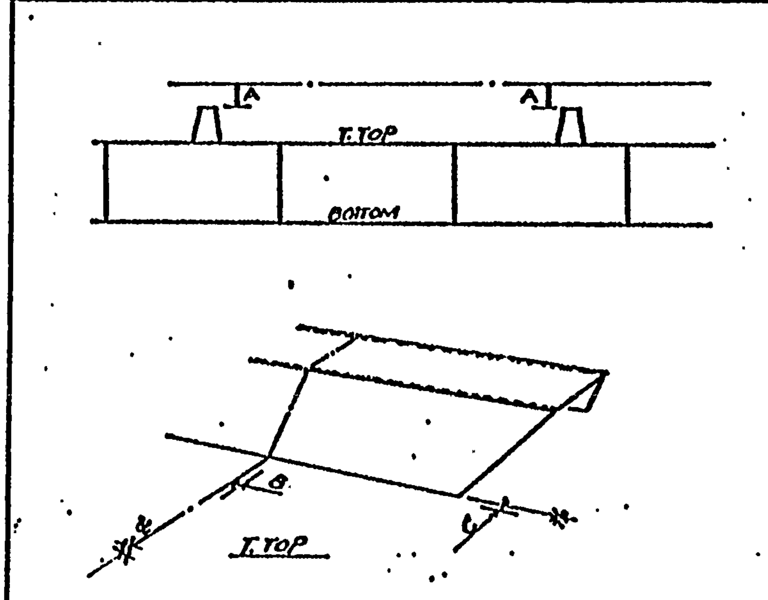
(TYPE 3 - E)

HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				BILGE SHELL.



MARK	DESCRIPTION	DIMENSIONS	TOLERANCE	CHARGE	NOTICE
A	Width & Perpendiculary			Worker AG	Read the gauge at "Q" by transit.
B	Alignment & Gap			Worker	Check discrepancy from marked line.
C	Alignment at fore butt			Worker AG	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.

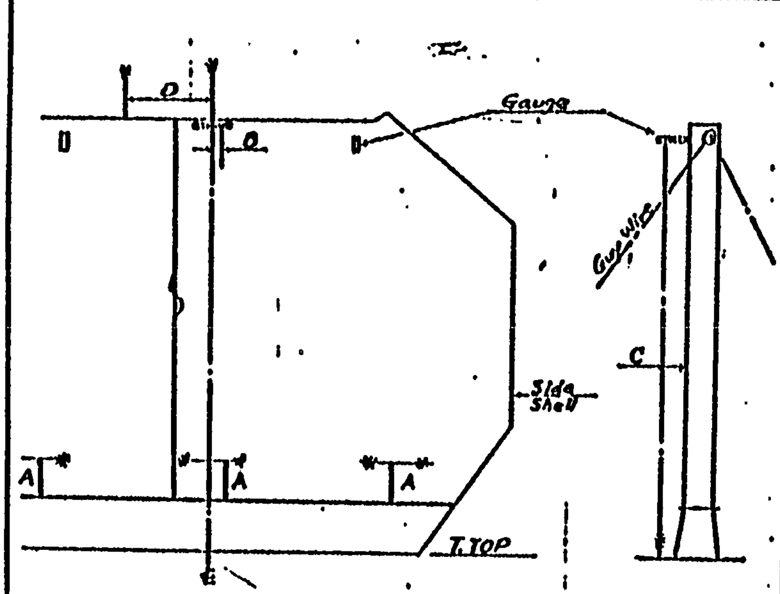


MARK	DESCRIPTION	DIMENSIONS	TOLERANCE	CHARGE	NOTICE
A	Level & Height			Worker AC.	Check of the level at the stool top
B	Center line			Worker	Check discrepancy from marked line.
C	Alignment of frame			" "	Do
D					

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

(TYPE 3 — E)

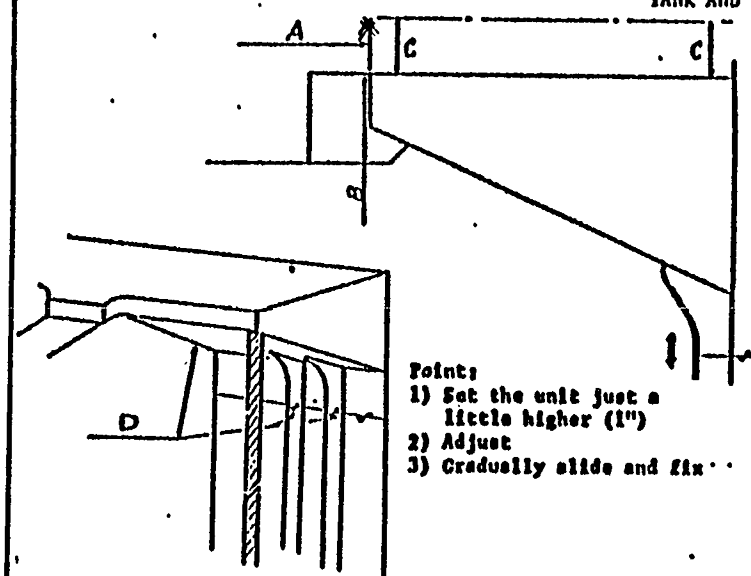
HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				CORR. BHD.



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

C-14

HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				UPP. WING TANK AND UPP. DK. SIDE



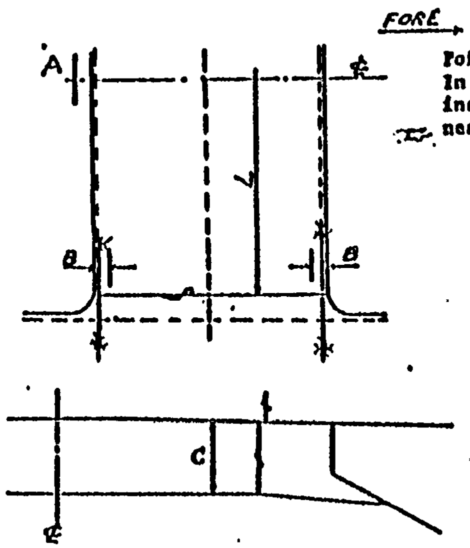
Points:
1) Set the unit just a little higher (1")
2) Adjust
3) Gradually slide and fix

MARK	DESCRIPTION	DIMEN-SIONS	TOLER-ANCE	CHARGE	NOTICE
A	Width			Worker AC	Measure from center line by ruler
B	Height			Worker AC	Measure from T. Top by ruler.
C	Level			Worker AC	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.

TYPE 3 - E

HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				UPP. DK. CENTER



Point:
In case of the unit to be inserted: Check "L" and neat cut. (at Assembly)

MARK	DESCRIPTION	DIMEN-SIONS	TOLER-ANCE	CHARGE	NOTICE
A	Center line			Worker AC	Check discrepancy by transit
B	Alignment of the joining part			Worker	
C	Height			Worker	Before erection, check the dimension and neat cut
D					

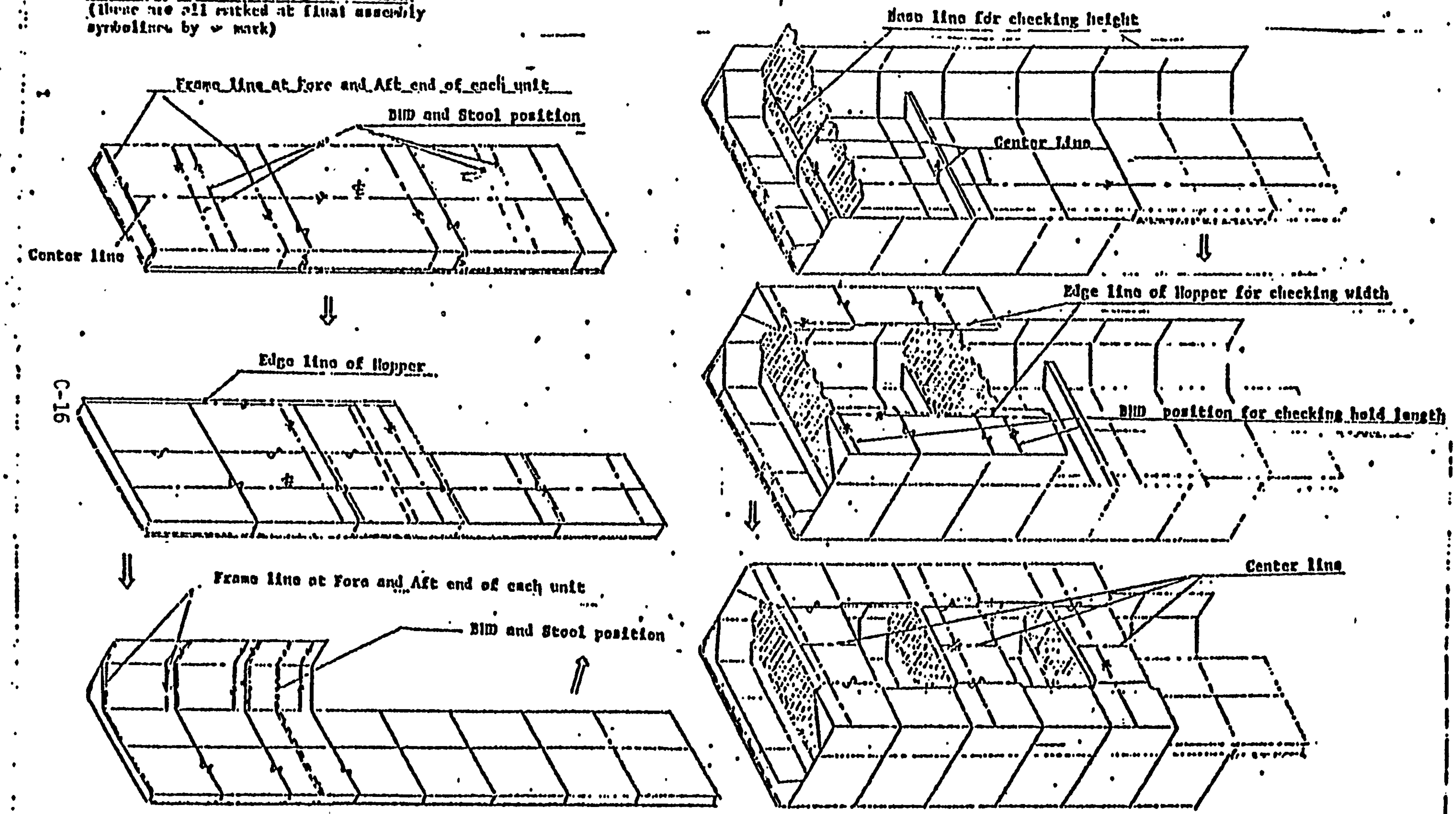
HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT

MARK	DESCRIPTION	DIMEN-SIONS	TOLER-ANCE	CHARGE	NOTICE
A					
B					
C					
D					

8/8

TYPE 3 - E

BASE LINES FOR SHIPWRIGHT AT ERECTION.
(these are all marked at final assembly symbolines by ✓ mark)



9/9

LSCo. Report No. - 2123-5.1-4-1 D-08
LSCo . 4

TECHNOLOGY TRANSFER PROGRAM (TTP)

FINAL REPORT

QUALITY ASSURANCE SYSTEM

Appendix D

Additional Material Planning

Q U A L I T Y   A S S U R A N C E

V O L U M E   2   A P P E N D I C E S

prepared by:

Livingston Shipbuilding Company
Orange, Texas

March 3, 1980

APPENDIX D

ADDITIONAL MATERIAL PLANNING

~~ADDITIONAL~~ MATERIAL PLANNING

(A.C. PLANNING ACTIVITY)

Prepared by
Osam-Togo
I.H.I
Sept. 20, 1979

CONTENTS

ADDITIONAL MATERIAL PLANNING

To keep the accuracy of the ship on the ways finally, there are two (2) kinds of ways. Oneway is to reduce the factors of inaccuracy using some effective method such as certain accuracy movement, improvement of equipment and construction methods, etc. This is very important for accuracy of ship. But actually, from the beginning through the end of construction, it is very difficult to keep the precise dimensions of materials at each step.

Because there are lots of factors to disturb the accuracy at each stage as follows:

1. Inaccuracy of Layout
2. Inaccuracy of Burning
3. Inaccuracy of Fitting
4. Shrinkage Welding
5. Deformation by Welding

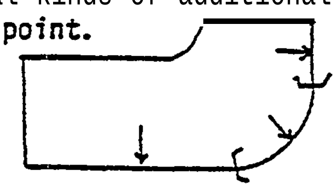
Usually these factors will be totaled from stage to stage.

The other way to keep the accuracy finally is to prepare some suitable additional materials that are enough to recover the factors that disturb the accuracy.

From this point of view, it is clear that one of the most important items of preliminary accuracy planning is additional material planning.

A. Kinds of Additional Material and Standard of Symbol

1. To show some additional materials in figures, it is convenient to use arrow **mark ⟶.** The arrow mark shows more clearly which part of material should have additional material. One arrow can cover the same condition of additional material. If there are several kinds of additional material on one line, put **the border mark] at border point.**



2. Other necessary information to be set into additional material planning is the suitable stage to cut neat additional material. Considerable stages are as follows:

Basic Stage	Basic Symbol
Cut neat at Fabrication	$\longrightarrow$
Cut neat at Assembly	$\xrightarrow{A}$
Cut neat at Erection	$\xrightarrow{=}$

For developing accuracy control activities into production,-more precise controls will be required. Depending on fabrication steps, the suitable stages to cut neat additional material will be the following three (3) kinds of way:

Kind of Type to Cut Neat	Symbol
a) Cut neat depending on marking line	
b) Cut neat as adjusting	
c) Cut neat depending on dimensional check with transit.	

Then for each stage, the following symbols should be prepared:

Fabrication Stage	Symbol
a) Cut Neat at Burning Stage	
b) Cut Neat after Bending or Flaming	S

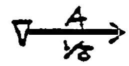
Note: Without the case of cutting neat with some Add. Mat., usually **symbol → is not necessary to be shown.**

Assembly Stage	Symbol
a) Cut Neat after Plate Jointing	A
b) Cut Neat during Final Assembly	A
c) Cut Neat after Final Assembly by Dimensional Check.	A

3. To set the amount of additional material by each part is very effective, not only to reduce manpower for each stage, but also to reduce percentage of scrap. For example, if some suitable additional material to recover the inaccuracy factors will be set at erection joint, it is possible to cut neat the joint on slabs including some suitable additional material and not to cut anymore on the ways.

   The suitable kinds of amount of additional material will be set finally as follows:

Kinds of Amount	Symbol	Descriptions
1/8" (this is minimum)	A 1/8	Cut neat after plate jointing with 1/8" additional material.
1/4"	A 1/4	Cut neat after final assembly by **dimensional check with 1/4" Add. Mat.**
1/2"	A 1/2	*Cut* neat during final assembly with **1/2" additional material.**
More than 1"		Keep additional material more than 1" after plate jointing.

Kinds of Amount	Symbol	Descriptions
Taper Add. Mat.		Upper side 1/8″ additional material lower side 0.

Using these symbols, it is possible to show any kind of suitable additional material for any place.

But actually, to decide some suitable additional material for some parts, such as 1/4″ at erection joint, so on, it is necessary to make lots of trial and error depending on the shipyards conditions.

B. Standard Items of Additional Material Planning

1. Transverse shrinkage of main plate by fillet continous welding for longitudinal stiffners can be calculated as follows:

$$S = \frac{L}{25 \times T} \times N$$

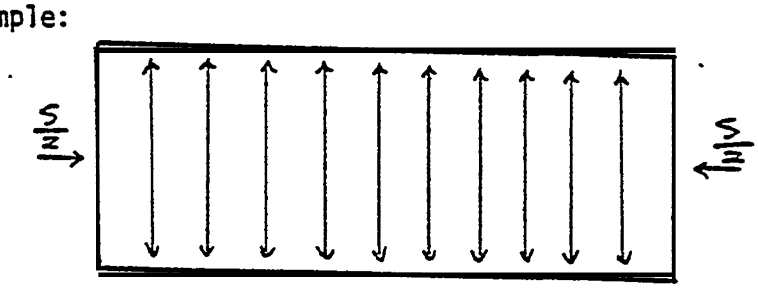
S: Transverse Shrinkage (INCH)

T: Thickness of Main Plate (")

L: Leg Length (″)

N: Numberof Stiffners

Example:



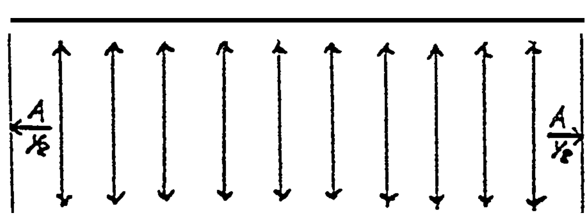
T: 1/2"

L: 1/4"

N: 10 pieces

$$S = \frac{1/4}{25 \times 1/2} \times 10 = 1/5 \fallingdotseq 1/4''$$

Then Additional Material as follows:



2. Additional material for internal structure should be decided depending upon additional material of main plates.

(Reference: C. Preliminary Planning)

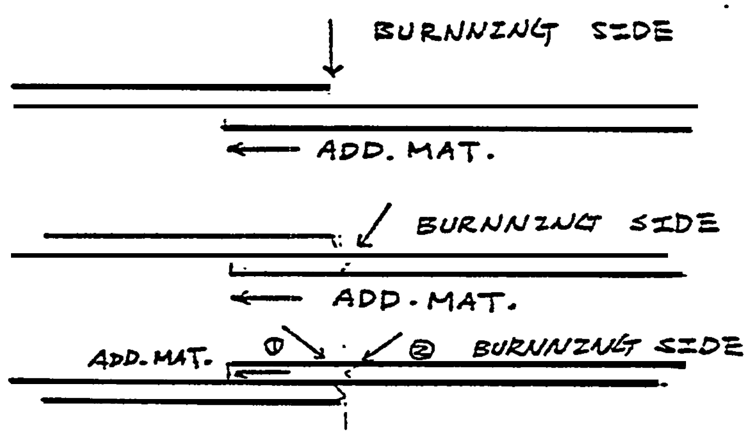
3. Standard to decide the suitable side of additional material.

a) Relation between edge preparation and the side of Add. Mat.

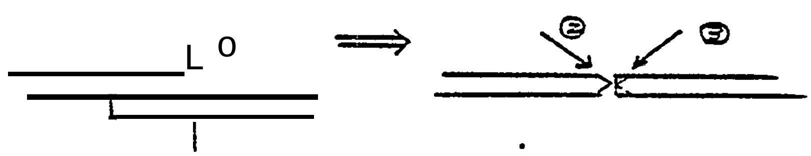
I Type

V Type

X Type



Note: Reverse case needs one more step.



b) The side of additional material for each unit on the ways.

1) 'Longitudinal Direction

i) Start Unit
Keep Add. Mat. at aft and fwd end.

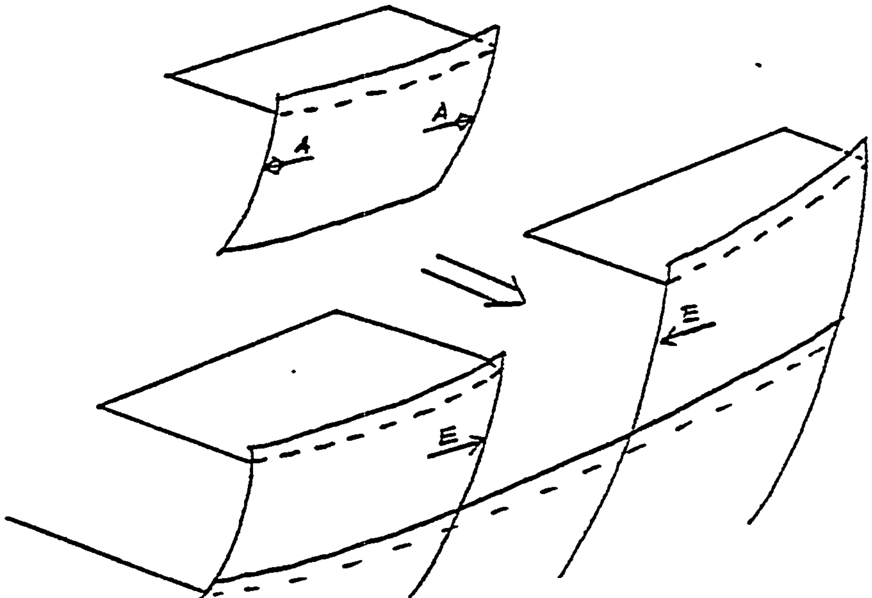
ii) Usually the part to keep Add. Mat. of erection-should be allowed one part by unit.
That is to say, fwd units have Add. Mat. at fwd joint, and units have add. mat. at aft joint.

iii) For Curved Shell Plate

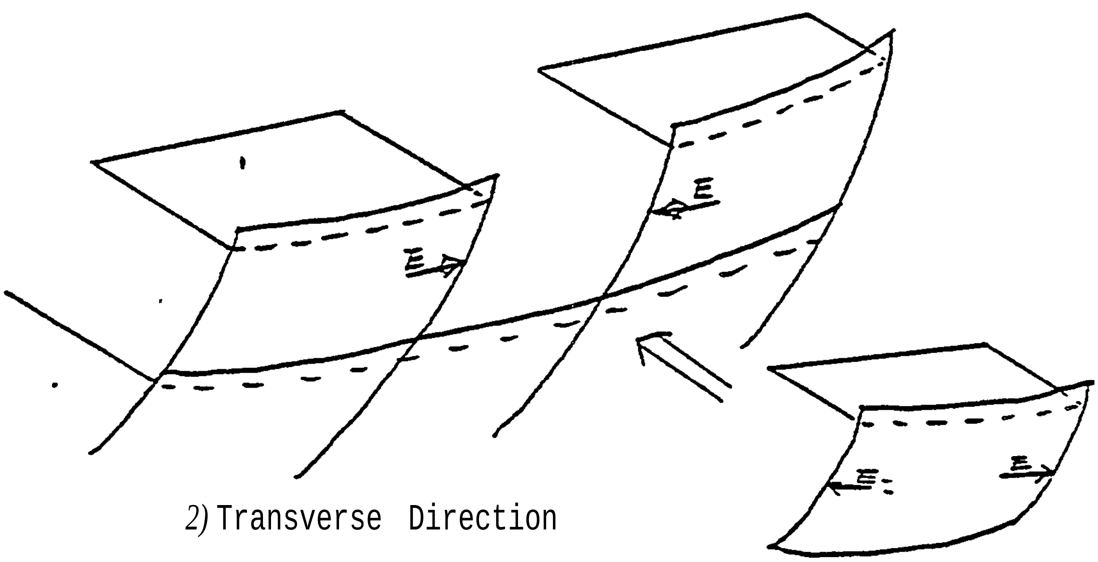
aa) The order of erection is normal. The side of Add. Mat. is as same as case ii).

bb) Drop-in Type Unit.

Case-1. Direction of erecting unit is inside-out.



Case-2. Direction of erecting unit is outside-in.



2) Transverse Direction

Basically depending on the plan for mid-ship section.

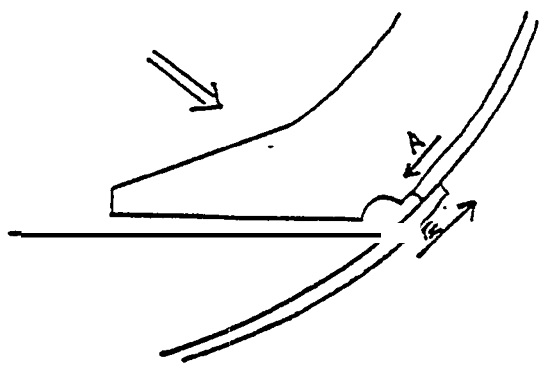
3) Vertical Direction

i) Stright Part

Basically depending on the plan for mid-ship section.

ii) Curved Part

Usually curved part unit will be erected inside-out. Then the side of Add. Mat. is as shown below.



4. Special Cases

a) At the butt joint which is close to the aft peak tank bulkhead or fwd peak tank bulkhead, the Add. Mat. should be kept enough (at

b) The joints concerned with initial hoging units must be cared about Add. Mat.

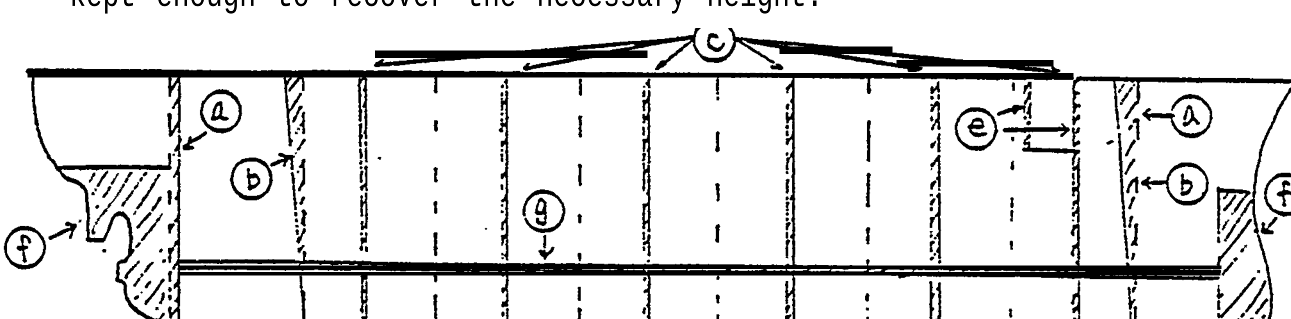
c) To keep the hold lenght, one joint by one hold must be kept enough Add. Mat. (about 1").

d) The case to use some kind of automatic welding method should be cared about edge preparation, suitable gap and special Add. Mat.

e) The joints contacted with drop-in type unit have to be kept enough

f) The plates of the heavy curved parts such as stern frame and bulbous **bow, must be prepared enough Add. Mat. (see appendix)**

g) At the top of the shell plate of the bilge unit, Add. Mat. must be kept enough to recover the necessary height.



C. Preliminary Plannin

1. Preparations

Unit Division (Unit Arrangement)

Mid Ship Section

Shell Expansion

Key Erection Plan

Standard of Symbols and Amounts

2. Planning Steps

The planning steps to make the preliminary Add. Mat. planning are as follows:

The object of preliminary pl anning is to set the basic policy of additional material for the ship totall y. Therefore, the following items have to be cleared with in-depth study of key plans, unit construction methods, and key erection plan.

Step 1

↓

Step 2 — **Set the Add. Mat. for Zone 1**

↓

Step 3 — Set the Add. Mat. for Zone 2

↓

Step 4 — Set the Add. Mat. for Zone 3

a) Planning Items

1) Make it clear which dimensions are most important for ship.

2) Make it clear which dimensions are most difficult to keep the accuracy.

3) Suitable stage *to cut* neat at erection joint.

4) Suitable amounts of Add. Mat. for each erection joint.

b) Timing and Charging

After completion of unit arrangement, this planning must be done as *soon as* possible by AC planning. Then depending on this planning, in the working drawing, the Add. Mat. information will be set by Engineering.

c) The Planning Items and Steps are as follows:

Step 1. - Set the Add. Mat. for mid ship part.

1. Decide Add. Mat. depending on erection order, from the bottom to the top, and from inside to outside.

2. Make it clear the important parts to keep the drawing dimension, such as depth, width, length of ship, and then set the Add. Mat.

See Appendix-i

◯ Mark shows the important parts.

Mark No. 1 : No. 2 The joint decides the actural width of double bottom and straightness of tank top.

Mark No. 3 : This point is one of the important points of strength for ship, and also, this joint is the key *to* decide not only width, but also, height of ship.

Mark No. 4 : This joint is the key to decide the actual height of ship as recovering unflatness of tank top.

Mark No. 5 : This is another key joint to decide the actual height of ship. So this joint should be cut neat after completion of bilge unit on the ways depending on dimensional check.

Mark No. 6 : This is the important joint to decide the actual width of main deck.

3. Make it clear the difficult part to adjust the unit and then set Add. Mat.

See Appendix-1

✓ Mark shows difficult part.

Mark No. 7 : The unit that is in double structure and irregular shape like this bilge unit is hard-to be kept completely stright at this joint. More Add. Mat. is needed to keep the width of ship.

Mark No. 8 : To keep the width and alignment between internal structures of stool and internal structure of double bottom. This Add. Mat. is effective.

Mark No. 9 No. 10 Usually the slant part is hard to be adjusted. Additional material is needed to recover the -gap.

Mark No.11 : No.12 The corrugated bulkhead structure is unstable especially in width direction. Adjusting and alignment are difficult to maintain without Add. Mat.

Mark No.13 : No. 14 The top side tank will be set depending on main deck base line. This unit must be set a little higher at erection and then as checking on dimensions, unit will be set at right position. Therefore, these joints will need some Add. Mat.

Mark No. 15 : These parts are free edges and will need some Add. Mat. to adjust them.

4. Set the important part to keep accuracy of unit.

See Appendix -1

1) Center Side Double Bottom Unit

After completion of unit, cut neat at seam joints of tank top and bottom by checking dimensions.

2) Bulkhead

Height of this unit must be kept precisely by checking dimension after completion on slab. The adjusting height. must not be done on the ways. The joint of center part should be welded on slab.

3) Top Side Tank Unit

Top side bottom plate should have some Add. Mat. at the cross point with shell plate before final assembly because this point is difficult to adjust and keep dimensions.

4) Main Deck Center Unit

Height and width of this unit must be cut neat depending on actual conditions on the ways before erecting this unit.

5. Set the Add. Mat. for main internal structures depending on Add. Mat. of main joints.

Note: The appendix was made *for* Hull 751. For the first time the kinds of symbols *must* be simple. Therefore, in this appendix, symbols of Add. Mat. were made simple.

Step 2. - Set the Add. Mat. for Zone 1 (See Appendix)-z

Depending on Add. Mat. planning of mid ship, the total Add. Mat. planning for Zone 1 should be *set* on unit arrangement.

Step 3. - Set the Add. Mat. for Zone 2 (See Appendix)-3

At Zone 2, the planning items should be separated into 3 parts as follows:

1) Hold Part

Add. Mat. for this part should be set depending on Add. Mat. planning for Zone 1.

2) Engine Room Part

The following items have to be considered:

i) Special Add. Mat. Parts

Initial Hoging

Aft end butt joint of engine room part

Top edges of shell plates of bilge units

ii) Set the Add. Mat. as considering with erection order

3) Aft Peak Tank Part

The following items have to be considered:

i) Special Add. Mat.

The Joint contacted with engine room part.

Stern Frame Part

Rudder Horn Part

Note: Add. Mat. planning for stern frame part and rudder horn part should be considered seriously depending on construction method and cast condition.

See Appendix-s

Step 4. - Set the Add. Mat. for Zone 3 (See Appendix)-4

At Zone 3, the planning items should be separated into 2 parts as follows:

1) Hold Part

Add. Mat. for this part should be set depending on Add. Mat. planning for Zone 1.

2) Fwd Peak Tank Part

The fol1owing items have to be considered:

i) Special Add. Mat. Parts

Initial Hoging

Joints contacted with Hold Part

Top edges of Shell Plates of Bilge Units

Bulbous Bow Part

Note: Add. Mat. planning *for Bulbous* Bow Part should be considered seriously depending on construction method.

See Appendix-5

d) Detail Planning

1) Object

The object of detail planning is *to* keep the accuracy of detail parts such as internal joints, and internal structures as keeping the balance against preliminary planning.

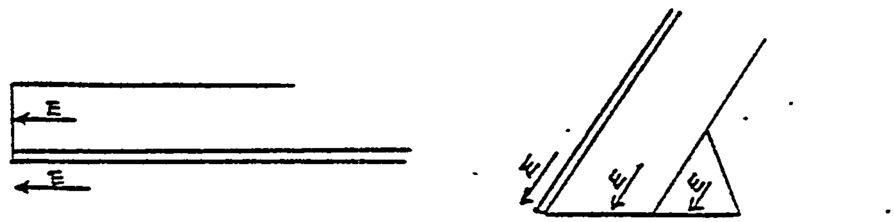
2) Timing and Charging of Detail Planning

After setting preliminary Add. Mat. in working drawing, the Add. Mat. information for detail parts will be set by Engineering.

3) Standard Type of Internal Structure to be prepared Add. Mat.

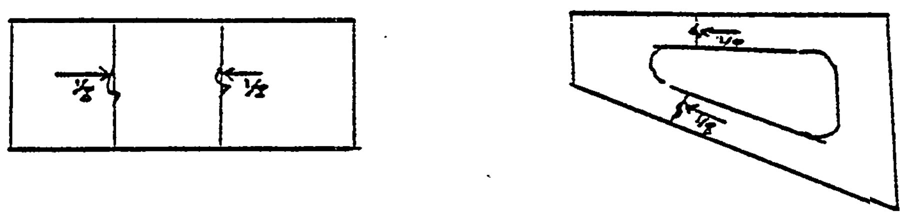
Type 1. - Edge of Unit Joint

Decide Add. Mat. depending on Add. Mat. of main joint.

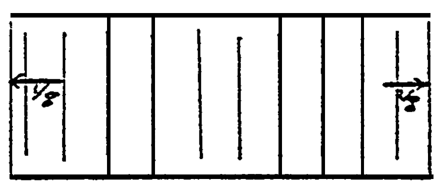


Type 2. - Internal Joint

Decide Add. Mat. as considering the shrinkage after welding.

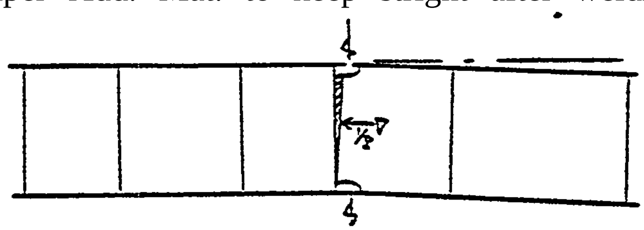


Type 3. - The internal structures with slot of stiffners, such as girders, floors, etc., will be shrunk too much by welding. Then for this part, some special Add. Mat. should be prepared.



Note: On calculation method of shrinkage, refer *to B-1* (Standard Items of Add. Mat. Planning).

Type 4. - For the part which has some possibility to be bent by welding, set taper Add. Mat. to keep stright after welding.



APPENDIX – 1.

ADDITIONAL MATERIAL PLAN
(FOR ZONE 1)

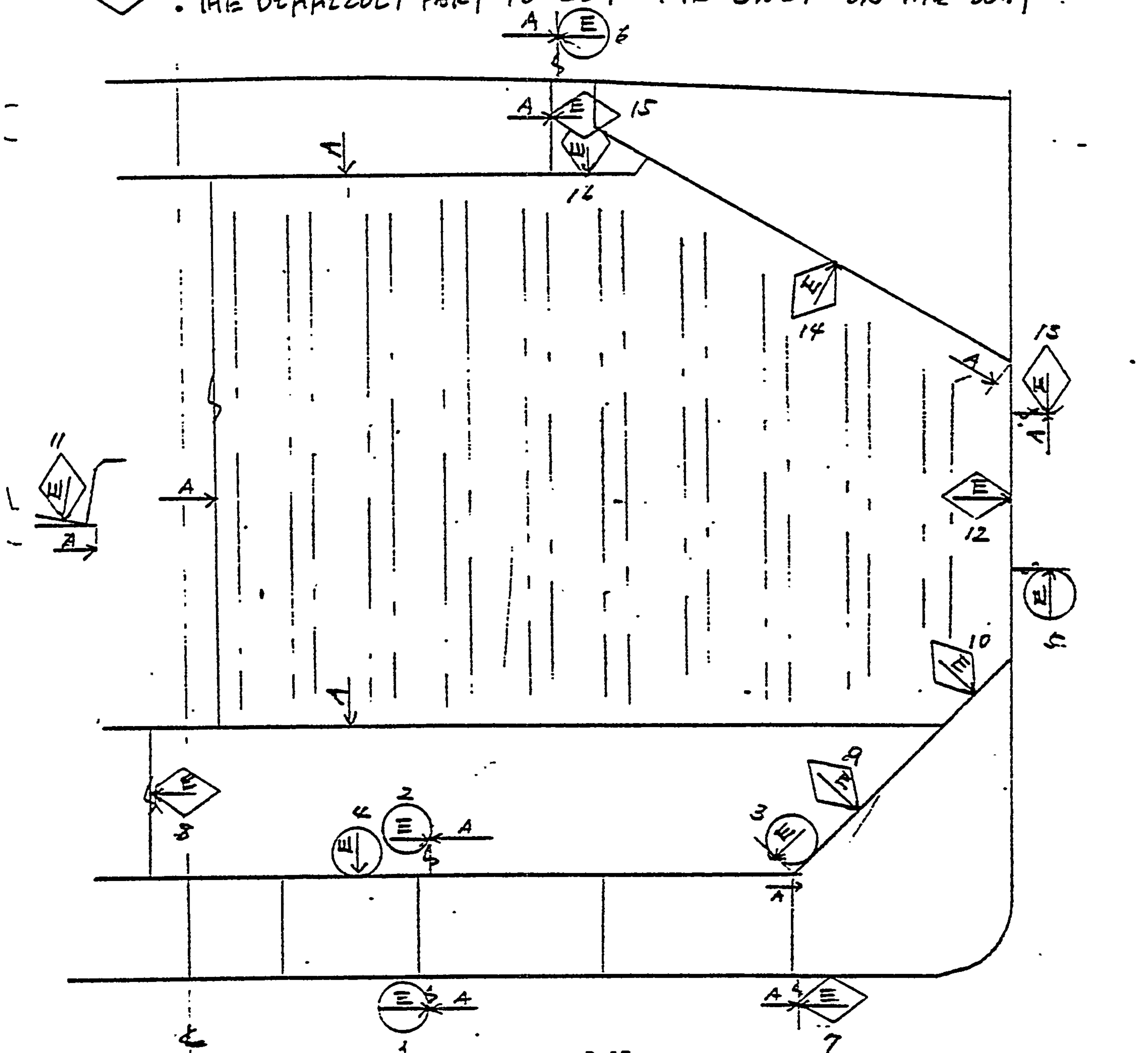
BY Z.H.Z
9.12.'99

A→ : NEED ADD. MAT 1½" AND CUT NEAT ON SLAB

E→ : NEED ADD. MAT 1½" AND CUT NEAT ON THE WAYS

○ : THE IMPORTANT PART TO KEEP THE DIMENSION OF SHIP

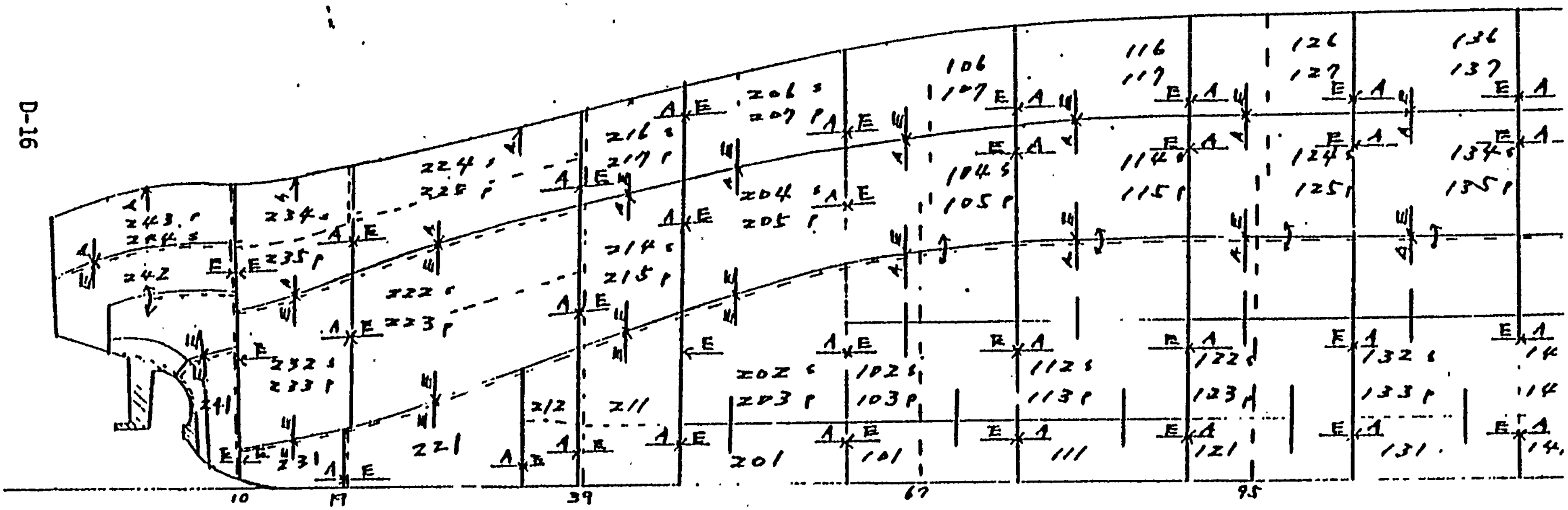
◇ : THE DIFFICULT PART TO SET THE UNIT ON THE WAYS.



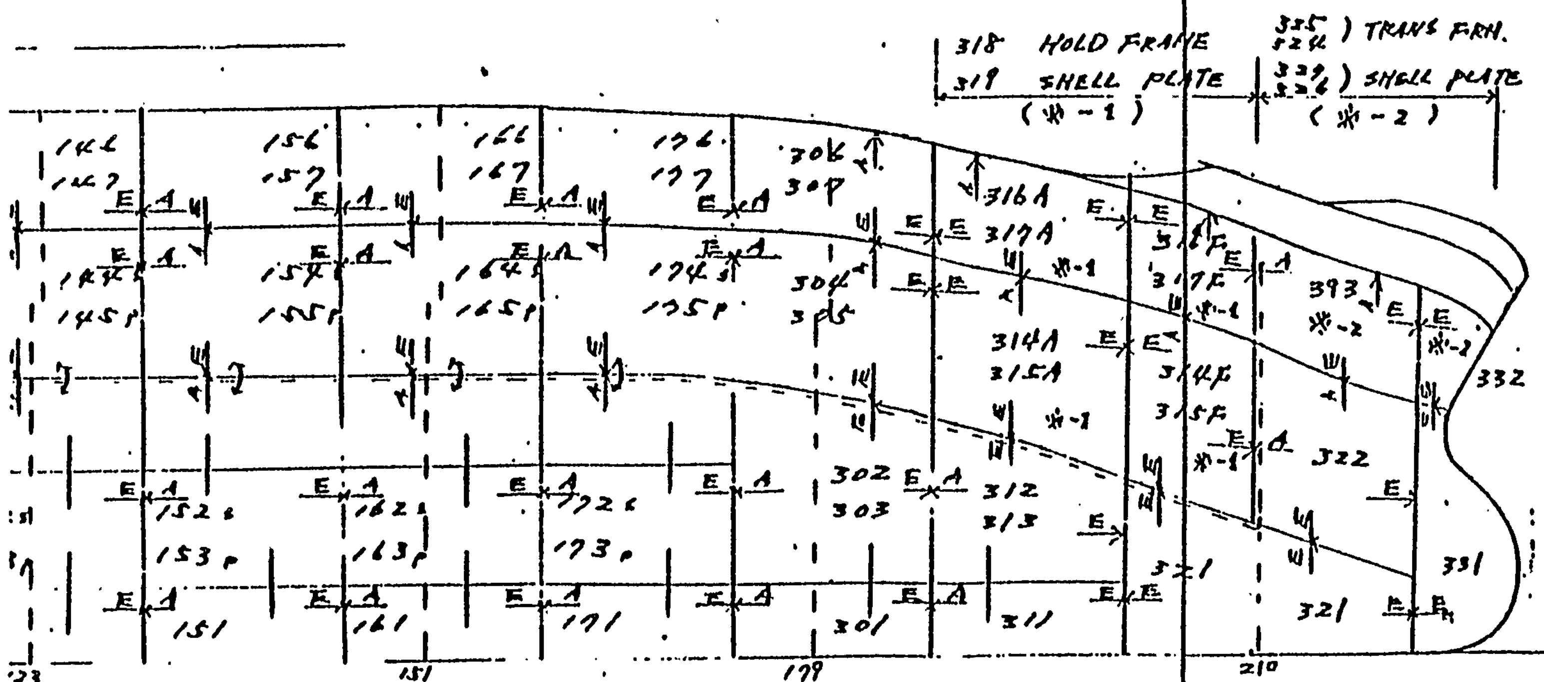
D-16

PRELIMINARY ADDITIONAL MATERIAL PLANNING

SHELL EXPANSION Appendix 1



APPENDIX – Z (cont.)



APPENDIX - 3

ADDITIONAL MATERIAL PLAN

(SNo 751 FOR ZONE 2)

AUG. 16. '79

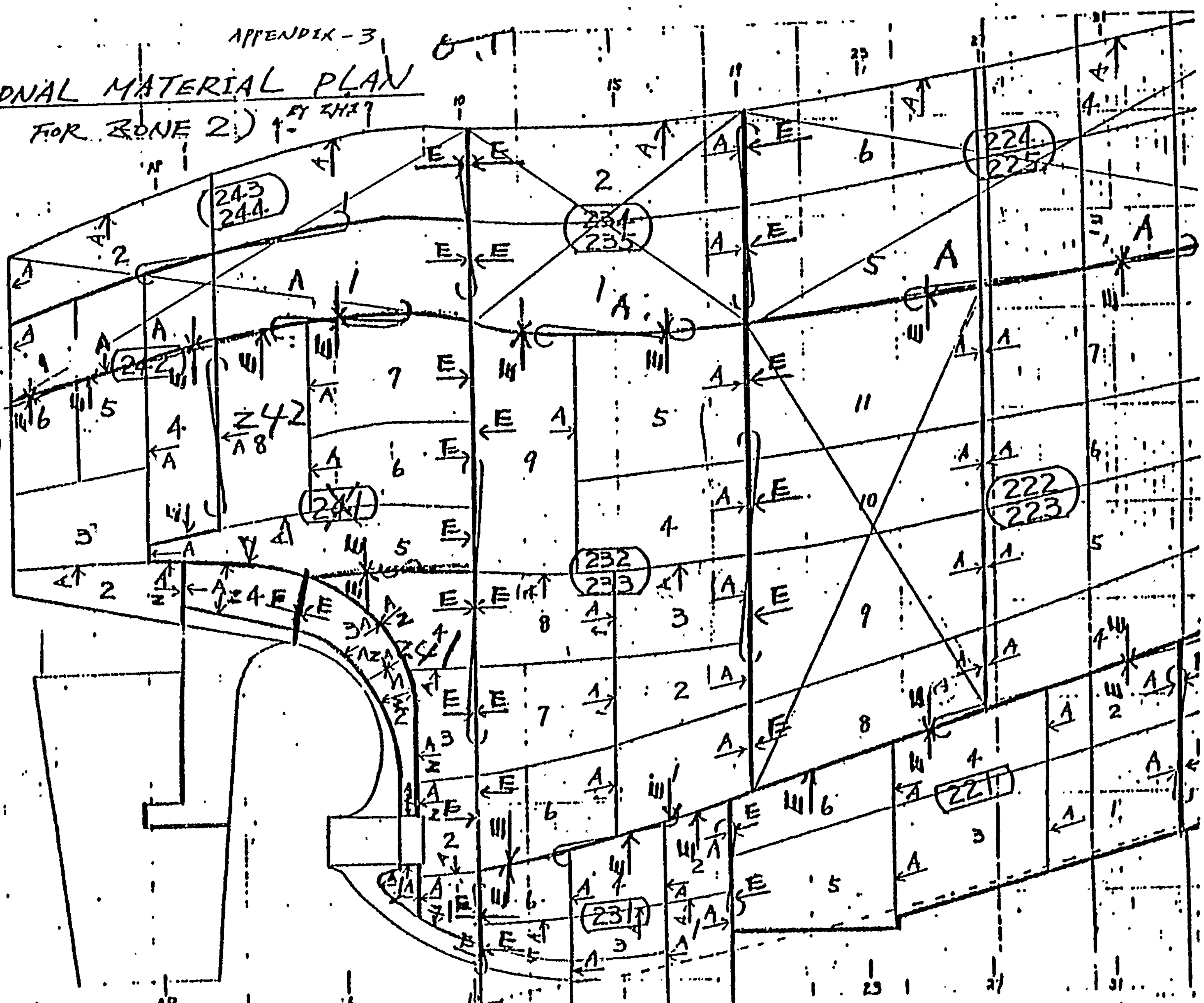
NOTES

☒ APPLY CURVED UNIT JIG SYSTEM

NO MARK: CUT NEAT AT FABRICATION

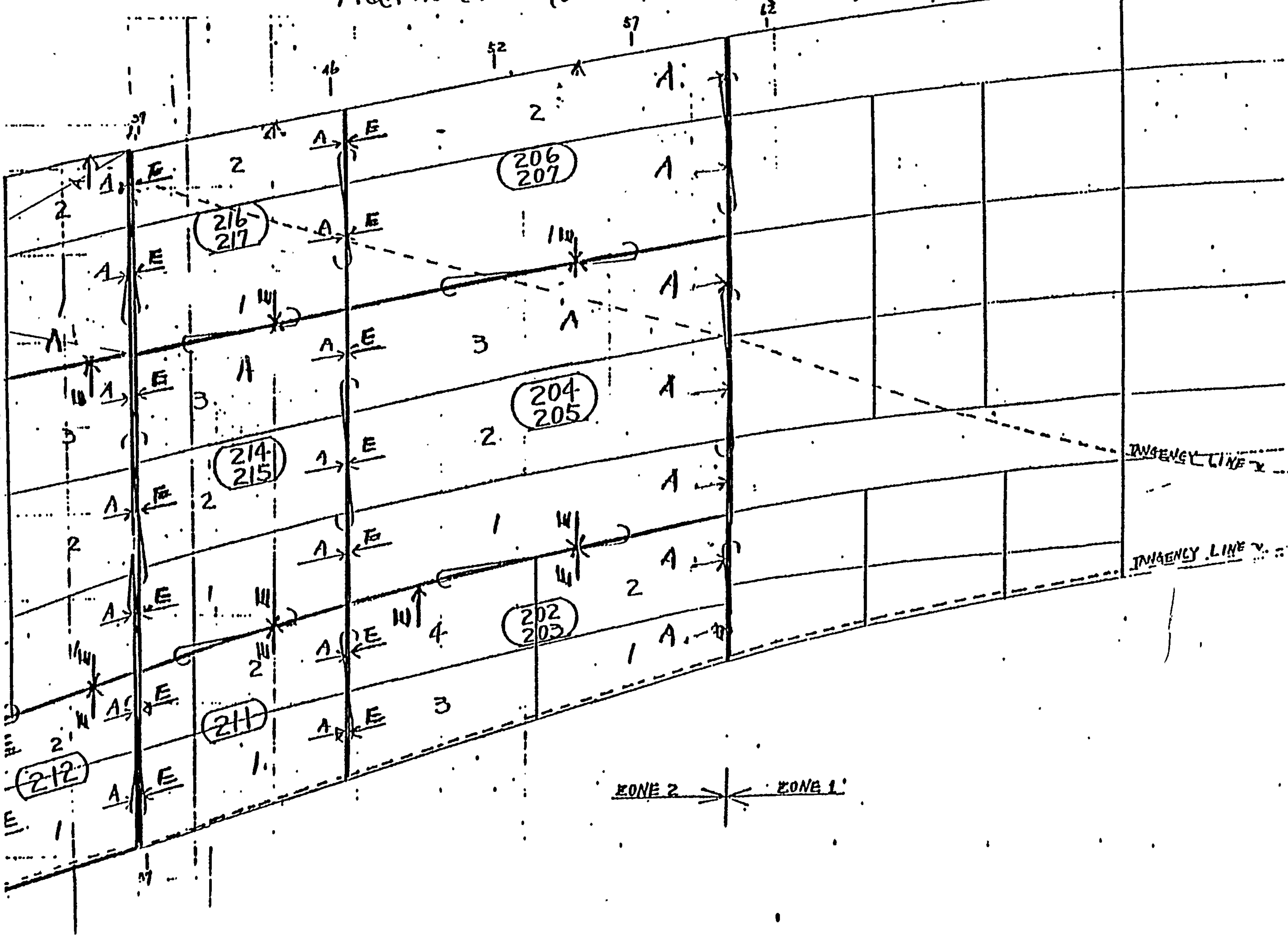
$\xrightarrow{A}$: CUT NEAT AT ASSY

$\xrightarrow{E}$: CUT NEAT AT EREC.



D-18

Additional Material Plan (Cont.)

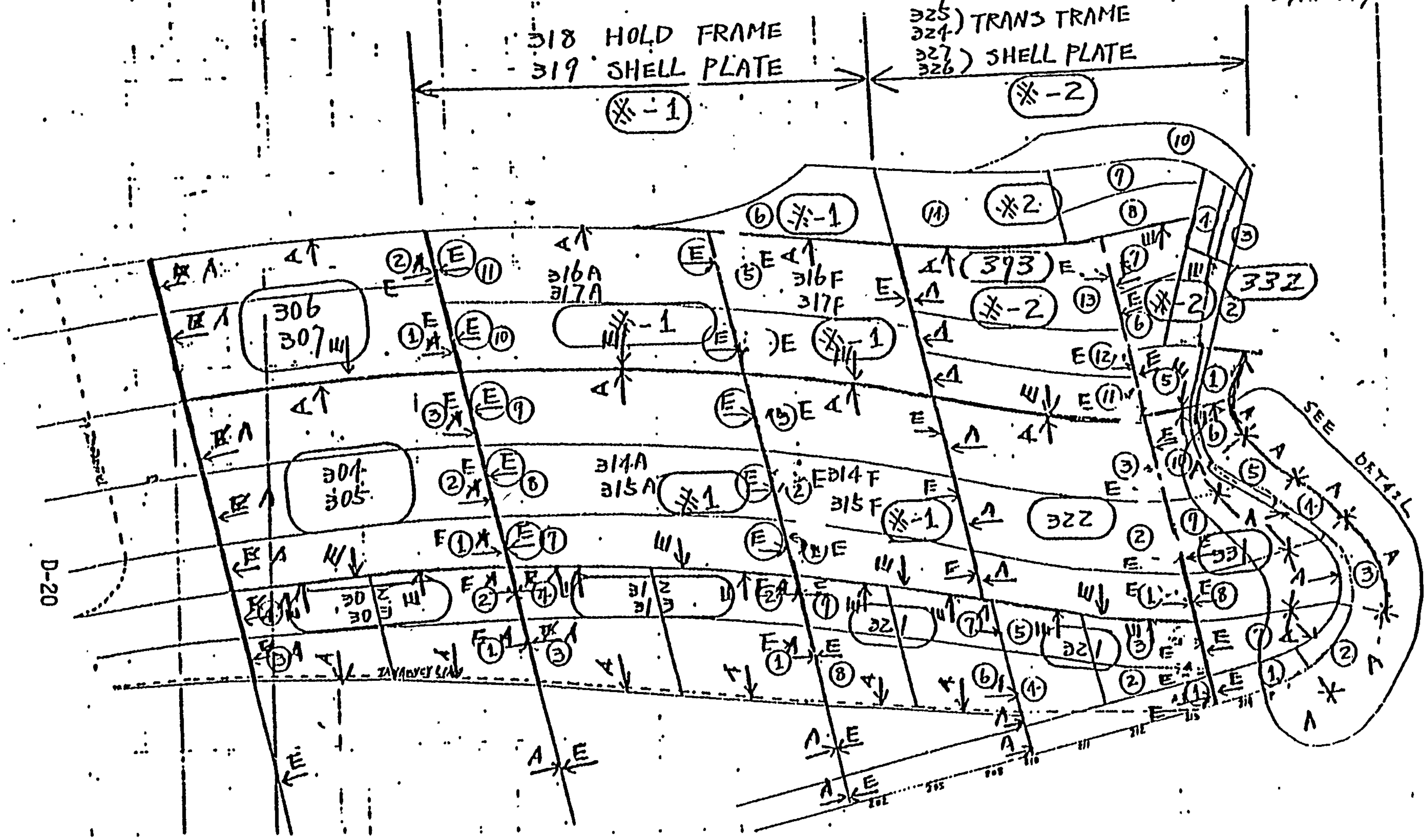


D-19

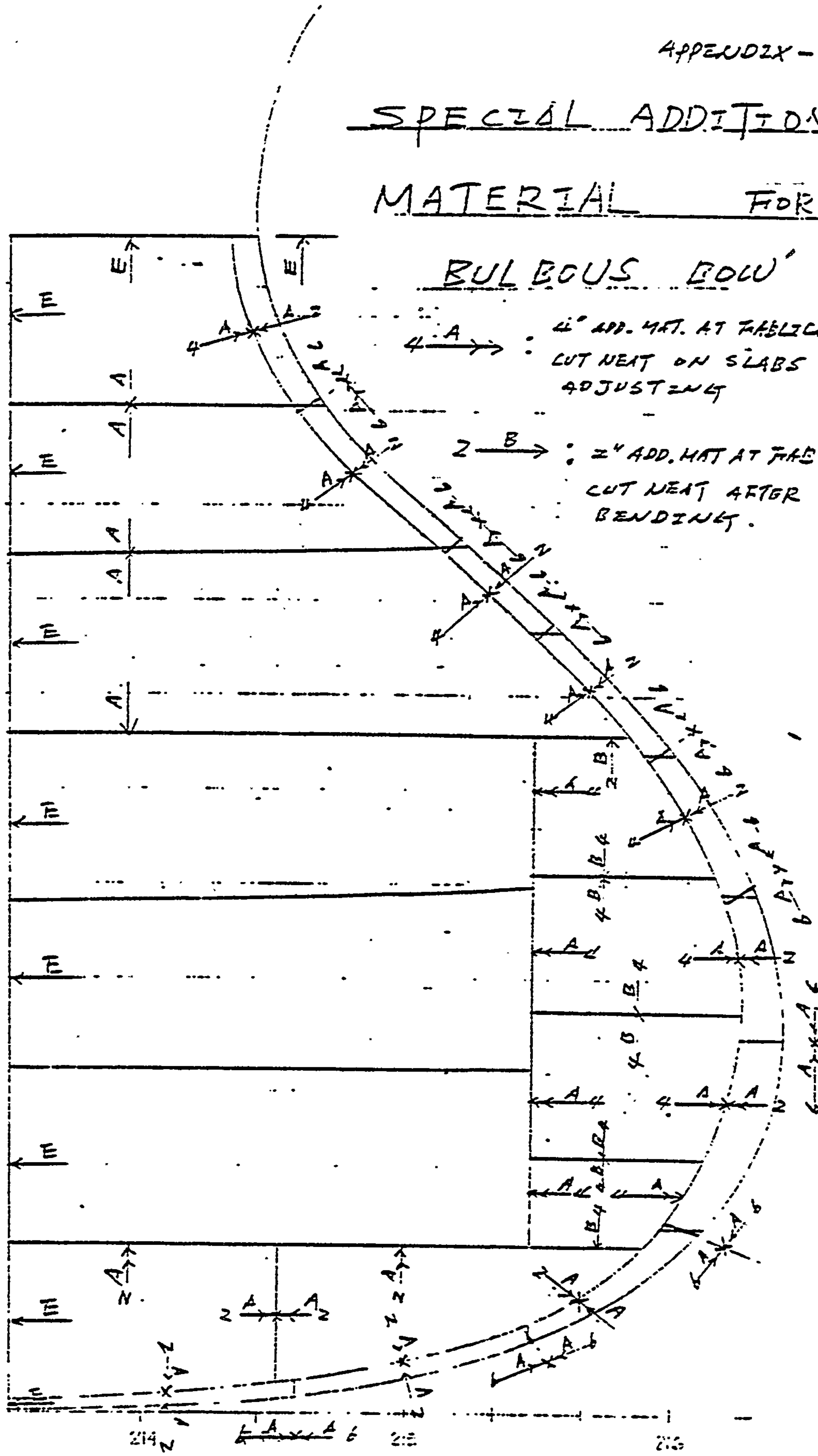
SHELL EXPANSION (ZONE 3)

ADDITIONAL MATERIAL PLAN (SUB 751 FOR ZONE 3)

1/2



SPECIAL ADDITIONAL MATERIAL FOR BULBOUS BOW



$4 \xrightarrow{A}$: 4" ADD. MAT. AT FABRICATION CUT NEAT ON SLABS AS ADJUSTING

$2 \xrightarrow{B}$: 2" ADD. MAT AT FAB. CUT NEAT AFTER BENDING.

LSCo. Report No. - 2123-5 .1-4-1

TECHNOLOGY TRANSFER PROGRAM (TTP)

FINAL REPORT

QUALITY ASSURANCE SYSTEM

Appendix E
Accuracy Check Sheets

QUALITY ASSURANCE

VOLUME 2 APPENDICES

prepared by:

Livingston Shipbuilding Company
Orange, Texas

March 3, 1980

APPENDIX E

ACCURACY CHECK SHEETS

ACCURACY CHECK SHEET

1. Fabrication and Sub-Assembly
2. Assembly
   (1) Zone 1
   (2) Zone 2
3. Erection

Prepared by IHI

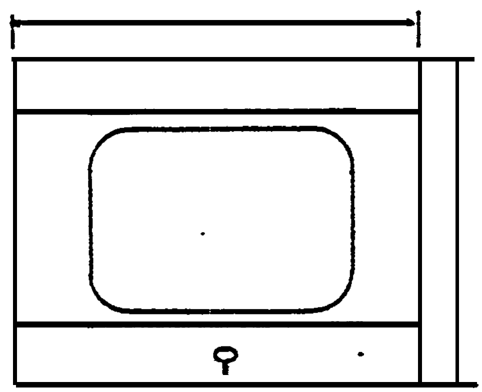
1. Fabrication And Sub-Assembly

Check Sheet

ACCURACY CHECK SHEET

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

BOTTOM CENTER UNIT FLOOR



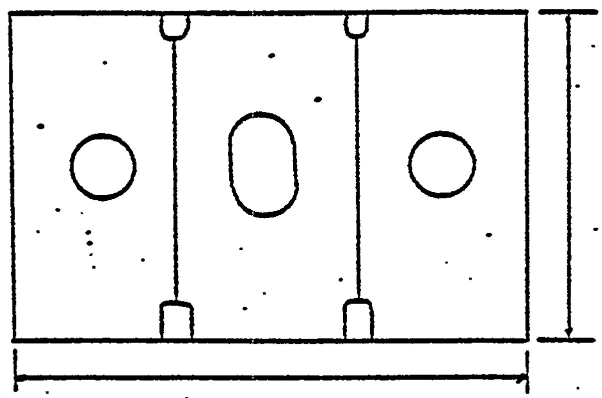
WRITER

PIECE NAME	HEIGHT	UPPER SIDE WIDTH	LOWER SIDE WIDTH

ACCURACY CHECK SHEET

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

BOTTOM CENTER UNIT FLOOR



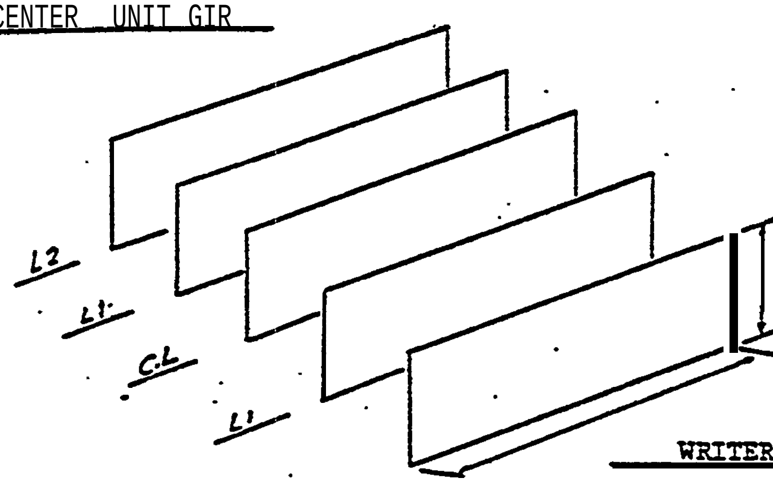
WRITER

PIECE NAME	HEIGHT	WIDTH

ACCURACY CHECK SHEET

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

BOTTOM CENTER UNIT GIR



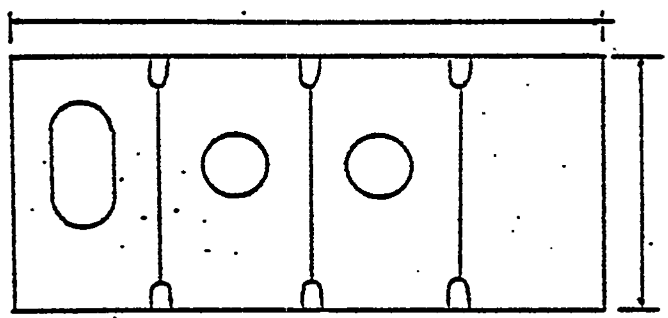
WRITER

UNIT No.	PIECE NAME	LENGTH	HEIGHT	UNIT NO.	PIECE NAME		HEIGHT

4

ACCURACY CHECK SHEET			
Ship No.	Unit No.	Shop	Condition
		Cut. Sub.As	Sampling: 2 pc/plate

BOTTOM SIDE UNIT FLOOR



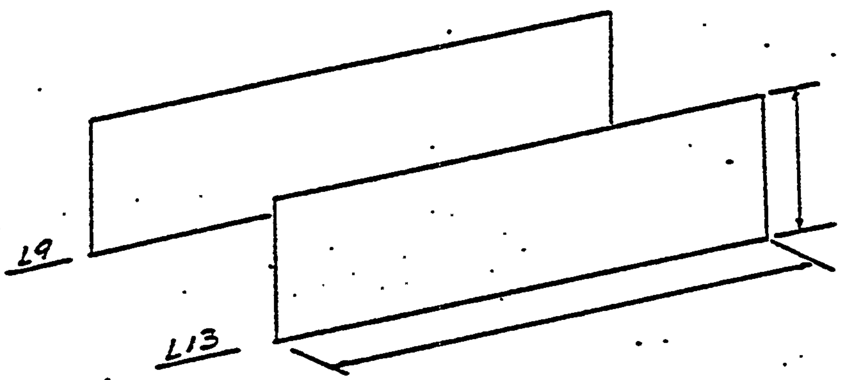
WRITER

PIECE NAME	HEIGHT	WIDTH

5

ACCURACY CHECK SHEET			
Ship No.	Unit No.	Shop	Condition
		Cut. Sub.As.	All pieces to be checked

BOTTOM SIDE UNIT GIRDER



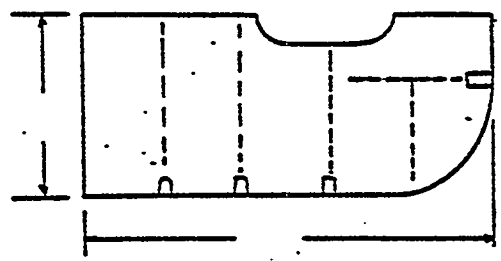
WRITER ____________

UNIT NO.	PIECE NAME	LENGTH	UNIT NO.	PIECE NAME	LENGTH

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Cut. Sub-As.	Sampling check 2 pieces/plate

Bilge Shell Unit Floor



WRITER

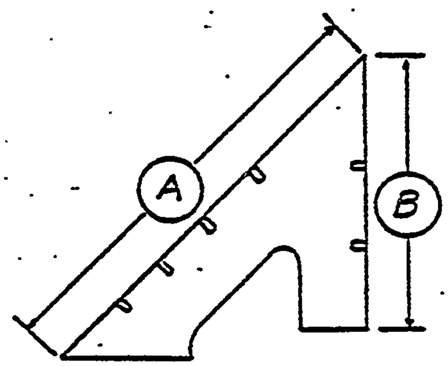
PIECE NAME	HEIGHT	WIDTH

7

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Cut. Sub-As.	Sampling check: 2 pieces/plate

Hopper Side Tank Unit Floor



(INCLUDING RATES TIGHT BED.)

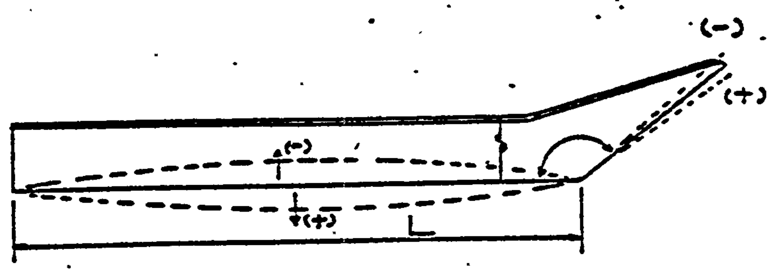
WRITER

PIECE NAME	HEIGT A	HEIGHT B

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Sub-Assembly	All pieces to be checked

HOLD FRAME



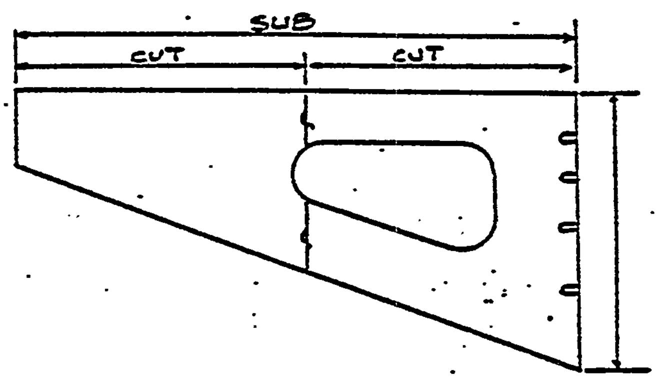
WRITER

PIECE NAME	LENGTH (L)	DEFORMATION	ANGLE

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Cut. Sub.As	Cutting: Sampling check Sub: All piece check

TOP SIDE TANK UNIT FLOOR



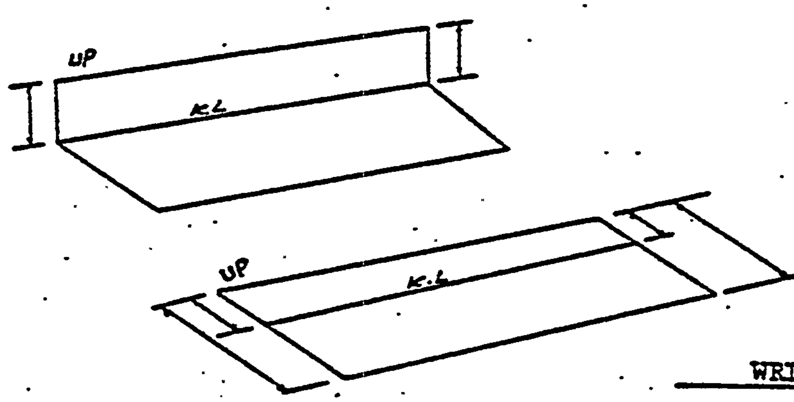
WRITER

PIECE NAME	WIDTH	HEIGHT

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Cut.-Bending	All Pieces Check

TOP SIDE TANK UNIT THE KNUCKLED PLATE



WRITER

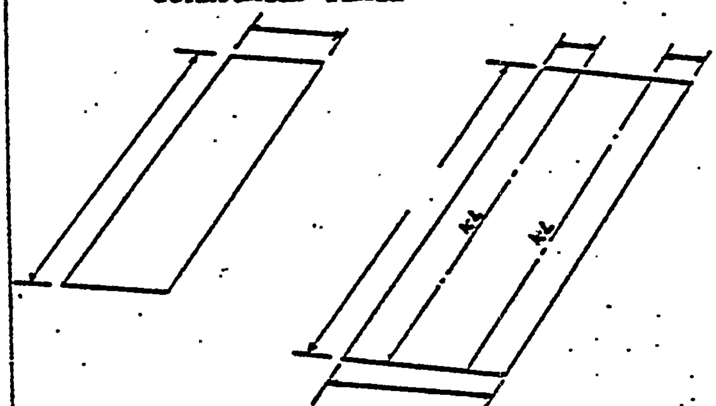
UNIT AND PIECE NAME	AT FORE END		AT AFT END	
	WIDTH	Distance from kl. to edge	WIDTH	Distance from kl to edge

11

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Cutting	Sampling: 2 pieces/unit

CORRUGATED DEEP TANK BHD. FLAT PLATE &
CORRUGATED PLATE



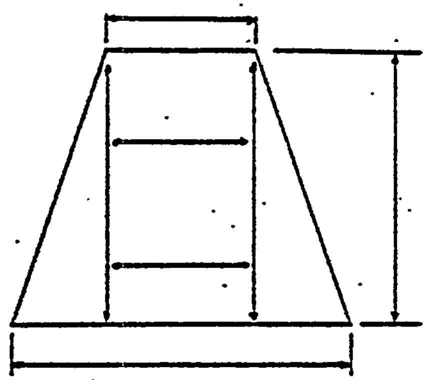
WRITER

PIECE NAME	WIDTH			LENGTH

ACCURACY CHECK SHEET

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

STOOL UNIT FLOOR



WRITER

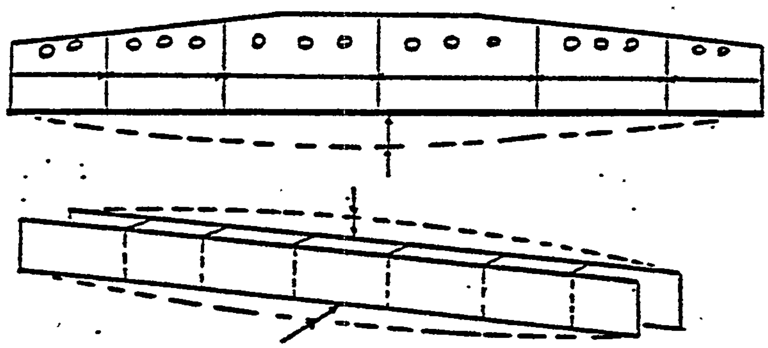
PIECE NAME	HEIGHT	WIDTH AT UPPER PART	WIDTH AT LOWER PART

13

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Sub-Assembly	All pieces checked

UPPER DECK CENTER UNIT HATCH END BEAM AND BOX BEAM



WRITER

PIECE NAME	DEFORMATION OR DISTORTION

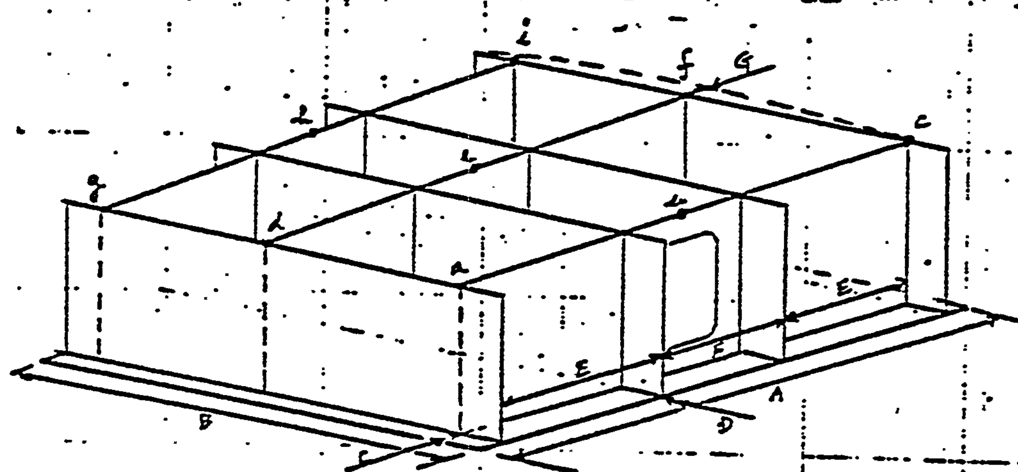
2 - (1) ASSEMBLY

CHECK SHEET

(Zone 1)

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Before combined with bottom plate

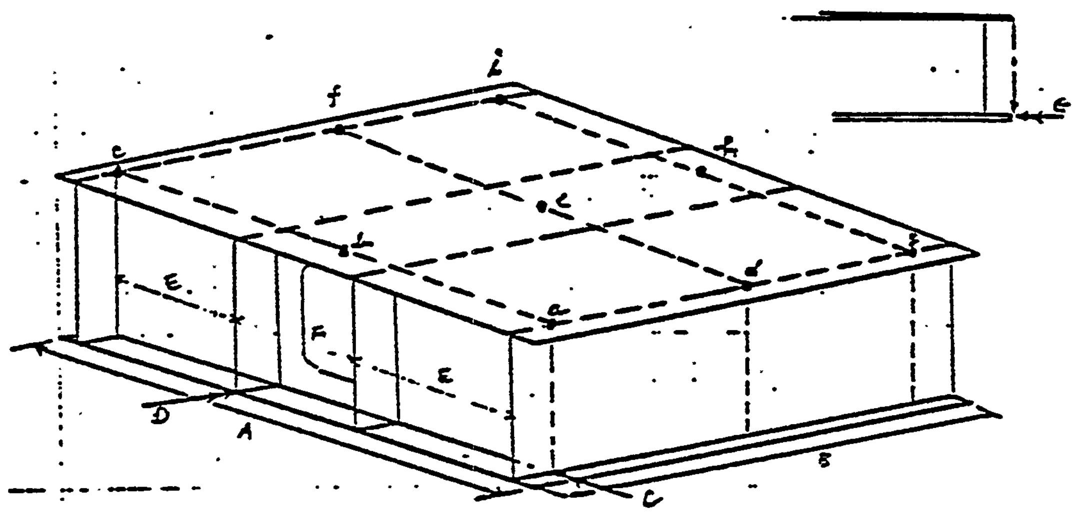


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
C				P / S	Worker AC	Both side (P.S)
D	Edge Alignment			F / A	"	Every Girder Both Side (F.A.)
E	Girder Spacing			P / S	"	Every Frame
F	"			FORE / AFT	"	Both side (F.A.)
G	Straightness				"	Each girder show maximum.
H	Level			a b c d e / f g h i i	"	9 points a - i

Notice: After fitting, welding

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Final Unit Assembly

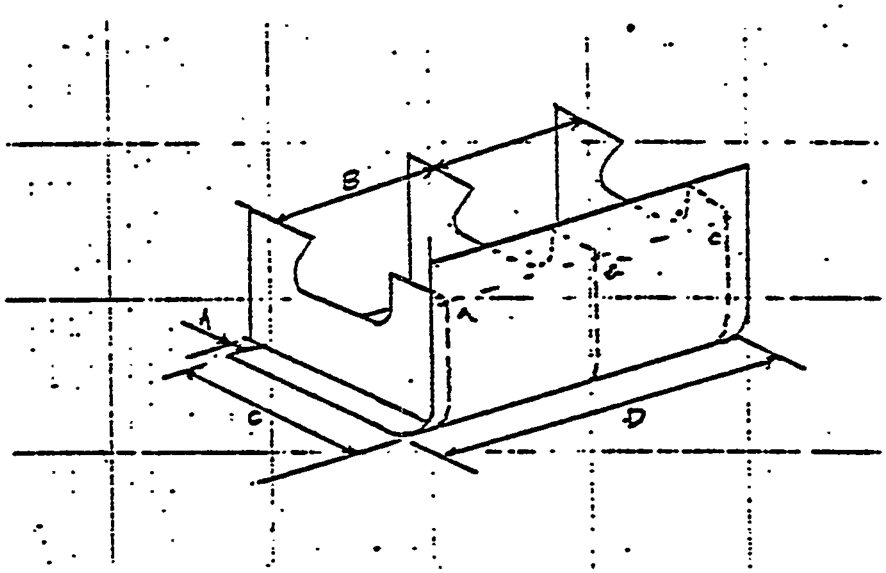


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
C				P S	Worker AC	Both side (PSI) Each Frame
D	Edge Alignment			F A	"	Every Girder Both side (F.A)
E	Girder Spacing			P S	"	Every Frame
F	"				"	Both Side (F.A.)
G	Relativity				"	2 points each edge
H	Level			a b c d e f g h i j		9 Points (a-i)

Notice After fitting, welding

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Before combined with side shell

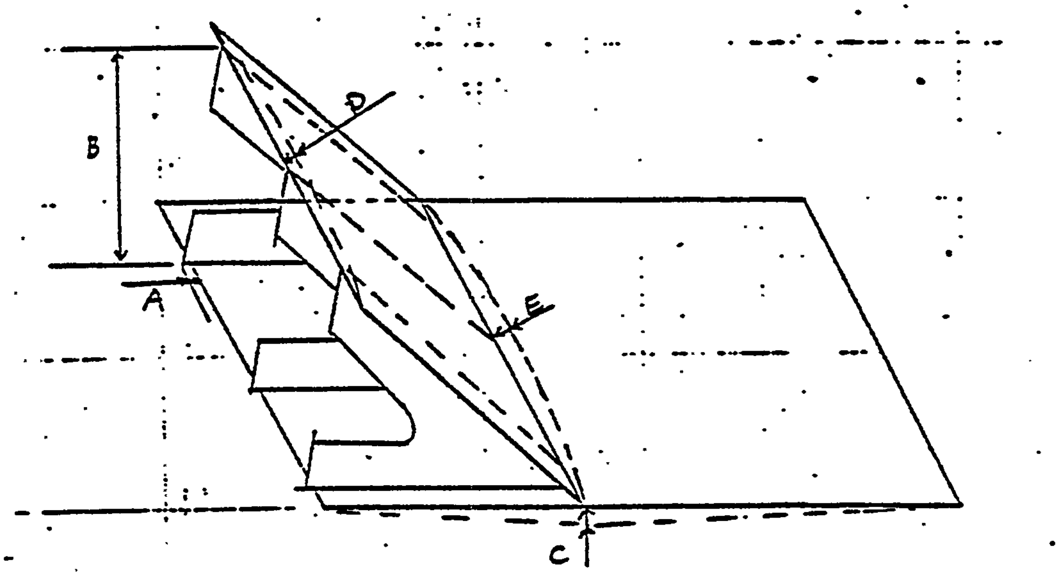


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension				Chg.	Notice
A	Edge Alignment							Worker AC	Every Trans Web.
B	Transv. Spacing							"	"
E	Deformation			a	b	c		"	3 points (a,b,c)
C	Width							AC	
D	Length							AC	

Notice: After welding, fitting

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Before combined with bilge unit

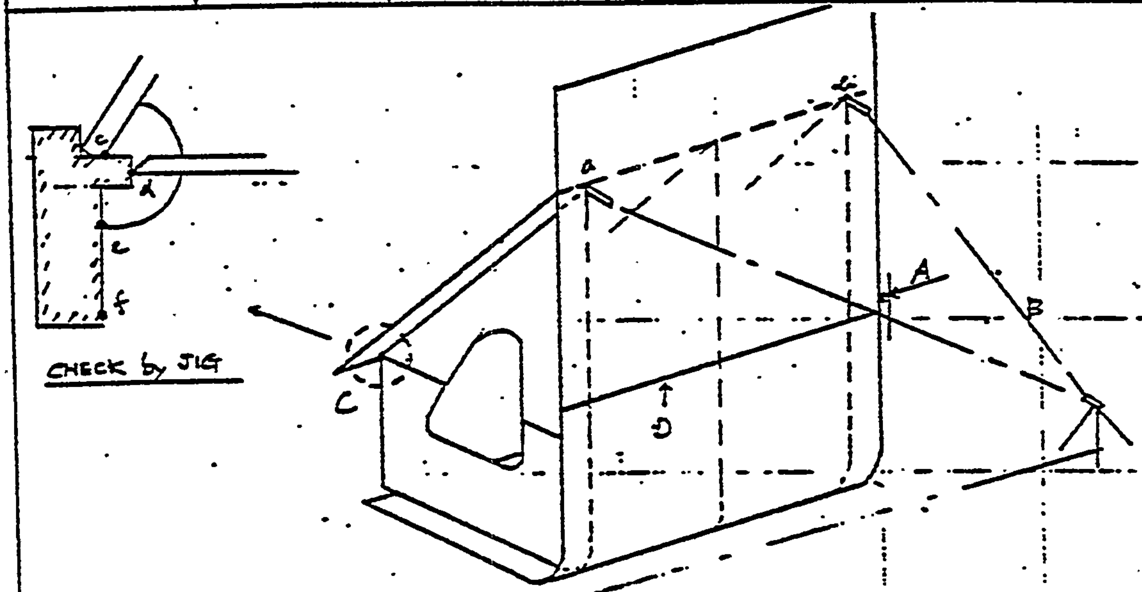


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension				Chg.	Notice
A	Edge Alignment							Worker AC	Every Transv. web
B	Width at Slant Plate							AC	"
C	Knuckle at Side Shell							AC	"
D	Bending at Slant Plate							"	"
E	Bending at Side Shell							"	"

Notice After fitting welding

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Unit to Unit

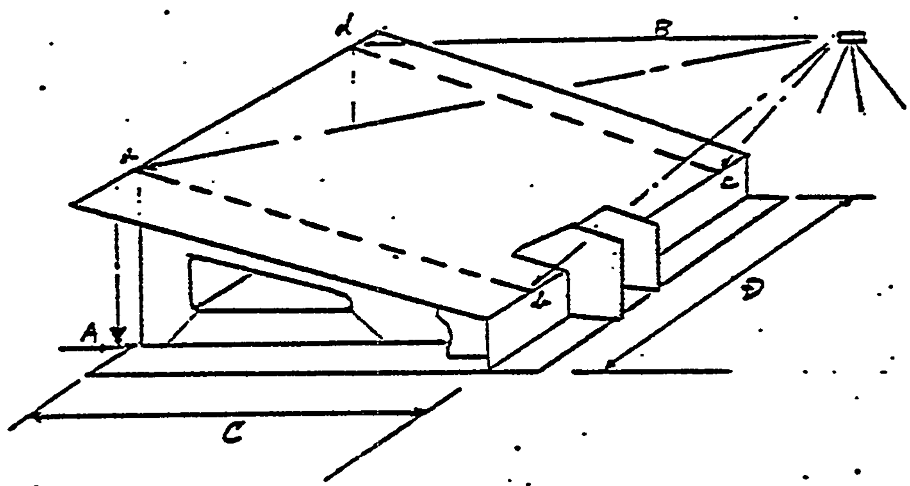


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Butt Alignment			FORE / AFT	Worker	Both side (A.F.)
B	Inclination			FORE / AFT	Worker AC	(a,b)
C	Alignment			c / d / e / f	"	Check by special jig.

Notice	1. After fitting and welding 2. Top seam at bilge should be checked and finished up before setting side shell unit.

ACCURACY CHECK SHEET

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

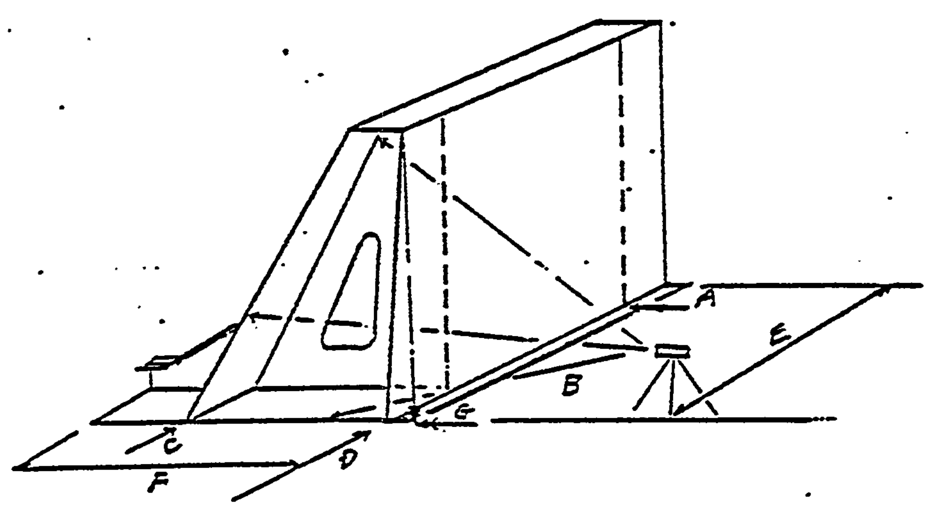


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Shift between U.Dk. & Top Side				Worker AC	Every Frame
B	Level				"	4 points (a-d)
C	Width				"	
D	Length				"	

Notice: After fitting, welding

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Final Unit Assembly

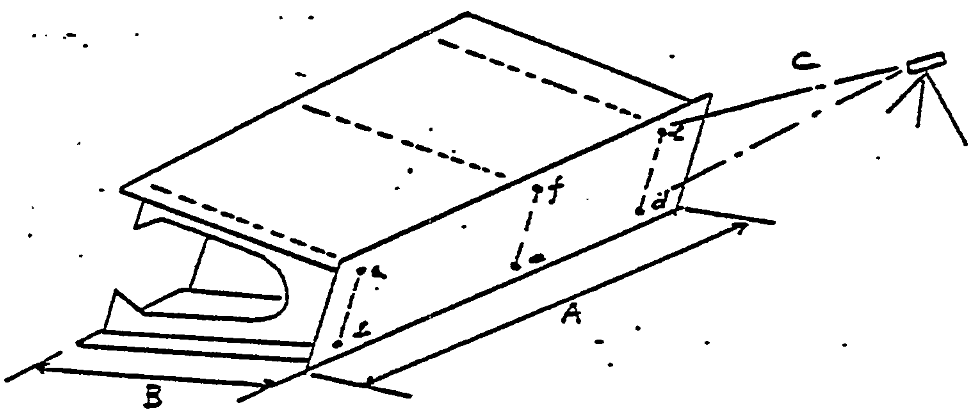


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Shift				Worker AC	Every Frame
B	Edge Alignment			AFT FORE	"	Both end (aft. fore)
C	Straightness				"	
D	Straightness				"	
E	Length				"	
F	Height				"	
G	Inclination			AFT FORE	"	Both End

Notice: After fitting, welding

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Final Unit

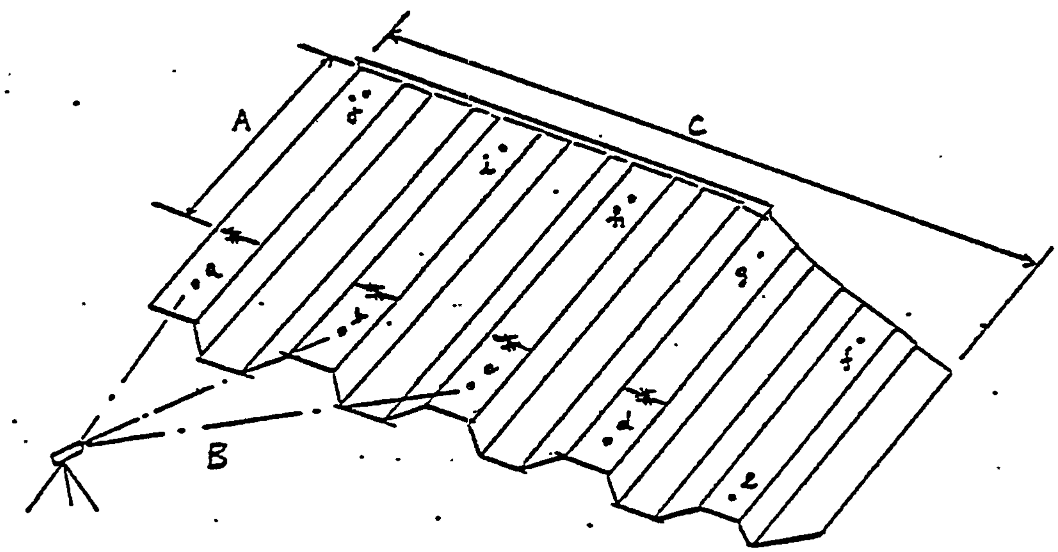


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Width				AC	
B	Height				"	
C	Flatness				"	2 points at each frame

Notice: After fitting, welding

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Final Unit Assembly

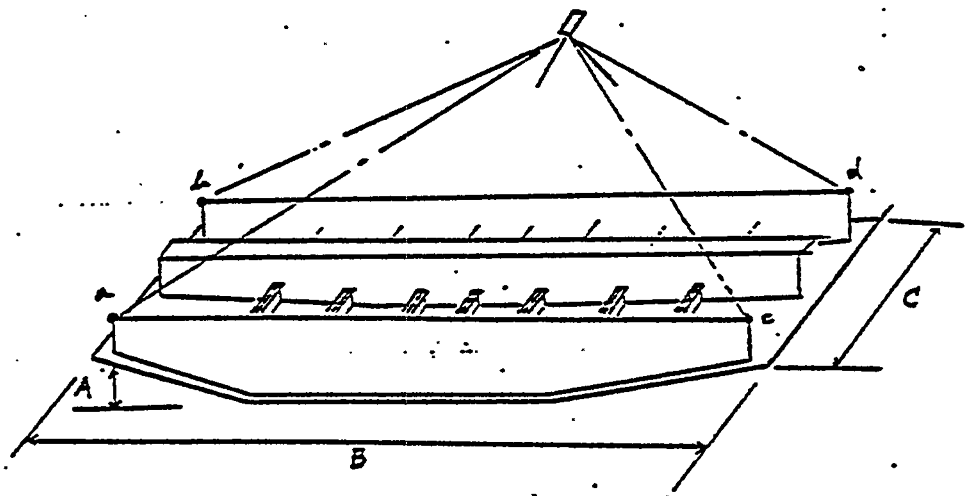


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Height				Worker	Mark check line for shipwright
B	Level				"	After checking level fix by temp. beam
C	Width					

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

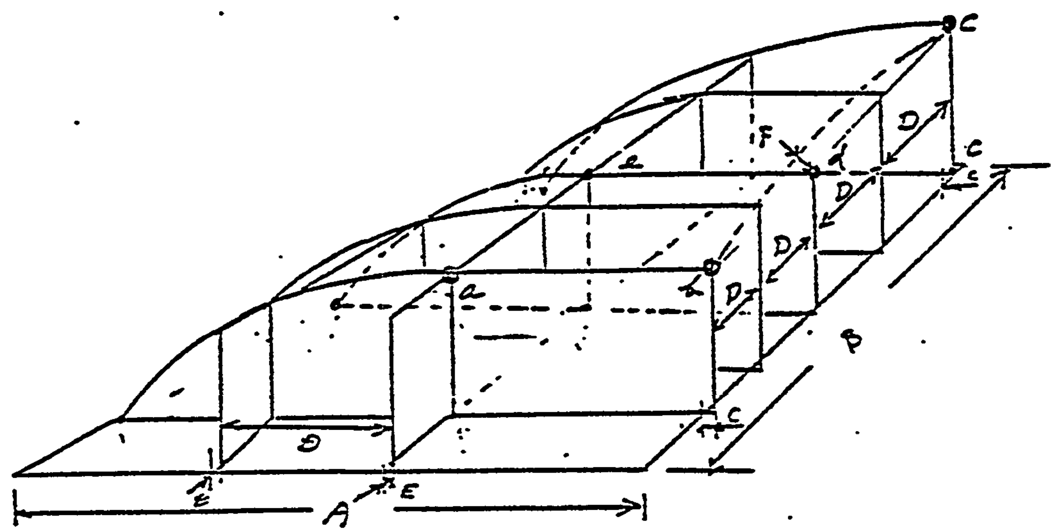
2 - (2) ASSEMBLY

CHECK SHEET

(Zone 2)

ACCURACY CHECK SHEET

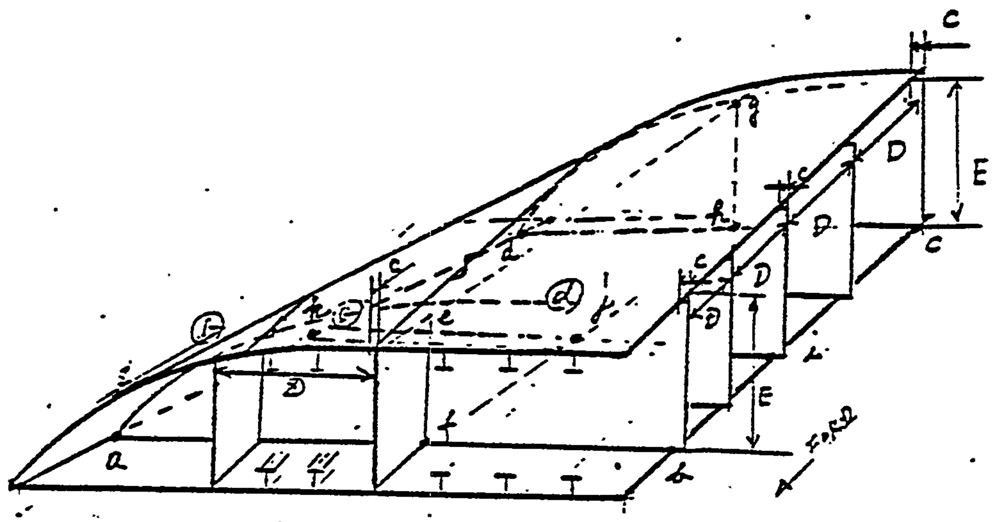
Ship No.	Unit No.	Shop	Condition
	202 (203)		Before Combine with Bottom Plate.



Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Width				Worker AC	
B	Length				Worker AC	
C	Edge Alignment				"	
D	Gir. Space Floor "				"	
E	Edge Alignment				"	
F	Straightness				"	
H	Level				AC	a,b,c,d,e 5 points

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
	202 (203)		Final Unit Assembly

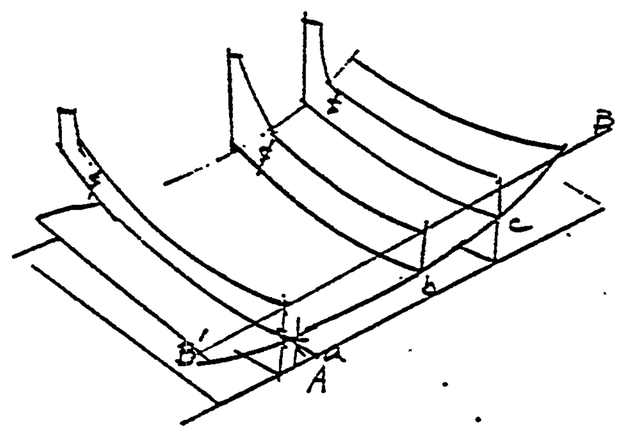


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
C	Edge Alignment				Worker AC	
D	Gir. Trans Space				"	Every frame
E	Height				"	
H	Level Twist				AC	a,b,c,d,f,h,i,j,k 9 points

Notice

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
	204		

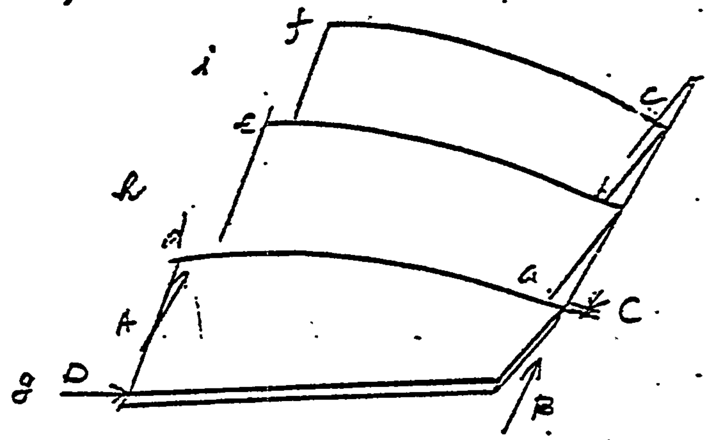


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Edge Alignment				Worker AC	a~c
B	Concave Deflection					

Notice

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
	204		

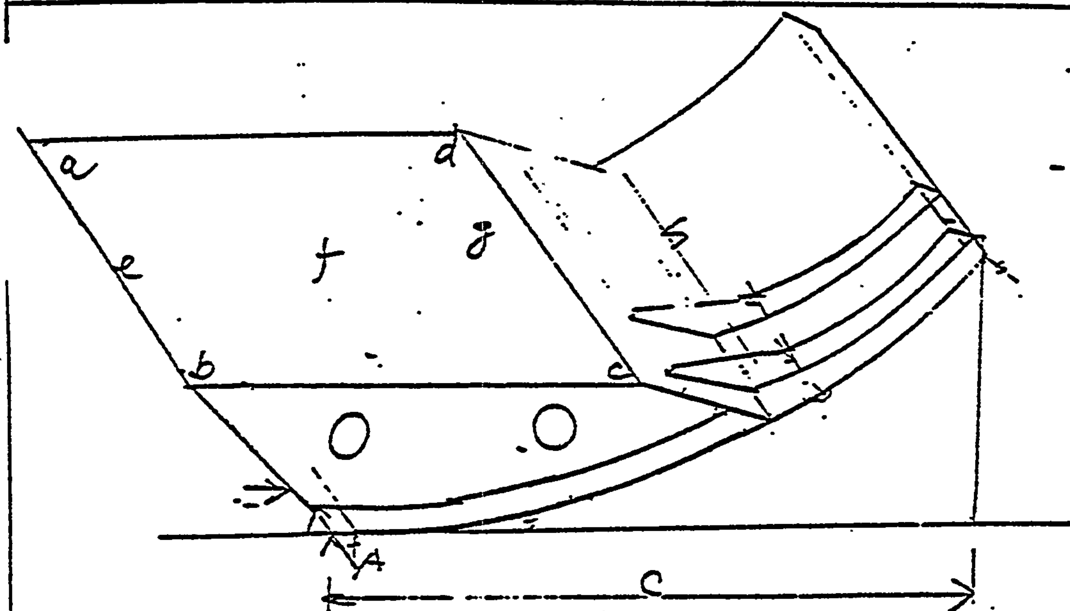


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A B	Alignment				Worker AC	Piano Wire
	Plainess				AC	" a～f
C	Edge Alignment				Worker AC	a～c
D	"				Worker AC	g～i

Notice

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
	204		

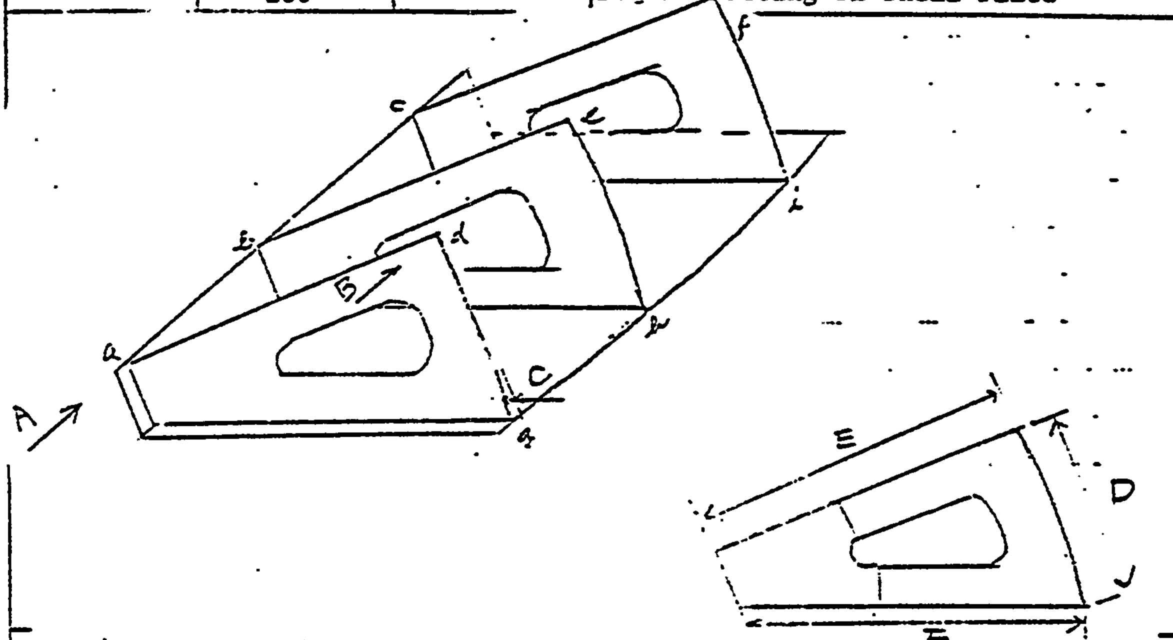


Mark	Item	Dim's In Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
	Plainess				AC	Transit a~j
A	Shift				Worker AC	At each Frame
B	Edge Alignment				Worker AC	"
C	Dimension Check				Worker AC	Aft and Fore End

Notice

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
	206		Before Putting on Shell Plate

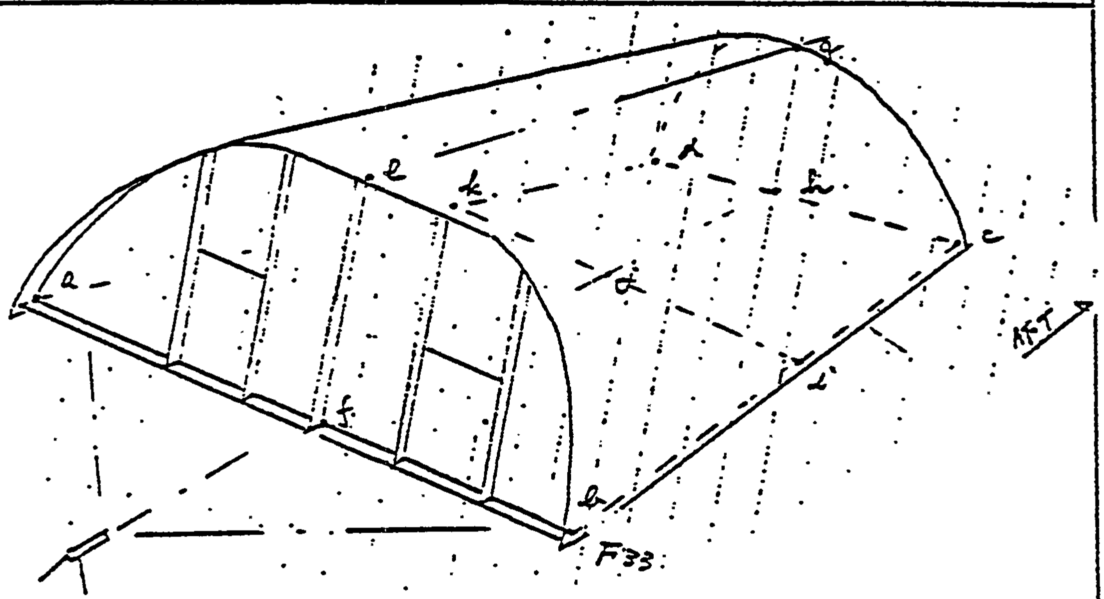


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A B	Alignment				Worker AC	Piano Wire
	Plainess				AC	Piano Wire a~f
C	Edge Alignment				Worker AC	g~i

Notice: After building up the trans frames, check the dimensions "D", "E", "F" prepared by the Mold Loft.

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
751	221		

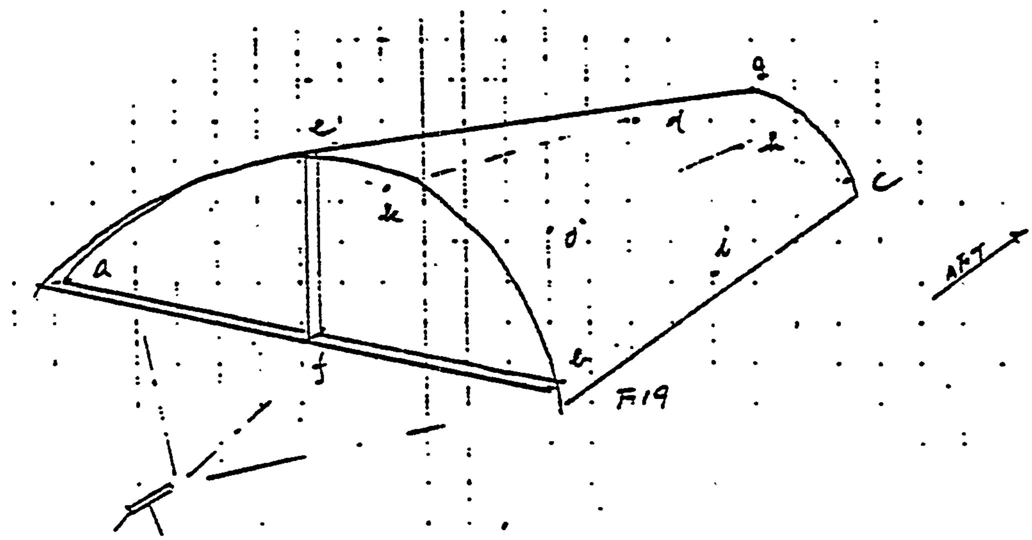


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg. Worker	Notice
a~d f h~k	Level & Twist at T. Top				AC	4 points
a – b i – k c – d	Width				AC	3 parts
a – d f – h b – c e – g	Length				AC	4 parts
e – f g – h	Height				AC	2 points

Notice

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
751	231		

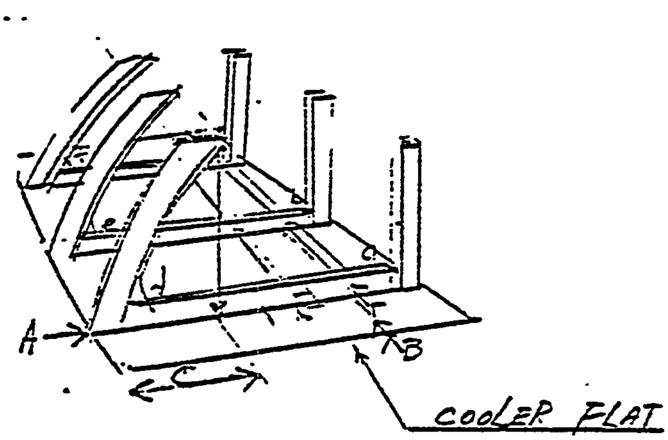


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg. Worker	Notice
a~d f h~k	Level & Twist at T. Top				AC	9 points
a – b i – k c – d	Width				AC	3 parts
a – d f – h b – c e – g	Length				AC	4 parts
e – f g – h	Height				AC	2 points

Notice

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
	222(223)-1/3		Cooler Flat Base

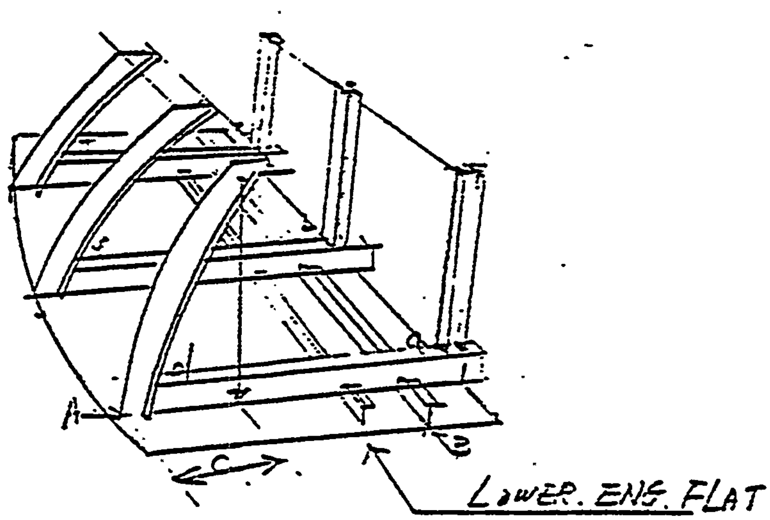


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Edge Alignment				Worker	At each frame
B	Shift				Worker	At each long'l
C	Inclination				Worker AC	At each frame with plumb
D	Level				Worker AC	a~f

Notice

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
	222(223)2/3		L. E. F. Base

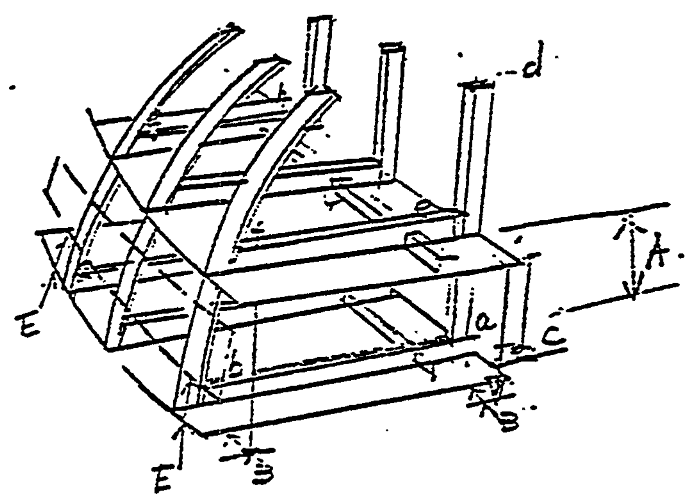


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Edge Alignment				Worker	At each Frame
B	Shift				Worker	At each long'l
C	Inclination				Worker AC	At each frame with plumb
D	Level				Worker AC	a~f Transit

Notice

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
	222(223)-3/3		Shell Plate to be put on

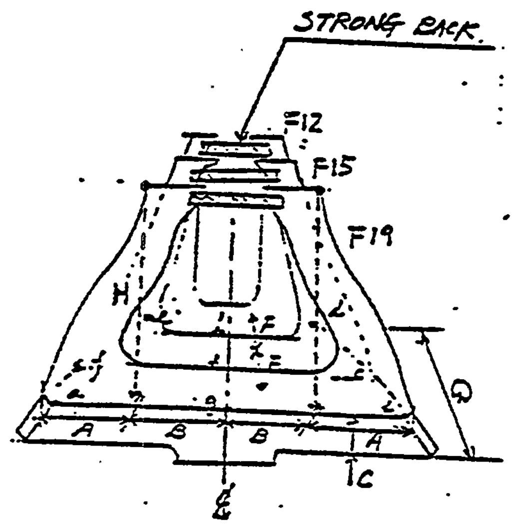


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Height				Worker AC	a~d
B C	Shift				Worker AC	Plumb at four corners
D	Level				Worker AC	a~d e~h Transit
E	Shift				Worker	At fore and aft frame positions

Notice

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
	232 (233)-1/2		Lower Engine Flat Base

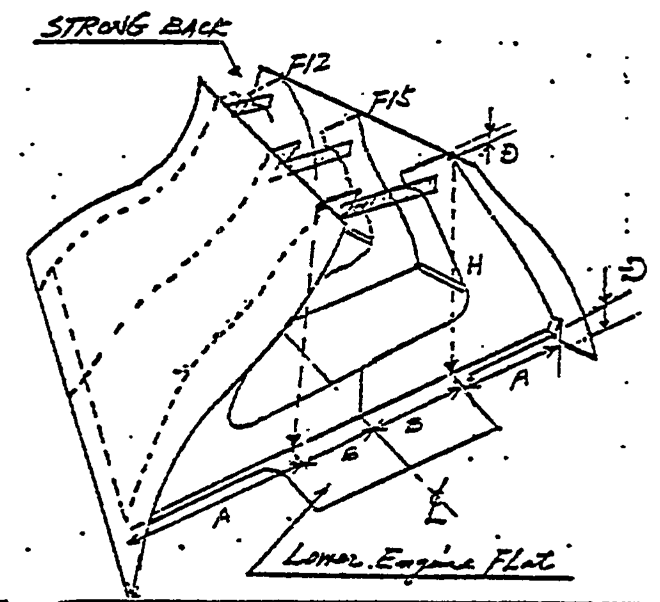


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
G	Lower Eng. Flat Level				AC Worker	a~i 9 points Keep horizontal plane
A B	Width				AC Worker	Plumb at every frame
H	Vertical Height				AC Worker	Plumb at every frame Check the vertical
C	Edge Alignment				"	Aft & Fore
F	Space				"	Each space at frame web
D	Length				"	

Notice
1) Keep the level and fix the flat panel.
2) Need support and strong back.

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
	232(233)-2/2		Final Assembly



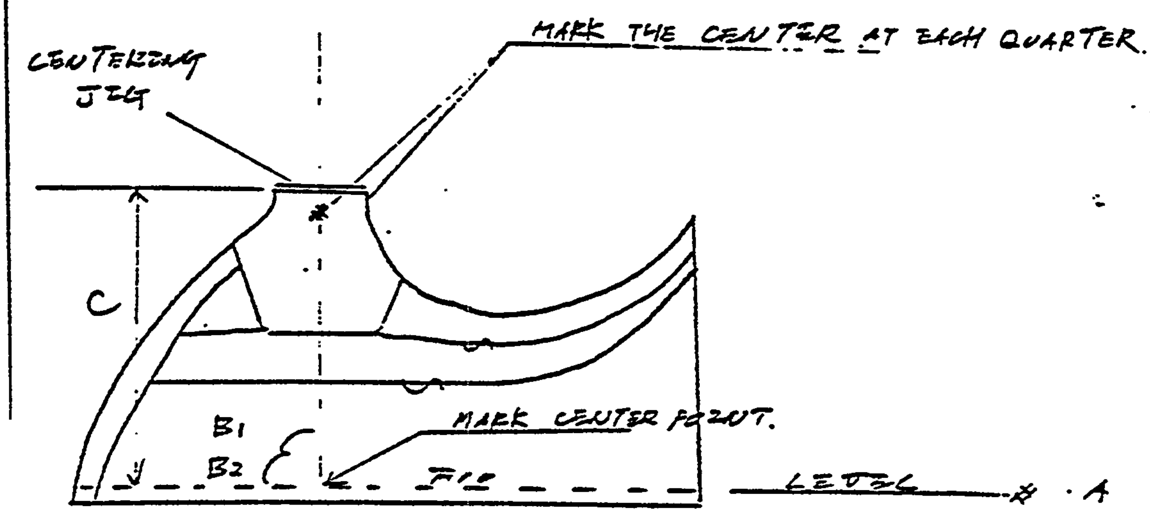
Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A B	Width				AC	Plumb Keep horizontal plane
D	Shift				AC Worker	
H	Height				AC	Plumb

After fitting and after welding.

Notice

ACCURACY CHECK SHEET

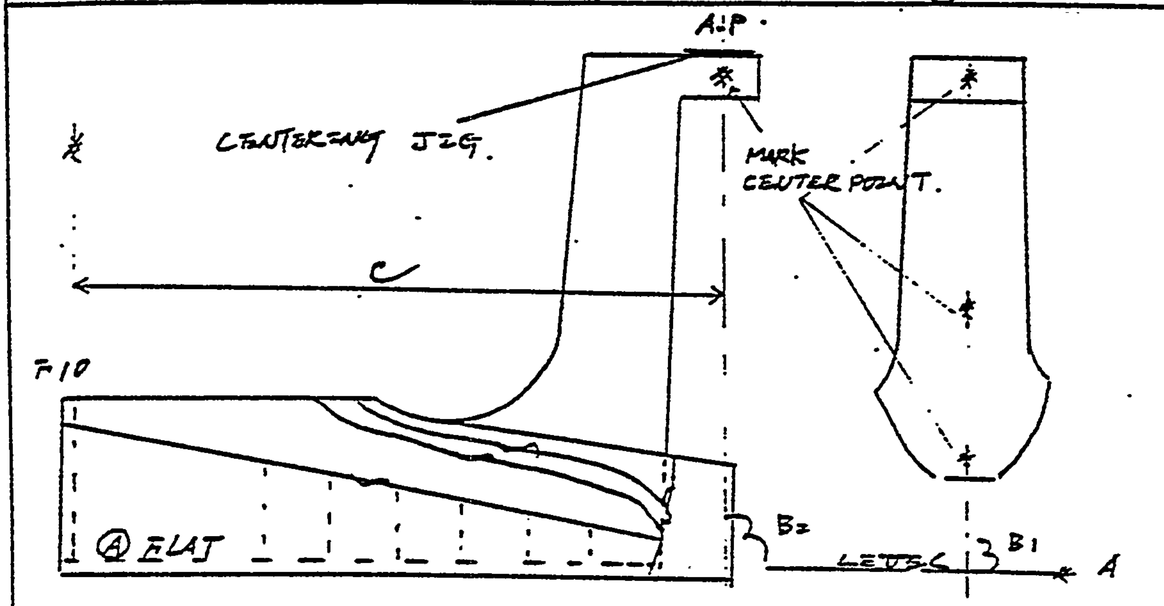
Ship No.	Unit No.	Shop	Condition
	241		Component Base F10



Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Level of Flat F10				AC Worker	
B_1	Square				"	Transverse direction Use Plumb
B_2	"				"	Long'l Use Plumb
C	Length				"	

Notice	Mark the centerpoint of shaft before setting the casting on the flat F10. Check the center before welding and after welding.

ACCURACY CHECK SHEET			
Ship No.	Unit No.	Shop	Condition
	241		Component Base (A) Flat

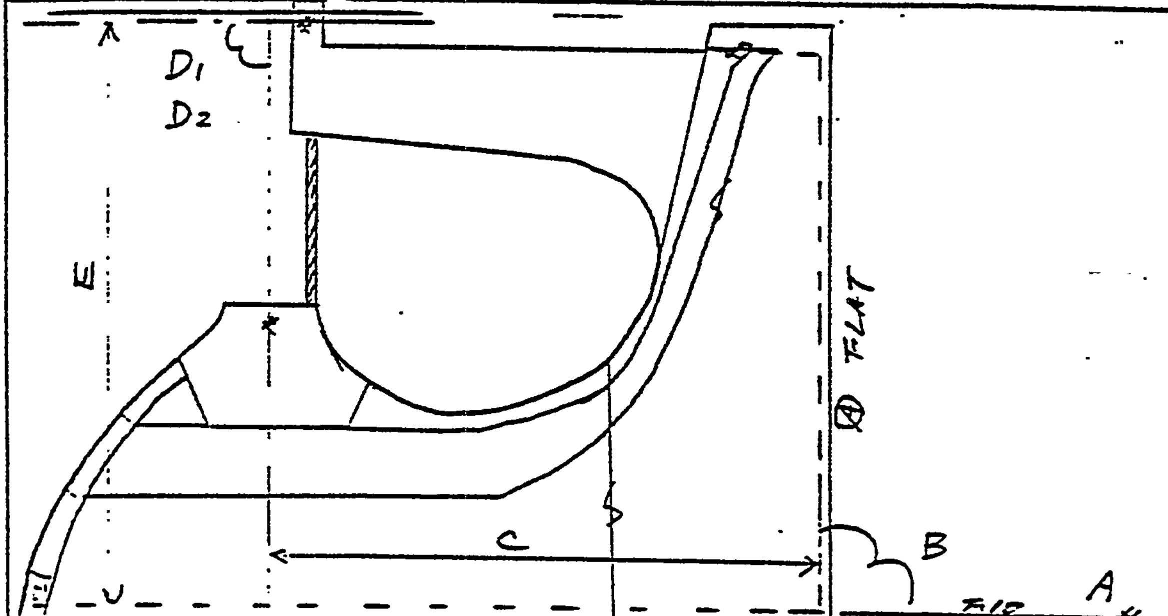


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Level of Flat (A)				AC Worker	
B_1	Square				AC Worker	Transverse Direction Use Plumb or Transit
B_2	"				"	Long'l Use Plumb or Transit
C	Length					

Notice: Before setting castings, mark the centerpoint on it and set the centering jig. Check the center before welding and after welding.

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
	241		Final Assembly Base F10

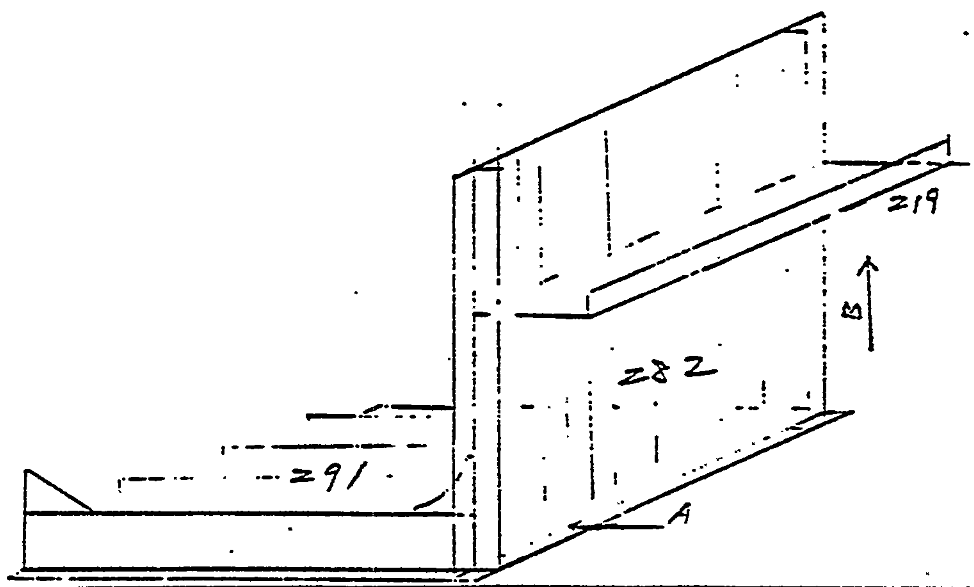


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Level				AC Worker	
B	Square				"	
C	Distance				"	Between shaft center and flat A
D_1	Square				"	Use Transit Transverse
D_2	Square				"	" Long'l
E	Distance				"	Between AP and shaft center

Notice: Check every item before welding and after welding.

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
	291x282x219		Unit to Unit

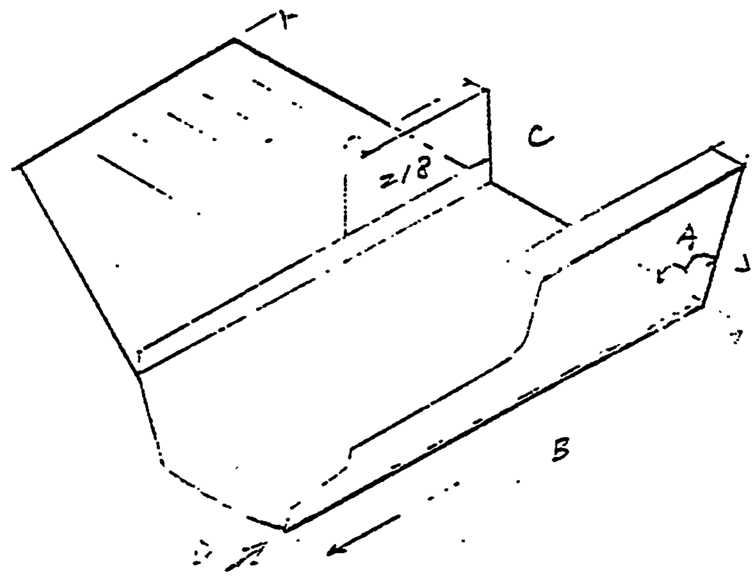


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Sift				Worker AC	Min. 3 points
B	Square				Worker AC	With plumb

Notice: Dimensional check should be done at Final Assembly.

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
	281 x 218		Final Assembly

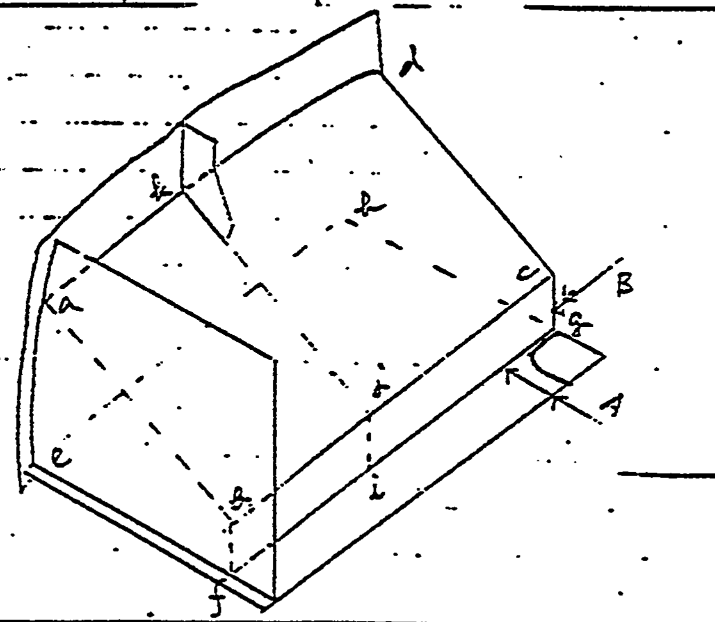


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Degree of L. E. Flat				Worker AC	With template
B	Width				AC	
C	Height				AC	
D	Bending of Flat				AC	With piano wire

Notice

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
	216		Final Unit Assembly



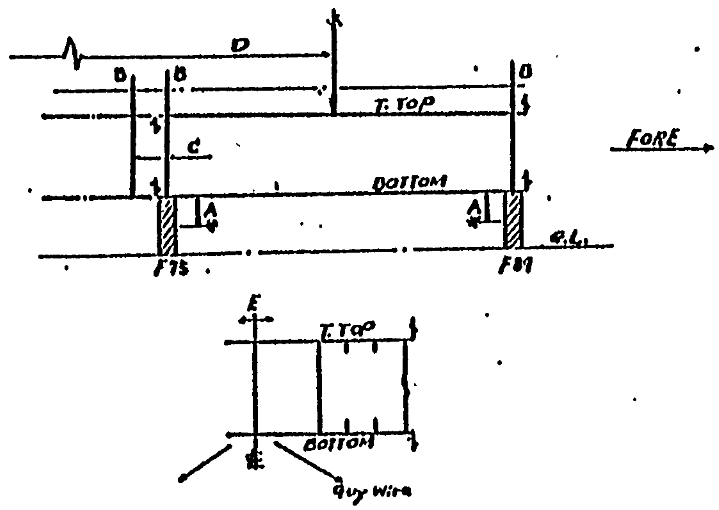
Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
	Plainess				AC	Transit a~d , k, j
A	Shift				Worker AC	At each Frame
	Straightness				Worker AC	At each Frame
	Height				Worker AC	a~c d~h
B	Edge Alignment				Worker AC	a,b,c,d

Notice

3. ERECTION

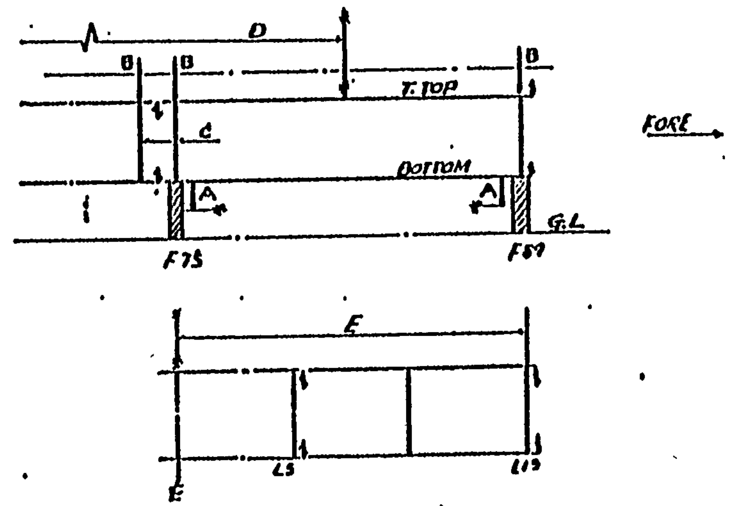
CHECK SHEET

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



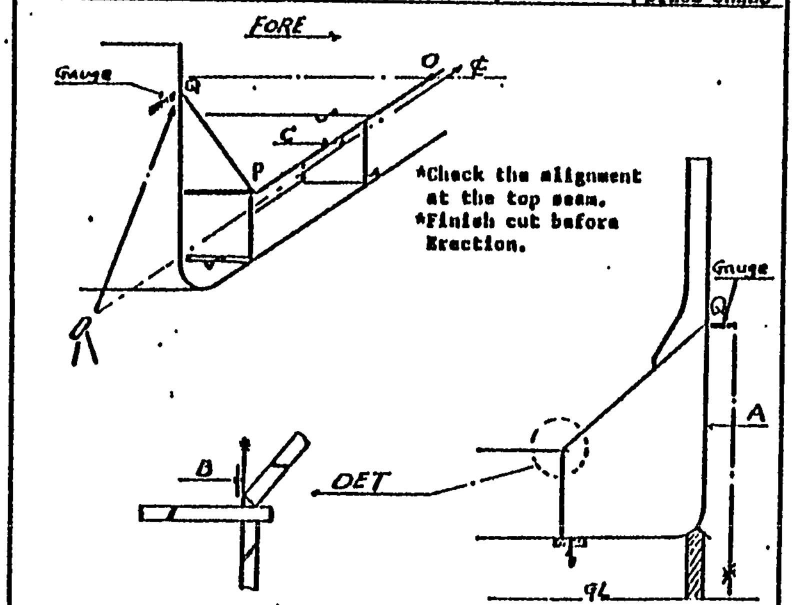
MARK	DESCRIPTION	DIMEN-SIONS	TOLER-ANCE	CHARGE	NOTICE
A	Bottom Height			Worker	Measure at C.CIR by special gauge
B	Level			Worker AG	Measure at 4 corner points by Transit
C	Space Check			Worker	Measure by ruler
D	Space Check from Bhd. to Bhd.			Worker AG	Measure by ruler
E	Center line check			Worker AG	Adjust at foreend by guy wire. Measure by Transit

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



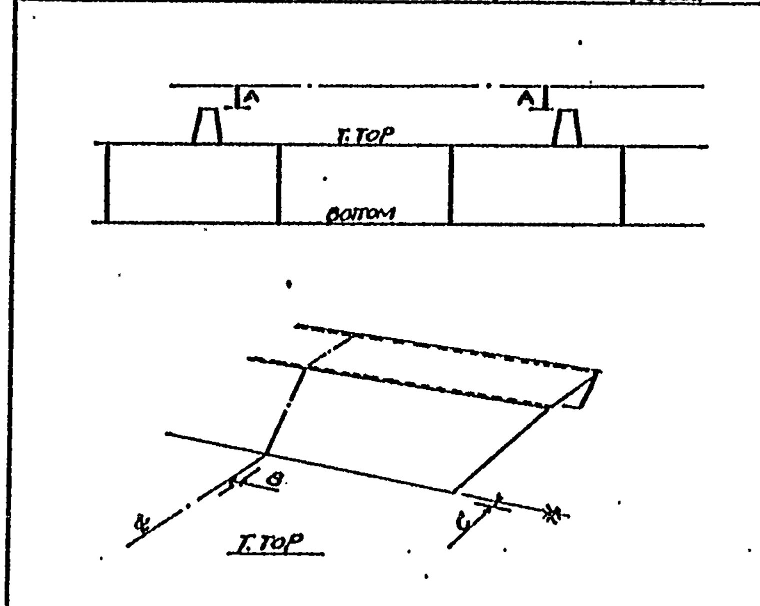
MARK	DESCRIPTION	DIMEN-SIONS	TOLER-ANCE	CHARGE	NOTICE
A	Bottom Height			Worker	Measure at L13 by special gauge.
B	Level			Worker AG	Measure at 4 corner points by transit.
C	Space Check			Worker	Measure by ruler.
D	Space check from Bhd. to Bhd.			Worker AG	Measure by ruler.
E	Width from C. line to L13.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

HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				BILGE SHELL



MARK	DESCRIPTION	DIMENSIONS	TOLERANCE	CHARGE	NOTICE
A	Width & Perpendiculary			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	

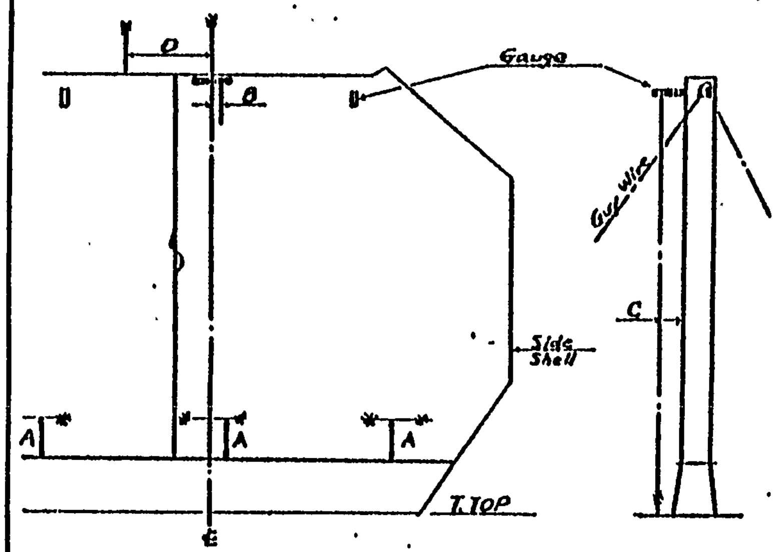
HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				STOOL



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					

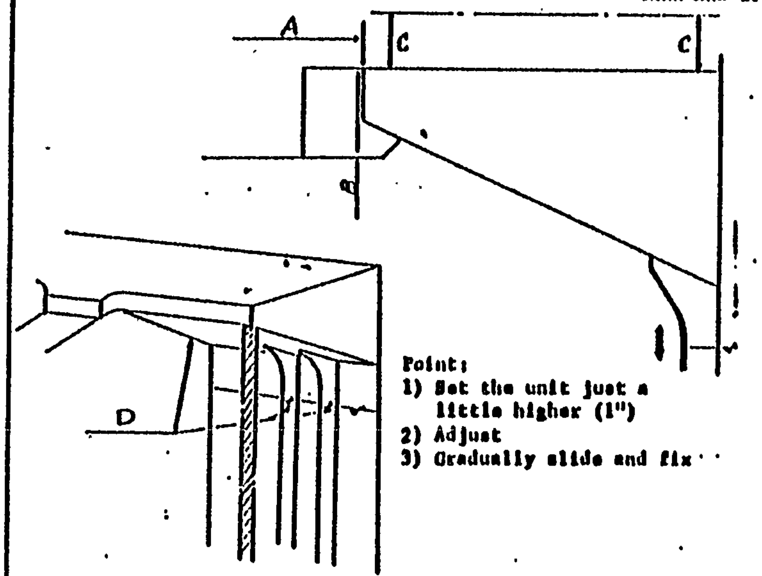
The unit is most vital to keep precise level and height of Bhd. and Upper deck.

HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				CORR. BHD.



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

HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				UPP. WING TANK AND UPP.DK. SIDE

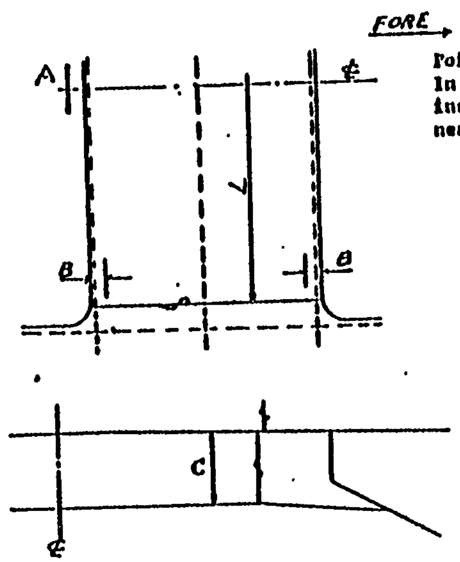


Point:
1) Set the unit just a little higher (1")
2) Adjust
3) Gradually slide and fix

MARK	DESCRIPTION	DIMEN-SIONS	TOLER-ANCE	CHARGE	NOTICE
A	Width			Worker AC	Measure from center line by ruler
B	Height			Worker AC	Measure from T. Top by ruler.
C	Level			Worker AC	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. DK. CENTER



Points:
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 AC	Check discrepancy by transit
B	Alignment of the joining part			Worker	
C	Height			Worker	Before erection, check the dimension and neat cut
D					

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

MARK	DESCRIPTION	DIMEN-SIONS	TOLER-ANCE	CHANGE	NOTICE
A					
B					
C					
D					

LSCo Report No. - 2123-5.1-4-1

TECHNOLOGY TRANSFER PROGRAM (TTP)

FINAL REPORT

QUALITY ASSURANCE SYSTEM

Appendix F

IHI SPAIS - The Shipbuilding Process and Inspection Standard

QUALITY ASSURANCE

VOLUME 2 APPENDICES

Prepared by:

Livingston Shipbuilding Company
Orange, Texas

March 3, 1980

APPENDIX F

IHI SPAIS - THE SHIPBUILDING PROCESS & INSPECTION STANDARD

IHI SPAIS

THE SHIPBUILDING PROCESS AND INSPECTION STANDARD

1978

Ishikawajima-Harima Heavy Industries Co., Ltd.

F-1

INTRODUCTION

We, Ishikawajima-Harima Heavy Industries Co., Ltd., are always willing to lake the responsibility for quality and performance of our built ships. Our "Quality Control"' throughout construction process is always based on the concept to "prevent any antcipatory defects" and aims at maintaining uniform quality and assuring reliable function.

It is generally known that some deflection of accuracy is unavoidable in manufacturing any products, which Inevitably Ieads to admission of a reasonable tolerance in enforcing quality control. Prevailing rules and require. ments of Classification Societies cover details in both design and fabrication work, but are indifferent to tolerance which is one of the most important subjects in fabrication work. Thus questions of whether accuracy of any products is in tolerable range or not have to Ire referred to individual judge rnent of inspector or supervisor which often causes disagreement and some. times develops into unnecessary disputes.

The lntent that wc have prepared this booklet is to eslablish common understanding between the parties as to tolerance in quality and accuracy for hull structures and outfitting works definding our minimum criteria of tolerance in each of said respects as WeII as our practice in both fabrication and Inspection rnethods to avoid any trouble or disputes,

The substance of this booklet dots not only reflect our present pro. duction facilities, fabrication methods and workmanship but also incorporate most up to date technlogy extracled from our vast experiences in actual construction of ships and criteria set forth in "Japanese Shipbuilding Quality Standard (JSQS)" issued by The Society of Naval Architects of Japan.

We are quite confident that this booklet is well acceptable to anybody concerned and our products will no doubt satisfy our customers.

IIII SPAIS

The Shipbuilding Process and Inspection Standard

CONTENTS

1. HULL CONSTRUCTION PROCESS

The Vessel shall be constructed and outfitted in accordance with the Builder's building process as specified hereunder.

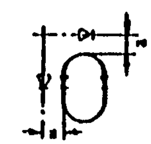
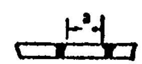
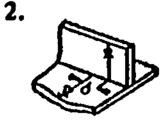
1.1 Hull Structural Construction

1.1.1 Assembly Block

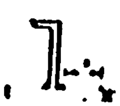
In general, steel construction blocks of suitable sizes shall be assembled in the workshop and then erected on the building berth and/or the building dock.

1.1.2 Distance between Adjacent Welding Beads

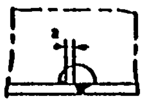
A. Distance between Adjacent Butt Welds

Item	Allowable Limit (mm)	Remarks
1.  	a ≧ 30	
2. 	b ≧ 0	No restriction for the location of butt.

B. Distance between Butt Weld and Fillet Weld

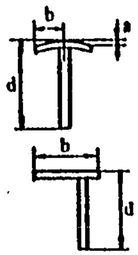
Item	Allowable Limit (mm)	Remarks
	a ≧ 10 (Main structures) [illegible]	Overlap of welds shall be allowed where the members are arranged diagonal to the butts in fore & aft constructions and in superstructures

C. Distance between Butt Weld and its Scallop Welding

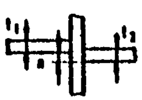
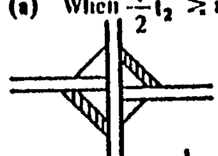
Item	Allowable Limit mm	Remarks
	a ≧ 5	

1.1.3 Accuracy in Hull Construction

A. Size of Built-up Sections

Item	Allowable Limit mm	Remarks
	$a \leqq \pm(3 + \frac{b}{100})$ d = nominal depth ±2 b = nominal breadth −2	

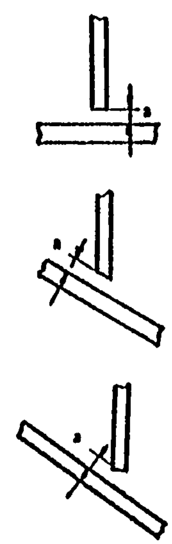
B. Mis-alignment in Fillet Connections

Item	Allowable Limit mm	Remarks
 t_1 & t_2: thickness of members. a: misalignment	1. Longitudinal members within 0.6L ⊠ and principal transverse supporting members: $a \leqq \frac{1}{3}t_2$	When "a" exceeds the allowable limit, following treatment shall be applied: 1. For main structures: (a) When $\frac{1}{2}t_2 \geqq a > \frac{1}{3}t_2$  Weld leg length shall be increased by 10%. (b) When $a > \frac{1}{2}t_2$: The member shall be re-aligned
where $t_1 \geqq t_2$	2. Others: $a \leqq \frac{1}{2}t_2$:	2. For Others: When $a > \frac{1}{2}t_2$: The member shall be realigned.

C. Mis-alignment in Butt Connections

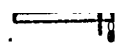
Item	Allowable Limit mm	Remarks
	1. Skin plates (Bottom shell, side shell and deck plate) and longitudinal strength members $a \leqq 0.15\,t$ (a max. = 3.0)	1. When "a" exceeds the allowable limit before welding, the butt shall be realigned. When "a" exceeds the allowable limit after welding, the butt shall be disconnected and re-aligned.
	2. Bulkhead plates and interior members (including face plate) $a \leqq 0.2\,t$ (a max. = 3.0)	2. When "a" exceeds the allowable limit, the reinforcement by welding shall be done or the plate shall be re-aligned after mutual discussion among builder, buyer and classification society.

D. Gap between Members in "T" Connections and Penetrations.

Item	Allowable Limit mm	Remarks
1. 	a ≦ 3	When "a" exceeds the allowable limit, following treatment shall be applied: 1 When 3 < a ≦ 5 Weld leg length shall be increased by "(a−2)" mm 2. When 5 < a ≦ 16 (in case pl. thick. ≧ 10 mm) 5 < a ≦ 12 (in case pl. thick. < 10 mm) (a) The edge of web plate shall be shaped to a bevel of 30° ~45° and welded on the bevel side using a backing strip.

Item	Allowable Unit mm	Remarks

backing strip 30° ~45°

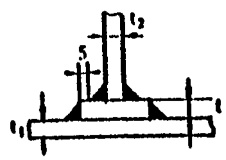


Then after removing the backing strip, this side shall be welded up to the de- stgned weld kg length.

$a \leq 3$

or
(b) A liner of following thickness shall be inserted and welded.

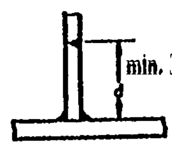
$t_1 \gtrsim t \gtrsim t_2$



3. When a >16
(in case pl. thick. ≥ 10 mm)
a > 12
(in case pl. thick, <10 mm)

(a) A lines shall be inserted similar to 2 (b).

or
(b) The plate of at least 300mm width shall be partially renewed.



Item	Allowable Limit mm	Remarks

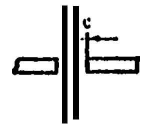
2. Members penel. raling through bulkhead plates

When "c" or "C_1" exceeds the allow. able limit, the slot shall be treated as follows:

1. When 3 < c or c_1 ≤ 7:

45° | | 45°

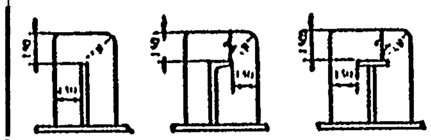
The edge of the Slot shall be beveled to 45° and the bevel side shall be welded first, and then the other side Shall be Welded after back chipping,



$c \leq 3$

$c_1 \leq 3$

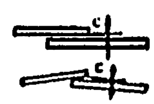
2. When c or c_1 > 7:
The slot part of bulkhead plate shall be replaced by an lnsert plate having same thickness as the bulkhead plate and butt welded.



The Insert plate may be cut in two (2) pieces to facilitate insertion. If the penetrating members are de. signed with a lapped collar plate, the collar plate shall be replaced.

3. When the penetrating member is a **"T" bar piece, the allowable limit of gap shall be same as above..**

3. Lap weld



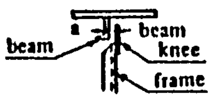
$c \leq 3$

When "c" exceeds the allowable limit, following treatment shall be applied:

1. When 3 < c ≤ 5:
Weld leg length shall be increased by "c" mm.

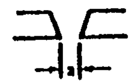
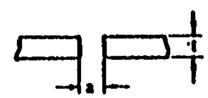
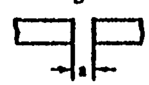
2. when 5< c:
The member shall be re.aligned.

E. Gap of Laps between Beams & Frames

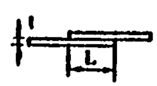
Item	Allowable Limit mm	Remarks
	$a \leq 3$	When "a" exceeds the allowable limit, the members shall be realigned.

F. Gap between Butt Weld Edge

Item	Allowable Limit mm	Remarks
1. Butt weld plates 	$a \leq 5$	When "a" exceeds the allowable limit, the edges shall be treated as follows: 1. When $5 < a < 16$ (in case pl. thick. $\geq$ 10 mm) $5 < a < 10$ (in case pl. thick. $<$ 10 mm) 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. When $25 \geq a > 16$ (in case pl. thick. $\geq$ 10 mm) $16 \geq a > 10$ (in case pl. thick. $<$ 10 mm) (a) When the renewal of a longitudinal member is necessary, the scope of the renewal shall be decided case by case, with the agreement of the buyer and the classification society. For the other members, the plate of at least 300 mm width shall be renewed. (b) If (a) is not applicable, the edge shall be built up by welding, and then the butt shall be welded. 

Item	Allowable Limit mm	Remarks
		3. When $a > 25$ (in case pl. thick. $\geq$ 10 mm) $a > 16$ (in case pl. thick. $<$ 10 mm) 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 	$17 \leq a \leq 40$	When "a" exceeds 40mm, the gap shall be treated as follows: 1. When $40 < a \leq 40 + t$: The edge shall be built up by welding. 2. When $a > 40 + t$: The plate shall be partially renewed. Note: * CES = Consumable nozzle electro slag welding.
4. Electro gas welding and electro slag welding 	$10 \leq a \leq 30$	When "a" exceeds 30mm, the gap shall be treated in the same way as specified in the CES welding.

G. Breadth of Lap Joints

Item	Allowable Limit mm	Remarks
Breadth of lap 	L = rule requirement	When "L" is less than the rule requirement, the joint shall be treated as follows:—

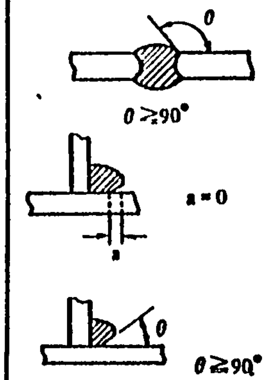
Item	Allowable Limit mm	Remarks
		1. When shortage of lap $\leq t$: The edge shall be built up by welding where the lap is short. 2. When shortage of lap $> t$: The plate in shortage of lap shall be partially renewed, or if applicable, the joint may be modified to a butt joint.

1.1.4 Shape of Welding Bead

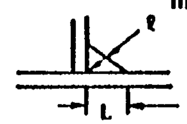
A. Under-Cut in Welding

Item	Allowable Limit mm	Remarks
1. Butt welds:	1. For main structures within 0.6 L ⊗ (skin plates, longitudinal members and principal transverse supporting members.) max. depth:0.5 (Length of more than 90mm) 2. For other members max. depth: 0.8	When the under-cut exceeds the allowable limits, the under-cut shall be filled up by welding, using electrodes of small diameter. However, the filled up welding shall not be ground off. (Carefully avoid short bead for higher tensile steels)
2. Fillet welds:	max. depth: 0.8	(Carefully avoid short bead for higher tensile steels)

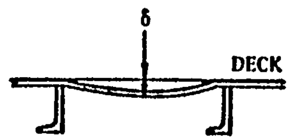
B. Over Lap in Welding

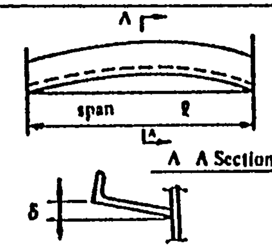
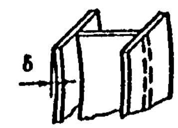
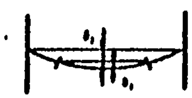
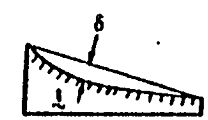
Item	Allowable Limit mm	Remarks
Butt welds and fillet welds		In case where θ is less than 90°, it shall be repaired by grinding or welding to make $\theta \gtrsim 90°$ (Carefully avoid short bead for higher tensile steels)

C. Welding Leg Length

Item	Allowable Limit mm	Remarks
Leg length	 L: Leg length ℓ: Throat thickness $L \gtrsim 0.9 \times$ (specified leg length) $\ell \gtrsim 0.9 \times$ (specified throat thickness)	In case where "L" or "ℓ" is less than allowable limits, weld up over it. (Carefully avoid short bead for higher tensile steels)

1.1.5 Fairness of Structure Surfaces

	Item	Location	Allowable Limit mm	Remarks
Indents (δ)	Side shell and bottom shell	1. Parts within 0.6 L ☒ 2. Fore and aft	6 7	
	Double bottom	1. Tank top , plate 2. Floor and girder	6 8	
	Bulkheads	1. Longitudinal 2. Transverse 3. Swash	8 8 8	
	Main structural decks	1. Exposed parts within 0.6 L ☒ 2. Exposed part at fore and aft 3. Enclosed or sheathed part	6 9 9	
	Second deck	1. Exposed parts 2. Enclosed parts	8 9	
	Superstructure decks and wall	1. Exposed parts 2. Enclosed parts	6 9	
	Web of girder and trans		7	

	Item	Location	Allowable Limit mm	Remarks
Distortion (δ)	Beams, frames or stiffeners	1. When $\ell \leqq 1000$ 2. When $1000 < \ell < 3500$ 3. When $\ell \geqq 3500$	7 $(5 + \frac{2\ell}{1,000})$ 12	
	H. pillars (between decks)		6	
	Cross ties	Distortion of fore and aft direction. δ_1 (cross tie only) Distortion of fore and aft direction. δ_2 (cross tie + trans web)	10 16	
	Tripping brackets and stiffeners attached to web	Distortion at the part of free edge	t	

1.1.6 Disposal of Temporary Pieces for Construction Purposes

Lifting pads and temporary pieces for construction purposes and lugs for scaffoldings etc., shall be disposed in accordance with the following standard.

Location			Standard	Remarks
Where good appearance is required		Exposed surfaces of shell, decks and superstructure walls and exposed walls in living quarters.	All temporary pieces for construction purposes shall be removed completely and if necessary, finished by chipping and/or grinding after welding.	
Where good appearance is not required		Inside tanks (cargo tanks, ballast tanks, void spaces, etc.)	In general, lifting pads and completely welded large pieces for construction purposes shall be cut off at the top of welding bead, and the edge shall be smoothed. Lugs for scaffoldings shall be left as fitted providing they are fully welded. Other small temporary pieces shall be removed and finished up by welding, if necessary.	Those pieces shall be left as they are if agreed by the classification society and buyer.
		Under Fcle space, bosn's store and pump room	Lifting pads and completely welded large pieces for construction purposes shall be cut off at the top of welding bead and the edges shall be smoothed. Lugs for scaffoldings shall be left as fitted. Other temporary pieces shall be removed and finished up by welding or ground smoothly if necessary.	
	Cargo hold	Inside surface of hatch coamings, hold bottom and lower hoppers.	All temporary pieces for construction purposes shall be disposed in the same way as the parts where good appearance is required.	
		The other parts in cargo hold.	All temporary pieces for construction purposes shall be disposed in the same way as the parts of under Fcle space.	
		In engine room and steering gear room	Lugs for scaffoldings in visible part, up to 2m above the floor, shall be removed and ground smoothly, and other pieces shall be left as fitted.	
Parts covered with insulation and/or lining.			Lifting pads shall be left after cutting off the top of the welding. Other temporary pieces shall be removed. Damages such as scars, flaking or under-cutting shall be filled up by welding.	
Decks covered by deck-sheathing			All temporary pieces shall be removed, and damages such as scars, flaking or undercutting shall be filled up by welding. However, the welded beads shall not be smoothed by chipping or grinding.	

1.1.7 Temporary Holes for Access during Construction

A. Temporary access holes for communication purposes, emergency escape of workers and maintenance of good sanitary conditions during construction, shall be opened on the shell, bulkheads or other locations, in accordance with the plan previously approved by the classification society, in which the position and size, etc. are described.

B. In general, the access holes shall be opened as follows:
- (a) Engine room side shell (on one side or on both sides)
- (b) Side shell of forward construction (on one side or on both sides)
- (c) Hold bulkheads (one for each bulkheads)
- (d) Inner bottom top and hopper top
- (e) Bottom shell in way of cargo tanks
- (f) Side shell of cargo hold (on either side)

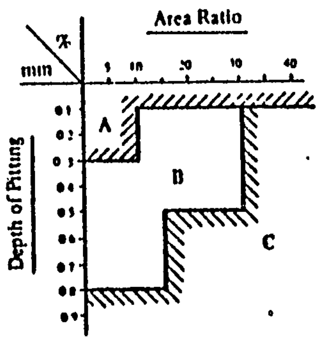
C. At least two (2) holes shall be opened in each double bottom tank, fresh water tank, peak tank, etc. Existing manholes shall be used as far as practicable, and additional holes may be converted to permanent manholes with approval of classification society and buyer.

1.1.8 Treatment of Defects on Steel Material Surfaces of Hull Structures

Defects on steel surfaces, such as pitting or flaking, shall be treated as follows:

A. Pitting

Grade of pitting



Remarks

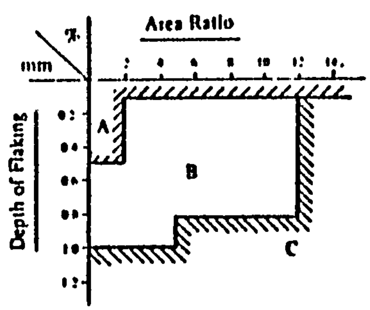
1. Pitting or flaking of grade "A" is considered not harmful, so no repair shall be done.

   Pitting or flaking of grade "B" is considered as medium defects. Defects on plates of this grade, used in main structural members, shall be repaired, otherwise, no repair shall be done.

   Pitting or flaking of grade "C" is considered as serious defects, so necessary repair shall be done.
2. Pitting or flaking on boundaries of grade "A" and "B", grade "B" and "C", and grade "A" and "C" shall be classified as grade "A", grade "C" and grade "A" respectively.

B. Flaking

Grade of flaking



3. The "Area Ratio" of pitting or flaking is defined as percentage of the defective area against the total steel surface area, i.e.,

$$\frac{\text{Area of pitting or flaking}}{\text{Total area of steel surface}} \times 100$$

C. Treatment of Pitting and Flaking Defects:

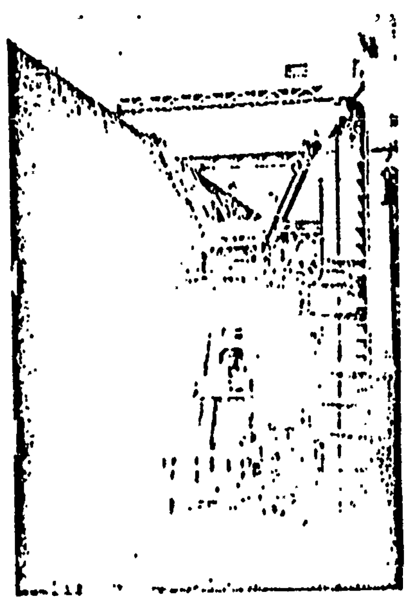
1. Surface defects, which depth do not exceed 7% of the plate nominal thickness, shall be removed by grinding. However, the depth of the defect must not exceed 3mm in any case.
2. Surface defects which cannot be treated by above, shall be be repaired by welding, provided that;
   (a) After removal of the defects, the depth of the removed part must not exceed 20% of the plate nominal thickness.
   (b) The welding shall be smoothed by grinder up to the nominal thickness.

1.2 Hull construction Work Units

1.2.1 Outline of Hull Construction WoIk Units

The Hull Construction Work Unit was developed by HII to ensure safety of the workers and to improve the quality and working efficiencies during construction on the berth or in the dock. In a word, it is a huge equipment which consists of many rnovable stages, power sources, hydraulic fitting tools, automatic welding equipment, etc. There are many variations to meet the different kinds of hull structures and shipyards facilities.

One of the Hull Construction Work Unit for tankers is shown in the Photograph below.



This unit moves forward gradually, and In principle, works and inspection must be completed before the unit moves to the next position.

some part of the hull structure must be designed to suit the use of the Hull Construction Work Units.

Mainly, there are two kinds of Hull Construction Work Units, one for hull construction works and the other for painting works.

1.2.2 Featres of Construction by using The Hull Construction Work Unit

Comparing with the conventional construction method of using wonden stages, following features can be distinguished by using this unit.

(a) Working conditions could be much safer on this staging equipment, so higher quality in works can be expecterd.

(b) By using this unit, works which were carried out manually, could be substituted by machines, so higher quality can be obtained.

(c) All works will be carried out and controlled, so high reliability Call be expected.

1.2.3 Works and Inspections by using Hull Construction Work Unit

Works and inspections, using this work unit, shall be carried out block by block,

In principle, while the unit is stationed at the spot, all erection work, fitting work and inspection, will be carried out on this unit, so they must be finished before the unit is moved forward to the next spot. The same procedure shall be repeated at each spot.

In order to maintain the working schedule, it is desirable to com. plete all works and Inspections properly at each spot, in order to avoid any turn back works, Therefore, the inspection schedule is required to be followed strictly in accordance with the working schedule.

2. PIPING PROCESS

2.1 Pipe Bending

As a standard for SICCI and non ferrous pipes, pipe benrling shall be carried OUt by the cold bending machinc having bending radius of approximately 3 times of the outside diameter of the pipe, to a maximum practicable extent according to the shipyard facilities.

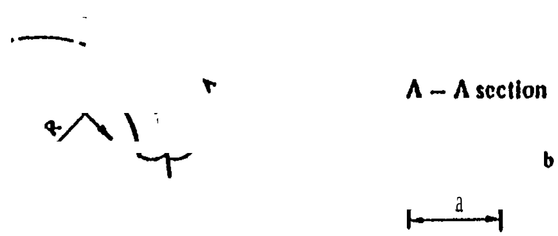
If the cold bending machine is not applicable, a high frequency Induc. tion include may be used.

Cold bending having bending radius of approximately 2 Times of the nominal pipe diameter may be applied to tank heating coils when it is required to facilitate the piping arrangement.

Ellipticity of the pipes caused by bendhrg shall not exceed following rangcs:

Ellipticity . . . . E (%)

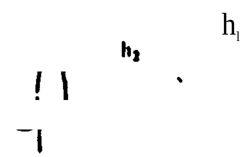
$$E = \frac{a - b}{D} \times 100$$



Where D : outside dia. of pipes
R : bending radius

R/D	D 111111	1:%
3 &above	40& above	8 & below
	25& below	10 & below
less than 3	80 & above	10 & below
	65 & below	10 & below

Allowahle hunt fut swells or wrinkles caused by bending shall be as follows



Swell: $h_1 \leq \frac{\text{[illegible]}}{100} \times D$

wrinkle: $h_2 \leq \frac{1}{100} \times D$

D: outside dia of pipes

In case the regular pipe bendhrg, as mentioned above, cannot be applied from following reasons, then commercial bend pieces shall be used.

(a) When the capacity of existing bendhsg machine Is not powerful enough to bend.

(b) When smaller pipe benrlhrg radius is necessary to faclliate the piping arrangement.

Commercial bend pieces shall be of scamless steel pipe for 200mm@ and below, anb fabricated pieces may be commonly used for those of 250mm$ and above, if there Is no specific requirement from the Classification Society.

In Case the arrangerment is difficult to adopt commercial bend pieces, thenn the miter welding pipe, having a radius approximately equal to the nominal pipe diameter shall be applied. Howevcr, the miter welding method shall be applied only to low pressure, Iarge size pipes, such as exhaust gas, *sea* water, exhaust steam piping, ctc.

Hot bemlhtg may be applied as a special case, If necessary,

Hot process shall be adopted for adjustment of pipe alignment.

2.2 Pipe Finishing

Welded beads on Inside surface of fabricated pipes, expepting butt welded joints using backing ring, shall be finished to suit to the purpose of the respectivc piping system in accordance with the following 3 grades. In case of TIG welding pipes, Inside finishing of butt joint shall be unitted.

GRADE: A

Welded beads of inside pipes shall be finished smoothly and welding spallcis and slags shall be removed.

This grade appplies to lubricating oil pipes, hydraulic oil pipes, fuel oil injection pipes after 2nd filter for main diesel engine, turbine steam pipes and for synthetic rubber or plastic lining pipes.

GRADE B

Welding spatters and slags shall be removed and welded beads shall be cleaned.

This grade applies to power steam pipes, turbine exhaust pipes, fuel oil service pipes, drinking water pipes, nozzle cooling pipes, feed water pipes, condensate water pipes, sea water cooling pipes, compressed air pipes, tank cleaning pipes and vent pipe for cargo tank.

GRADE C

Welding spatters and slags on the flange face shall be removed but welded beads inside pipes shall not be finished.

This grade applies to all other pipes which arc not specified in GRADE A and GRADE B, and such open ended lines as dralrrs,over-flows, vents and boiler escape pipes.

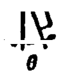
2.3 Flange Fitting in Shots

The pipe shall be inserted into the flange and stopped at a osition so that the welding beml will not overpass the flange face. The flange face is usually not finished by grinders, but welding spatters and slags on flange face shall be removed.

Tolerance for distance "C_2". bet ween flange face and the pipe end, shown in the "Standard Piping Works" drawing shall be as follows:

Pipe dia. (nun)	allowance for C_2 (mm)
250 and above	**±2**
200 and below	**±1**

Tolerance for angle θ of flange face fitted on pipes, except pipes adjusted on board, shall be as follows:



200 ~ 350	**≤ 20**
150 & below	< 30

2.4 Pipe Joints

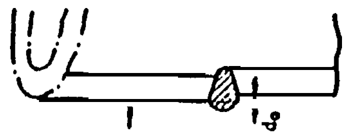
Pipe joints in respective piping systems specified in the Pipe Table of the Specifications, shall be applied in accordance with the following standard.

2.4.1 Sleeve Joints and Butt Joints

A. Generallly, sleeve welded joints and butt and butt welding joints shall be used to prevent Ieaks from pipe joints, unless other]oints are specified in the Hull and/or Machine Specifications. Especially, these joints shall be applied to all pipes in spaces such as tanks, cargo holds, cofferdams, void spaces, ducts, sipic, spaces, accom. modation spaces, hatch side spaces etc., where the removal of pipes is usually not necessary.

Butt welding joints shall be applied applied to high pressure feed water pipings and high pressure steam pipings having diameters of 65mm and above, and also to high pressure pressure fuel oil and hydraulic pipings in the spaces where there is difficulty in installation. Stress relie-ing of these welded joints shall be done by local annealing, which method and scope shall be in accordance with the rules of the clas-sification society, However, if it is impossible to use an anncaling furnace because of the shape of the pipe and the welding on the spot, then partial anncaling shall be carried out by the methods approved by the classificafication society .

B.. Tolerance limits of pipe diameters at butt welded joints be. tweeen pipes and/or between pipe and bend piece or T piece, shall be as follows.

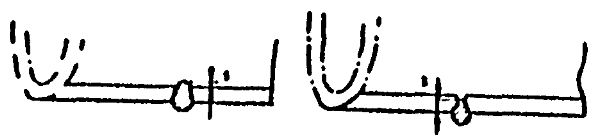


d_0 = **tolerance limit of** outside dia.

Tolerance limit of pipe diameters

pipe dia. (mm)	d_0 (mm)
250 & shove	4
Ho- 200	3
65 & beluw	2

C. Allowable limit of conved or concave butt welded beads (URA-NAMI) on the pipe internal surface shall be as follows:



Allowable Limit or "s":

Grade of Pipe	Allowable Limit (mm)
Inside lining pipes in Grade A	0 ~ + 1.0
Other pipes in GRADE A	0 ~ + 3.0
GRADE B	− 0.5 ~ + 2.5
GRADE C	no restriction

Note: (1) Pipe Grade A, B, C are specified In Page 19 & 20,

(2) Partial concave of the bend in circumference, shall be allowedhawcd for GRADE B.

2.4.2 Flange Joints and Union Joints

Flange joints, union joints and other removable joints shall be used in addition to sleeve welded joints and butt welded joints for the steel pipes in the engine room, pump room, steering gear room and other machinery spaces, and also on exposed decks to facilitate the removal of pipes.

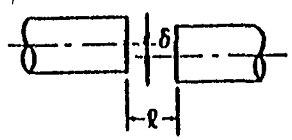
Flanges or screwed union joints shall be used at connections to all pipe fittings, machinery and equipment for maintenance or over. haul purposes.

2.4.3 Socket Joints

For pipes of the high pressure piping system having nominal pipe dia. of 50mm and below socket joints shall be used to prevent leaks.

2.4.4 Dresser Coupling Joints

The pipe alignment of the dresser coupling joint part shall be as follows;



$\delta \lesssim 5$ (mm)

$\ell \lesssim 50 \pm 10$ (mm)

2.4.5 Robber Ring Type Joints

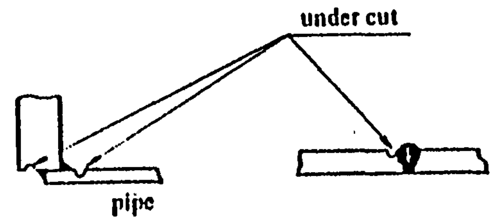
Rubber ring type joints shall be applied to low pressure water piping, etc, having nominal pipe dia. of 40mm and below.

2.4.6 Joints for Non-Ferrous Pipes

Pipe joints for non-ferrous pipes shall be applied similar to those for steel pipes, unless otherwise specified in the Specifications.

2.4.7 Under-Cuts in Pipe Welding

Allowable limit of under cuts in pipe joint welding shaIl be Joints to depth, and those exceeding the allowable limit shall be corrected.



2.4.8 ANSI Joint

Where application of ANSI standard flanges are specified in the Specification, the ANSI type flanges of the builder's standard having same outside diameter, bolt drillings and thickness as ANSI standard shall be used.

2.4.9 Joint Gaskets

Universal heat and oil resisting asbestos joint sheets shall be used generally in all piping systems, excepting those for high pressure and high temperature piping systems where spiral wound gaskets shall be used.

Neoprene gaskets shall be used in P.V.C. pipes and also in low pressure water piping of non-ferrous pipes.

2.5 Pipe Dranches

In general, branch pipes shall be welded directly to the main p having branch axis angles of at Ieast 40°

For high pressure and/or high temperature pipes having nominal dia. of 50mm and below furged steel socket welded T-pieces may be used.

Rubber ring type T-pieces of F.C.M.D. (black heart malleable Iron casting) may be used in low pressure water piping, etc, only for steel pipes having normal pipe dia. of 40mm and below.

Non-ferrous pipes shall be branched by standard T-pieces,

2.6 Reducing Pipe Diameters

For connecting pipes of different diameters, commercial reducing pieces shall be used.

Commercial reducing pieces shall be of scamless steel for nominal pipe dia. of 200mm and below, and fabricated reducing pieces shall be commonly used fur nominal pipe dia. of-250mm and above unless specially required by the classification society.

Reducing pieces having a reducing ratio of 3:I or over, shrill be of fabricated steel irrespective of their nominal sizes,

2.7 Pipe Penetrations

For penetrations in spaces where sleeve welded joints are used, welded sleeve type pipe penetration pieces shall be used, but if welded sleeve type penetration pieces cannot be used to adjust the pipe aslingment, penetrationcnctnrtiwr pieces with middle flange and welded sleeves at both ends may be used at thc Builder's option.

For penetrations in other spaces, penetration pieces with middle flange shall be used and end joints shall be as same the pipe joints used in corresponding spaces.

In general, the wall thickness of penetration pipes shall be schedule 80. But for pipes of f250mm$ and above,the wallthickness of penetration pipes shall be 12.7mm. Penetration pipes for hydraulic oil pipes and non-ferrous pipes shall have the same wall thickness as the corresponding pipes.

In accommodation quaters, deck penetration pieces with middle flange may be fitted from the underside of the deck for convenience of welding, and mastic compound shall be filled into the process of the middle flanges to avoid water accommuilation.

If compensation is required for the penetration, the thickness and the plate lap of the middle flange shall be in accordance with the classiufication socicties' requiremcnts.

2.8 Pipes Joints Done on Board

Adjusting pipes shall be generally used for connections on board betwccn pipes already fitted on the blocks. The flanges of the adjusting pipes may be welded on board.

In order to keep the flange face parallel to the mating flange on board, the flange angle of the adjusting pipe may be sloped. Pipes of nominal dia of 25mm and below may be fabricated on board excepting surface treated pipes.

After checking the alignment of the pipes on board, correction of the alignment shall be done on the spot by heating process, but lubricating and hydraulic oil pipes shall be returned to the shop for proper alignment.

2.9 Pipe Galvanizing

Galvanizing of pipes shall be applied to those specified in the Pipe Table of the Specifications. In principle, galvanizing shall be carried out after fabrication of pipes, but if the welding is carried out after galvanizing, such as the cases as mentioned hereunder, the external of the damaged parts shall be touched up with zinc solution paint of high purity, and internal parts shall be touched up with the same paint as far as practicable.

(a) Sleeve welded joints fabricated on board.
(b) Flanges of pipes adjusted on board.
(c) Middle flanges of penetrating pieces adjusted on board.
(d) Anchoring pieces welded on galvanized pipes after adjusting on board.

2.10 Pipe Pickling by Acid

After finishing the steel pipes, Acid Pickling shall be carried out on following pipes before installation on board.

For rust prevention after pickling, the inner surface of the pipes of items (a), (b) and (c) shall be coated with suitable oil or sprayed with the absorbent (Vaper Phase Inhibiter or equal) and those of item (d), (e), (f) and (g) shall be sprayed with the absorbent (Vaper Phase Inhibiter or equal).

(a) Lubricating oil pipes excepting oily bilge pipes and air vent pipes.
(b) Fuel oil service pipes for main engine, diesel generators and boiler burning line only.
(c) Hydraulic oil steel pipes
(d) Boiler superheated steam pipes
(e) Boiler pressure desuperheated steam pipes
(f) Boiler feed water pipes
(g) Condensated line pipes

(d)–(g): for turbine ship only.

2.11 Flushing of Pipes

Following piping systems shall be flushed with the following medium after being fitted on board.

Piping	System Applied	Flushing Method
Lub. oil piping	For main engine and stern tube	System shall be circulated by flushing oil or system oil.
	For generator engine	System shall be circulated by system oil.
Fuel oil piping	For main engine and boiler F.O. burning	System shall be circulated by Diesel oil.
	For D/G engine	System shall be blown out by compressed air.
Compressed air	For main engine starting air, aux. diesel engine starting air and control air	System shall be blown out by compressed air.
Hydro. oil piping	For steering engine (at the manufacturer) and deck machinery	System shall be circulated by flushing oil or operating oil.
	For remote control	System shall be circulated by operating oil, or blown out by nitrogen.
Steam piping	For steam supply line for steam driven machinery	System shall be blown out by steam.

2.11.1 Flushing of Main Diesel & Turbine Engine L.O. Pipe Lines

Before starting flushing, it must be confirmed that the L.O. sump tank, other L.O. tanks and the main engine crank case are properly cleaned and are ready for flushing.

It must also be confirmed that the temporary filters (about 200 mesh) are fitted in strainers, and magnets are properly installed.

The flushing temperature shall be in accordance with the recommendations of the oil manufacturers. (about 40°C – 55°C)

The flushing time shall be 24 hours. The completion of flushing shall be finally decided after checking the conditions of the temporary filters.

The flushing is considered to be completed when the filters have maintained a constant clean condition for over two (2) hours by periodical inspection.

2.11.2 Flushing of Generator Engine L.O. Pipe Lines

If pipes of the L.O. system are fitted by the engine manufacturer, no flushing for the system shall be required on board.

For pipes of the L.O. system which are manufactured and fitted by the shipyard, the flushing shall be required on board or at shore.

After flushing, the condition of the filters (about 200 mesh) in the strainers shall be checked in the same way as for the main engine.

2.11.3 Flushing of Stern Bearing L.O. Pipe Lines

Flushing shall be carried out by using system oil (or flushing oil) and the temporary filter (about 200 mesh) shall be installed in the L.O. pump strainer.

The finishing of flushing shall be decided in the same way as for the main engine L.O. pipe line.

2.11.4 Flushing of Main Engine F.O. Pipe Lines

Flushing shall be carried out by using "Diesel fuel oil" according to the following process:

The main engine F.O. inlet shall be connected to the return pipe by is temporary pipe and diesel shall be circulated by the booster pump at room temperature. 60 mesh filter shall be installed on the booster pump suction side to check the conditions of filteration.

2.11.5 Flushing of Main Boiler F.O. Pipe Lines

The F.o. supply lines to the main boiler shall be circulated by "Diesel fuel oil".

2. I I.6 Flushing of Steam Supply Lines for Steam Driven Machinery

Flange connection of main and aux. steam machinery (turbo generator, feed pump, ballast pump, tank cleaning pump and deck machinery. etc.) shall be detached and steam blow out shall be carried out for flushing these pipe lines.

2.11.7 Flushing of Starting and Control Air Pipe Lines

Starting air pipes for main & nux, engines and control air pipes shall be detached and opened at a position furthest from the air vessel, and the flushing shall be carried out by air blow out. For control air lines only main air lines shall be blown out. The root valve at branch to the controllers shall be closed during blow out.

2.11.8 Flushing of Main Boiler Feed Water ZPipe Lines

Flushing of these pipes shall be carried out by removing the cover of the feed pomp suction strainer, and let the water drop from the deacrating feed heater.

2.11.9 Flushing of Hydraulic Oil Pipe Lines

The flushing shall be carried out by circulation of flushing oil or operating oil, and a vinyl filter (150 - 200 mesh) shall be Installed for checking purpose. The finishing of the flushing shall be decided in the same way as for the main engine. Non-ferrous pipes for remote control may be blown out by nitrogen gas instead of flushing by oil.

2.12 Bolts for Pipe Flange Joint

JIS Standard hexagon head bolts and nuts of non-galvanized steel shall be generally used for pipe flange joints. Galvanized bolts and nuts shall be generally used in water tanks, weather decks, etc.

The length of bolts protruding from the nuts after tightening, shall be between zero and one half of the bolt diameter.

2.13 Pipe Supports

In General, steel supports and U-type bolts shall be applied to pipe lines at suitable intervals. Pipe supports for non-ferrous pipes shall be lined with copper, brass or neoprene. The length of the screw part of the U-type bolts, protruding from the nuts after tightening shall be between zero and one bolt diameter.

2.14 Piping Tests

Hydrostatic test of partial sections of piping may be carried out in order to check intermediate connections.

The whole system shall be Hydrostatic tested again at completion of the installation, to check the newly installed connections.

2.15 Non-Destructive Test for Butt Welded Joint

For the purpose of quality check and security of welded joints, the following non-destructive test shall be applied to welded joints designated by the Classification Society and/or any other parts considered necessary by the Builder.

(a) Radiographic Examination

(b) Magnetic particle Examination

3. HULL OUTFITTING PROCESS

3.1 Outfitting on Hull oBlocks

Out works on the hull works on the hull blocks shall be generally carried out in parallel with the assembling work of the hull blocks,

Fittings, such as pipes, bands, trunks, electric cable ways, etc. shall be fitted on the hull blocks at the assembling site.

3.2 Outfitting during Erection of Hull Blocks

In general, installation and outfitting works of machinery and electrical equipments etc. shall be carried out, in parallel with the erection of the hull blocks on the berth or in the dock.

3.3 Unit Assembly

In general, aux, machinery shall be assembled into appropriate units, togesther with their seats or beds, pipes, values, etc., in the shop, and then installed into thc vessel. After installing these assembled units into the vessel, the centering of the aux. machinery shall be checked by the builder, and corrections of the centering, if necessary, shall be made by shims,

Fittings, such as pipes, valves, ladders etc., which which do not contain any auxiliary machinery, shall be installed as a unit built up at ground

3.4 Outfitting of Living Quarter Construction

Internal outfitting, such as piping, ducting, pancling, cellling,flooring, etc. shall be done as far as practicable at the assembling site, three-dimensional structural blocks of one or multiple stortes.

In connection with the outfitting works, hydraulic tests or water tests of pipings fitted in the blocks, may be carried out individually at each block, and connection joints shall be checked on board after the whole installation has been completed,

3.5 Galvanizing of Fittings

3.5.1 Adhesiveness

The film of the galvanized surface shall not continuously peel off or become loose by hammering test (Re-galvanizing is required for defective parts) (To comply with JIS H-0401)

3.5.2 Appearance

Galvanized surfaces must be practically smooth and free from conspicuous defects, such as bare spots. (Details shall be in accordance with JIS H-8641)

Note: Damaged parts caused by gas cutting or welding shall be generally touched up by an approved zinc solution paint.

3.6 Rubber and Steering Gear

(1) In general, steering gear shall be assembled into appropriate units together with beds, pipings, etc., in the shop, and then installed into the vessel.

(2) Before boring the gudgeons, rudder stock centering shall be checked.

(3) After boring the gudgeons and/or the inserting bush case, rudder stock centering shall be carried out using transit or other suitable method.

(4) The bush shall be inserted into the bush case by force fitting in the shop.

(5) The bush case shall be machined up, based on the measurement of gudgeons' inside diameter, and/or the rudder stock centering record, and then inserted into gudgeon holes by chilled fitting or force fitting.

(6) After bush case insertion, rudder and rudder stock shall be fitted.

(7) Coupling bolts of rudder and rudder stock shall be inserted by chilled fitting or force fitting.

(8) Before launching, clearance of rudder bearings shall be checked finally

3.7 Deck Machinery (WindlassCargo Winch and Mooring Winch}

(1) In peneral, resin Iiner shall be used instread of Steel liner and tightness of holding down bolts shall be checked.

(2) Anchor test for windlass and load test for cargo winch shall be carried out, and the mooring winch shall be checked under the no load running.

3.8 Match Cover Match Coaming

3.8, 1 Accurancy in Construction

Item			Allowable Limit (mm)		
			Single pull type	Side rolling type	Pontoon type
Hatch cover	Length	1 set	± 7	± 7	± 7
		1 panel	± 4		
	Breadth	1 set	± 5	± 7	± 7
		1 panel		± 5	
	Height		± 3	± 3	± 3
	Diagonal	1 set	≤ 7	≤ 7	≤ 7
		1 panel	≤ 5	≤ 5	≤ 5
Hatch coaming	Length		±10	±10	±10
	Breadth		±10	±10	±10
	Diagonal		≤15	≤15	≤15
	Level of compression bar		± 5	± 4	± 3

3.8.2 Weather Tightness Test for Bulk, Orc Carrier and Container Ship (Except Oil Carrier)

After Installing installing on board, hose testy (with the pressure not less than 2kg/cm² and/or some other sultable testfo confirm the weather lightness of cross joints and compression packings shall be caried out.

3.8.3 Operation Test

Operation test shall be carried out using ship's driving device, and operating condition shall be checked.

3.8.4 Emergency Operation Test

Emergency operation test shall be carried out on one set of hatch cover by using one emergency device.

3.9 Air Conditioning Test

Air conditioning tests, such as tests for heating in summer or cooling in winter where the tests by automatic temperature control device cannot be carried out due to prevailing temperature conditions, shall be tested manually to ensure satisfactory operation of the machinery and equipments

3.10 Foam Fire Extinguishing Test

In view of "International convention for prevention of pollution of the sea", the substitutional test (sea water discharging etc.) for the above shall be carried out without discharging foam.

4. MACHINERY FITTING PROCESS

4.1 Shafting and Propeller

4.1.1 Main Shaft Alignment

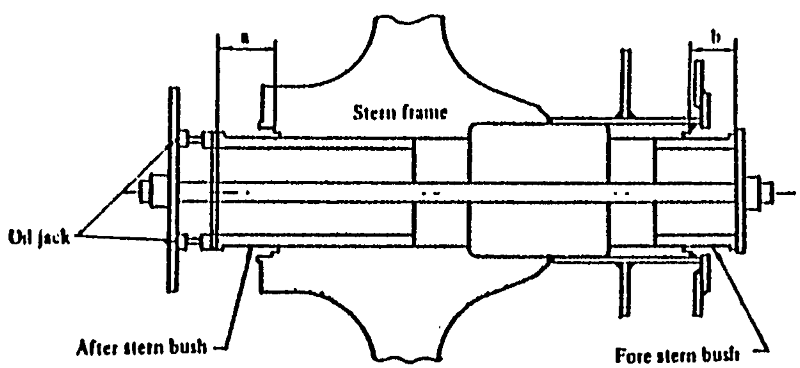
Shaft centering shall be carried out at following conditions.

A. Hull construction works, excepting minor internal welding, below the lower engine flat level and aft of the engine room forward bulkhead is completed and hydraulic tests for cooling space or void spaces are finished but the internal inspection of the hull construction mentioned above may not necessarily be finished.

B. For hull construction works below the steering engine flat, the surface welding for butts and seams of skin plates are finished.

C. Other hull construction works not mentioned above, shall be carried out in accordance with the Builder's construction schedule, irrespective of the shaft alignment.

4.1.2 Fitting of Stern Bush

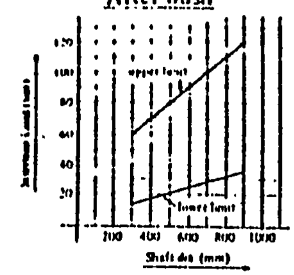


Pressure of the hydraulic power and load shall be measured during measurement of the distance of insertion.

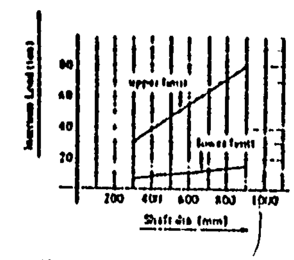
The measurement shall be recorded at the last 100mm (b) drive for forward bush and at the last 250mm (a) drive for the aft ward bush.

The bushes shall be inserted into the stern tube by the following insertion loads.

After bush



Fore bush



4.1.3 Contact Conditions of The Propeller Shaft and The Propeller

The key shall be fitted to the propeller shaft and blue paint shall be painted on the shaft to check contact condition of the cone-part of the shaft and the propeller boss.

Then the propeller shaft shall be removed from the boss, and the contacting surface of the cone-part shall be checked.

Acceptable contact condition of the cone-part shall be determined by cross contact of at least 4 points per 25 millimeter square.

4.1.4 Fitting of Propeller

The fitting stroke shall be decided considering temperatures of the propeller boss and shaft cone just before fitting.

4.1.5 Tightening-up of Propeller Nut

The propeller nut shall be tightened up to following final torque.

Shaft dia. D (mm)	Torque (ton-m)
300 ≤ D < 500	5 ~ 10
500 ≤ D < 700	10 ~ 15
700 and above	15 ~ 20

4.1.6 Tightness Test of Oil Seal

A. After installing the seals on the fore and aft part of the stern bearing and flushing, the oil shall be supplied to the stern bearing and the head tank up to the normal level corresponding to the full loaded condition, and then the level shall be maintained for at least 4 hours to check the leakage.

B. The bottom plugs of the seals shall be detached and the tightness of the seals shall be checked.

4.1.7 Connection of The Shaft

A. The reamer bolts and holes shall be checked to confirm the coincidence with the drawings by measuring its dimensions at the shaft couplings.

B. Reamer bolts and holes shall be painted with Moly-coat or equal, and then fitted together by using the hydraulic jack with a force of 3~20 tons or by other suitable methods, such as chilled bolt fitting and hammering.

4.2 Main Diesel Engine & Appurtenant Equipments

4.2.1 Force Fitting of Holding-Down Reamer Bolts

Reamer bolts and holes shall be painted with Moly coat or equal, and then the bolts shall be forced into the holes by using the hydraulic jack with a force of 1.5 – 15 tons or by other suitable methods such as chilled bolt fitting or hammering.

4.2.2 Installation of Main Engine

A. Hammering check shall be carried out to confirm that the chock liners are fitted in good condition, or that foundation bolts are well tightened, and also acceptable clearance of the chock liner shall be confirmed by the feeler gauge of 4/100mm thickness that it does not enter more than 10mm.

B. The deflection of crankshaft shall be measured by turning the crankshaft ahead using the turning gear if necessary.

The record of the deflections shall be compared with that taken at the cold condition after assembling, and the deflection should not exceed the following allowable limits recommended by the engine manufacturer.

Engine Type		Allowable Limit of Deflection mm
Sulzer	RND68	0.125
	RND76	0.155
	RND90	0.155
	RND105	0.180
Same as RND (M) Type		
Pielstick	PC2	0.056

4.3 Main Turbine & Appurtenant Equipment

4.3.1 Force Fitting of Holding-Down Reamer Bolts

Reamer bolts and holes shall be coated with Moly-coat or equal and then the bolt shall be forced into the holes by using the hydraulic jack with a force of 1.5 ~ 15 tons, or by hammering.

4.3.2 Alignment of Shafting

The alignment of the shafting, thrust blocks and main gear case shall be checked with the plumber blocks and the thrust block positioned with jack bolts, but the chock liners shall not be fitted underneath. While, under the main gear casing, only key liners shall be fitted at the center, and holding down bolts shall be tightened, but other parts shall be supported by jack bolts.

Centering measurement shall be carried out at faces of the coupling flanges by using straight blocks and feeler gauges or other appropriate method. Off-sets and tolerance shall be shown on the drawing. Good conditions of gear tooth contact shall be confirmed at this condition.

After fitting all chock liners and tightening the holding down bolts under the gear casing, the gear tooth contact shall be checked.

The 2nd reduction gear shaft, thrust shaft and intermediate shafts shall be connected with working coupling bolts, and the propeller shaft shall be connected with temporary bolts.

Chock liners shall be fitted under the plumber blocks and the thrust block, and holding down bolts shall be tightened.

Bearing reactions shall be measured by jacking up the shafting in accordance with the drawing. The allowable bearing load is shown in the drawing.

If the bearing load exceeds the allowable load, then the plummer blocks shall be adjusted, and the jack up test shall be repeated.

Clearance of plummer block bearing shall be finally checked.

4.3.3 Vacuum Test

Vacuum test shall be carried out when the pipes and accessories appurtenant to the main engine are installed, and the flushing of L.O. pipes, cooling water pipes and steam pipes shall be completed.

The operating conditions of appurtenant machinery and the water level of condensers shall be checked, and then the vacuum shall be raised by using the air ejector to confirm that the designed vacuum pressure is maintained.

After the ejector is stopped, the elapsing time of the vacuum drop shall be recorded to confirm that the vacuum drop is within 152mm Hg for an elapsing time of one hour.

4.3.4 Tooth Contact of The Reduction Gear

After completing the preliminary and official sea trials, the tooth contact of the reduction gear shall be examined by means of visual checking Dy-kon through the peep holes.

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4.4 Boiler

4.4.1 Hydrostatic Test on Board

Hydrostatic test shall be carried out in accordance with the classification rule requirements in case the boiler unit is assembled on board.

If the boiler unit is assembled and tested at shop in accordance with the classification rule requirements, only leakage test shall be carried out on board with a test pressure of 1.5 times the working pressure.

Hydrostatic test for smoke tube boilers shall not be carried out on board.

4.4.2 Soda Boiling

Soda boiling for water tube boilers shall be carried out to remove oil, grease, paint and alkaline formation at shop (I.H.I AIOI No. 2 Works), it shall not be done at shipyard.

4.5 Auxiliary Machinery

4.5.1 Diesel Generator

A. The fitting conditions of chock liners and the tightening of holding down bolts shall be checked.

Crankshaft deflection shall be measured at cold condition, and the deflection should not exceed the allowable limit recommended by the engine manufacturer.

B. The cleanliness in the crank case and the L.O. sump tank shall be checked.

4.5.2 Turbo Generator

A. The alignment shall be adjusted in accordance with the manufacturer's recommendation.

In case of a three-point supported turbo-generator set, only the gear tooth contact shall be checked.

B. The fitting conditions of chock liners and the tightening of holding down bolts shall be checked.

C. After sea trial, the tooth contact of the reduction gears shall be examined by visual checking through peep holes.

4.5.3 Turbine Driven Cargo Oil Pumps & Ballast Pumps

The fitting conditions of chock liners, and the tightness of holding down bolts of the pump and turbine shall be checked.

The alignment shall be checked by centering at the coupling flange by using a dummy or a working intermediate shaft. The allowable limit of the alignment shall be as follows.

For horizontal type:

0.5mm by rim reading and 0.25mm by face reading.

For vertical type:

1.00mm by rim reading and 0.5mm by face reading.

4.5.4 Shaft Alignment of Turbine Driven and Motor Driven Auxiliaries

The shaft alignment shall be checked by centering at the coupling. The allowable limit shall be 0.1mm by run and face reading.

4.5.5 Installation of Auxiliary Machinery

Installations of aux. machineries shall be carried out in accordance with the following three grades:

A. **Grade 1 Auxiliaries**

Tightness of the chock liner shall be checked by hammering after tightening the holding down bolts and confirming that a feeler gauge of 4/100mm thickness should not insert more than 10mm.

Grade 1 Auxiliaries include:

Generator set, plumber blocks, steering gear and aux. turbines.

B. **Grade 2 Auxiliaries**

Tightness of holding down bolts shall be checked by hammering at the time of the centering on board.

Grade 2 Auxiliaries include:

Pumps, fans, aux. condensers, gas air heaters, deaerators, ref. machines, emergency diesel generator and other rotating or reciprocating aux. machineries.

C. **Grade 3 Auxiliaries**

Tightness of holding down bolts shall be checked by hammering on board.

If the auxiliaries and the seats are assembled in a unit at the shop, such checking shall be performed at the shop.

Grade 3 Auxiliaries include:

Strainers, heaters (excepting Grade 2), coolers, electric apparatus and other statical aux. machinery and tanks.

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4.6 Overhauling Items

After finishing the sea trial, overhaul shall be carried out as follows to confirm that they arc in normal condition.

In addition to thc above, if abnormal condition were found out during running, the abnormal parts shall be opened and checked.

4.6.1 Main Diesel Engine

(a) Piston for 1 cylinder
(b) Crosshead pin and bearing for I cylinder
(c) Crank pin and bearhtg for I cylinder
(d) I set of main bewlng
(c) Injection test for all fuel valves
(f) Tooth contact check of reduction gear

4.6.2 Main Turbine and Reduction Gear

Tooth contact check

4.6.3 Main or Auxillary EBoiler

(a) Steam and water drums
(b) Furnace

4.6.4 Generasting Turbine

Tooth contact check through peep hole

4.6.5 Generating Diesel Engine

Injection test for all fuel valves

4.6.6 other

(a) Fuel oil and Lub, oil purifiers
(b) Sea water side of Main condenser
(c) Jacket cooling F.W. expansion tank
(d) Piston cooling F.W. filter tank
(c) Fuel valve cooling F.W. filter tank
(f) Feed water filter tank
(g) Atmospheric drain tank
(h) Strainers for fuel oil, Iub, oil, bilge and sea water

5. ELECTRIC FITTING PROCESS

5.1 Cable Installation

5.1.1 General

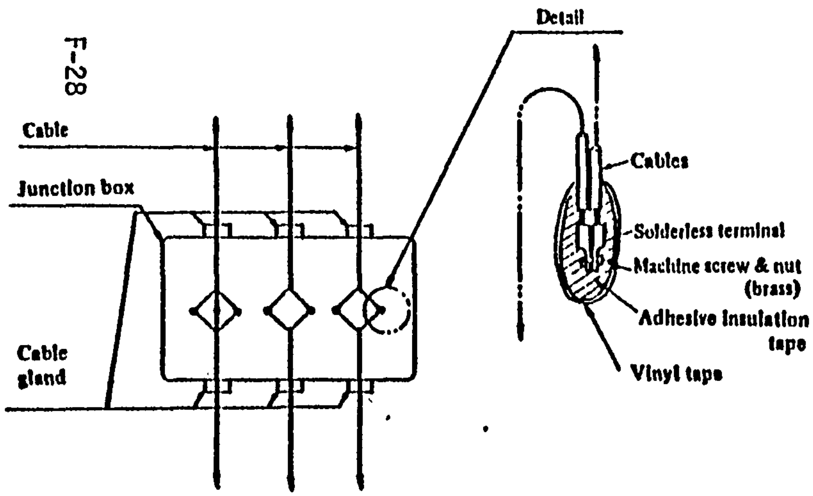
A. As far as practicable, cable ways shall be separated from oil, steam and hot water pipes.

B. In case intrinsically-safe cables pass through a hole in the hull structure together with other kinds of cables, the intrinsically-safe cables must be passed through a pipe for shielding.

C. Where cables penetrate through "A" or "B" class fire protective boundary divisions, non-combustible compound or fire resistant hard-setting compound shall be used as a sealing medium.

5.1.2 Cable Connection in Junction Box on Exposed Parts

Cables in Junction box of projectors, lights, etc. fitted on exposed weather spaces, shall be directly connected as shown in figure below, without using a terminal board in order to prevent decrease in insulation resistance.



5.2 Generator

5.2.1 Insulation Resistance

Before and after the running test, insulation resistance of the following circuits shall be measured by a 500 V megger.

(a)	Amature coil	to earth
(b)	Field coil	to earth
(c)	Space heater	to earth
(d)	Governor motor	to earth

For semiconductive rectifiers, a circuit tester shall be used.

5.2.2 Running Test

Each generator shall perform 1 hour continuous running either at full rated output load in Killo-watt of 100% power factor by water load or at practical ship's load. During this test, output, temperature, voltage, current, frequency etc. shall be measured.

5.2.3 Voltage and Speed Regulation Test

Momentary and permanent variation of voltage and speed shall be measured by suddenly taking off full load in Kilo-Watts, or by suddenly applying practical load after no-load running, by using either water load of 100% power factor or ship's load.

But in case the generator is coupled to a high super charged engine, the load is to be 60 or 70% of rated load under agreement of classification society.

5.2.4 Parallel Operation Test

A. Each generator, at 75% load, shall be adjusted so that the output load (at 75% load) becomes proportional to the nominal load.

B. The unbalance in active power of each individual generator, shall be checked at loads between 20% to 100% (such as 20%, 50%, 75%, 100%) of the total combined nominal load of each generator, and confirm that the difference between the load, proportionally shared from the nominal output of each generator, and the output of each generator, do not exceed the allowable limit of the nominal active power of the largest machine, and that the generators are running in suitable condition.

C. For series production ships, the unbalance of active power shall be confirmed by the load obtainable by running all auxiliaries available at test instead of using water load, providing approval by the classification society.

5.2.5 Safety Device Test for Generator Engine

The operation test shall be carried out on following devices.

(a) Over speed alarm & trip
(b) L.O. low pressure alarm & trip
(c) Cooling water high temperature alarm & trip
(d) Cooling water low pressure alarm
(e) High steam back pressure alarm & trip
(f) L.O. priming pump auto start & stop

5.2.6 Auto Starting, Auto Synchronizing and Auto Load Sharing Test

These operation tests shall be carried out in accordance with the test method for generator auto starting, auto synchronizing and auto load sharing.
(Refer to "THE TEST METHOD ON BOARD" issued by Design sec.)

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5.3 Transformer

5.3.1 Insulation Resistance

Insulation resistance of the following circuits shall be measured by a 500 V meggcr.

(a) Primary COII to secondary COIL.
(b) Primary coil and secondary COil to earth.

5.3.2 Operation Test

Voltage and current of primary and secondary sides shall be measured under the actual service conditlon.

5.4 Batteries and Charging Device

5.4.1 Charging Test

The charging function shall be checked by operation of the voltage regulator.

5.4.2 Discharging Test

The discharging condition shall be checked by switching on the battery lights.

5.5 Switchboard

5.5.1 Insulation Resistance

The lnsulation resistance between busbar and earth shell be measured by 500 V megger.

5.5.2 Generator Protective Device Test

For tile following device, the operation test shall be carried out to confirm trip condition.

(a) Overcurrent trip device
(b) Reverse power trip device
(c) Proferential trip device
(d) Under voltage trip device
(o) Interlock with space heater circuit
(f) lnterlock with shore power breaker

5.6 Motor and Control Gear

5.6.1 Insulation Resistance

The insulation resistance between the motor with control gear and the earth shall be measured by a 500V megger.

5.6.2 Operation Test

The voltage and currents shall be measured under service condition.

5.7 Accessories of Motor

5.7.1 Emergency Stop System Test for Motors

This test shall be carried out by operation of emergency stop push buttons or switch and this test may be carried out without running of motors.

5.7.2 Alarm System Test for Motors of Essential Machinery

This test may be carried out by operation of control gear without running of motor.

5.7.3 Sequential Starting System Test for Motors

Motors connected with this system shall start sequentially by disconnecting and connecting main power supply.

5.7.4 Automatic Change Over and/or Cut in System Test for Essential Working Machine with Standby Machine

The standby machine shall start automatically by artificial or actual failure of the working machine.

5.7.5 Automatic Start and Stop Test for Water, Oil and Air Controlling Machines

This operation test may be carried out by artificial working level or pressure switches.

5.7.6 Alarm Test for Steering Gear Motors

A. Over load alarm test
This test shall be carried out by manual tripping of the over current relay.

B. Stop alarm test
This test shall be carried out by operation of the control gear.

5.8 Heating Equipment and and Miscellaneous Electric Power Equipment

5.8.1 Insulation Resistance

Insulation resistance shall be measured by a 500 V megger.

5.8.2 Confirmation

The functioning of cooking range, baking oven, washing machine etc., shall be confirmed during actual services.

5.9 Radio, Nautical, Interior Communication and Control Equipment

5.9.1 Insulation Resistance

The insulation resistance shall be measured by a 500 V meggcr.

For semiconductive rectifiers, a circuit tester shall be used.

5.9.2 Confirmation

Functioning of following equipment shall be confirmed.

A. Radio telegraph , radio telephone and V.H.F. telephone (Including portable radio equipment for life boat).
Confirmation subjects 10 be as follows.
(a) The operation of auto alarm, auto keyer and emergency light.
(b) Power at each transmiltting frequency.
(c) Communication service between the ship's station and the coast stations.

D. Radio direction finder
The calibration shall be conducted as follows.

A radio station boat shall run clockwisc and counter-clock around the vessel, sending a signal wave of approximately 410 KIlz continuously.

Meanwhile the direction of the boat shall be detected on the vessel by means of the "Direction Finder" and the visual detector at every 5 or 10 degrees.

The error of the directionbetween tile direaction finder and the visual detector shall be calibrated, If possible.

The homing on the radiotelephone distress frequency shall be capable of taking direction finding beatings on that frequency without ambiguity of sense within each 30 degrees on either side of the bow.

Provided that, in case the homing capability cannot be achieved due to technical difficulties, exceptions of the administration requirements may be granted to such ships

C. Echo sounder

Its functions shall be confirmed during the sea trial.
Depth indication of the indicator or recorder shall be examined by comparing with the water depth of the chart.

D. Electric ship log and under water log

Its functions shall be confirmed during the sea trial.
The error of the under water log shall be examined by comparing with the results of the speed trial.

E. Radar

Its functions shall be confirmed during the sea trial.
The indication of some objects shall be checked and examined by comparing with the chart reading.

F. Gyro compass and Auto pilot

(a) Gyro compass
The gyro compass shall be checked for its indication and stabilization during sea trial.

(b) Auto pilot system
The functioning of the following items shall be confirmed during the sea trial.

(1) Manual steering
Manual steering shall be confirmed by turning the steering wheel and/or operating the non follow up controller.

(2) Automatic steering operation test during sea tiral.
The functioning of Automatic steering shall be confirmed by operation of the automatic course keeping and/or automatic course changing device.

(3) Off course alarm test

G. Following equipment shall be operated.

(a) Engine order telegraph
(b) Steam & Air horn (whistle)
(c) Rudder angle indicator
(d) Ref. chamber emergency calling bell
(e) Public addressor
(f) General alarm
(g) Electric temperature indicator
(h) Engineer's alarm device
(i) Tank liquid level detector
(j) CO_2 release alarm
(k) Fire alarm
(l) Extension alarm
(m) M/E control console
(n) Engine monitor & data logger

5.10 Lighting Equipment

5.10.1 Insulation Resistance

The insulation resistance shall be measured by a 500 V megger.

5.10.2 Confirmation

A. Electric navigation light

The functioning of following item shall be confirmed.

(a) Lamp fail alarm
(b) Power source change over

B. Signal and Warning Lights

Following items shall be lighted confirmation

(a) Anchor light
(b) Not under command light
(c) Dangerous cargo light
(d) Morse signal light
(e) Portable daylight signal light
(f) Daylight signal search light

C. General, emergency and/or battery lighting

Lighting test shall be carried out on each circuit and correct connections of the light fittings, switches and accessories shall be confirmed.

The automatic lighting system of the emergency and/or the battery light shall be operated.

5.11 Elevator

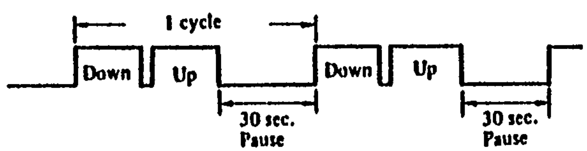
5.11.1 Insulation Resistance

This test shall be measured before and after running test by a 500 V megger.

For semiconductive rectifiers, a circuit tester shall be used.

5.11.2 Load Test

A. Return trip of fifteen times on a constant at cycle as undermentioned shall be carried out at rated load.



B. Overload test shall be carried out on one (1) return trip at 125% of rated load.

5.11.3 Level Test

This test shall be carried out at no load and at 100% of carrying loads.

5.11.4 Confirmation

Functioning of each apparatus shall be demonstrated under the actual service conditions.

5.11.5 Safety Device

Functioning of following Items shall be confirmed.

(a) Over travel limit switch
The cage shall be stopped by manual operation of the over travel limit switches.

(b) Governor trip device
Governor shall be tripped within the specified speed by manual acceleration of the guide wire without running the cage.

(c) Overload alarm device

(d) Manual operation of the cage downwards

(c) Escape from the cage

6. AUTOMATIC AND/OR REMOTE CONTROL EQUIPMENT INSPECTION PROCESS

6.1 General

The following machinery and/or apparatus equipped with automatic and/or remote control equipment shall be tested in accordance with the test methods described in this chapter, and the booklet "THE TEST METHOD ON BOARD", issued for each vessels.

(a) Main engine and its essential auxiliaries
(b) Steam generators
(c) Electric generating plant
(d) Fuel oil system
(e) Bilge system
(f) Cargo pumping system for tankers
(g) Ballast system
(h) Deck machinery
(i) Remote reading (control) equipment for draft, trim and heel
(j) Inert gas system

6.2 Operation Test for Equipment

As far as practicable operation test shall be carried out at working conditions. However, sensors, limit switch etc. which are composed of the equipment, may be operated manually or by a dummy circuit.

6.2.1 Main Engine

This test shall be carried out in accordance with the booklet, "THE TEST METHODS FOR AUTOMATIC AND/OR REMOTE CONTROL EQUIPMENT FOR MAIN ENGINE" which is issued separately for each vessel.

6.2.2 Auxiliary Machinery

The following equipment shall be checked as follows:

A. Oily bilge separator

Separation test shall not be performed, however, electro-magnetic valves for automatic oily bilge discharge, and indicating lights shall be checked.

B. Bilge Suction Test

In view of "INTERNATIONAL CONVENTION FOR PREVENTION OF POLLUTION OF THE SEA BY OIL", this test shall be carried out by some suitable method without discharging bilge out of the vessel.

6.2.3 Alarm System

Alarm system shall be checked at operation test of each sensor, excepting those systems linked with bridge area and/or accommodation quarters, which shall be tested separately.

6.3 Operation Test for Sensors

Sensors shall be tested by following methods.

6.3.1 Temperature Sensors

A. Thermal switch

Operation of thermal switch shall be checked by manual operation of contact of the thermal switch.

B. Thermo couple and resistance bulb

Setting point shall be checked by connecting a dummy.

C. Exception

For sensors which can not applied the above test methods, only electric circuit shall be checked.

6.3.2 Pressure Sensors

In principle, pressure sensors shall be tested at working pressure. However, the differential pressure switch, which having no differential pressure gauge, shall be checked by the compressed air into high pressure side.

6.3.3 Level Sensors

A. Air conversion type

This test shall be carried out by the compressed air into the conversion unit.

B. Float switch type

Mechnical and electrical operation of Ievel sensors shall be checked by winking the float manually or by other suitable methods.

C, Transistor amplifier type

Electrical operation shall be checked by dummy signals.

6,3.4 Electric Signal Converters

Equivalent test of electric signal converters shall becarricdont by using a simulator,

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7. PAINTING PROCESS

7.1 General

Paintine work shall basically follow the Builder's standard process as sicscribed hereon as well as the Q.I.S.S.P. (IIIII Quality & Inspection Stamdard for Ship's Painting) and shall also follow the paint manu-facturer's recommendation.

In general, painting work shall be proceeded in accordancc with the Builder's schedule which Is prepared and based on the Contract Specifications.

7.2 Surface Preparation

7.2.1 Standard of Dc-rusting

Refer to Q. I.S.S.P. Article 1.1

7.2.2 Standard of Surface Cleaning

Refer to Q. I.S.S.P. Article 1.2.

7.3 Hull Block Painting

After finishing the hull block construction works, coating shall be applied. Whenever the surface of the hull block is fully or partially cleaned, tile coating shall be applied to the cleaned surface in good time before it becomes rusted.

Outfitting works on the hull block, may be carded out before or after application of the coating, whichever suitable for the construc-lion schedule.

7.4 Correction of Slight Damages or Defects

Slight damages or defects, which have been miss detected at block inspection and found after surface preparation etc., shall be marked and left without treating and the whole other surfaces shall be ap-plied with the first coating, and after that, such damages or defects shall be treated by means of welding, chipping and/or grinding and then touched up with paint,

7.5 Finishing of Free Edges of Steel and welded Heads

In principle, free edges of steel members, such as those formed by gas cutting and/or welded beads shall not be finished by chipping and/or grinding if it is for printing purpose only.

Howevcr, the parts such as badly irregular beads and spatters which the Builder considers it necessary to grind off, shall be treated In accordance with the surface preparation shown in Photographic Standard Nos. 16,17,18,19 Of the IIII Q. I.S.S.P.

7.6 Painting for Fittings Manufactured By Subcontractors

in general, fittings which we manufactured by subeontractor shall be applied with I or 2 coals of anti-corrosive paint and/or finish-coated at the subeontractor's, and then embarked on board the vessel.

7.7 Film Thickness

7.7.1 Measuring Points of Film Thickness

Refer to Q.1.S.S.P. Article 2.1

7.7.2 Instruments for Measurement of Film Thickness

Refer to Q. I.S.S.P. Article 2.1

7.7.3 Measurement Method

Refer to Q. I.S.S.P. Article 2.1.

7.8 Surface of Final Coat

Refer to Q. I.S.S.P. Article 2.2

7.9 Inspection Iterm Subject to Attendance of The Buyer's Supervisors

Refer to Q. I.S.S.P. Article 3.1 & 3.2

8. INSPECTION

8.1 General

All necessary inspections shall be carried out, based on the contract specifications and the descriptions in this standard.

In principle, the inspections shall be carried out by the Builder's inspectors in accordance with the Builder's working schedule.

The Buyer's supervisors may attend the inspections which are required to be witnessed by the Buyer's supervisor, as listed in "LIST OF INSPECTION AND TESTING", and may take access to any part related to the construction of the vessel at any time, as long as it does not unreasonably disturb the Builder's working process.

8.2 Requirements and Comments of The Buyer's Supervisors

If there are any requirements or comments of the Buyer's supervisors, which provides alterations or changes to the approved Specification and/or plans, these requirements or comments must be indicated on the plans before the work is commenced, and to be subject to approval of the Buyer's head office. Any defects on function, material, or workmanship, must be reported to the Builder's inspection section, as soon as they are detected.

8.3 Request for Inspection by The Buyer's Supervisor

In addition to the specified inspections weekly schedule, the Builder may additionally request for the attendance of the Buyer's supervisor for inspection in writing, daily in advance indicating inspection items, and the time and site of the inspection.

The Builder shall provide all necessary arrangements to enable the Buyer's supervisor to attend the inspection at due time. The Buyer's supervisor shall attend these inspections at the appointed time irrespective of the normal hours. Some minor works which will be subject to inspection at the later stage, at completion, may be left unfinished at the supervisor shall continue the inspection to finish in reasonable time.

Failure of the representative, without proper causes, to be present at the tests and inspections, after due notice to him or to one of his assistants in case of his absense shall be deemed to be a waiver of his right to be present.

8.4 Subcontractor's Equipment

The Buyer shall be notified of what time and site of any sub-contractor's tests or inspections included in the "LIST OF INSPECTION AND TESTING"

If it is judged by the Builder that the quality control system of the sub-contractor is established satisfactorily and the required quality of the equipment is steadily maintained to the satisfaction of the Builder, the Builder may propose to the Buyer for omission of inspection or tests at sub-contractor's shop. And in case, similar type equipments (such as motors, pumps, etc.) are provided for the vessel shall be tested only one set of each type of equipments.

8.5 Communication between The Builder and The Buyer's Supervisors

The Builder's and the Buyer's supervisors shall communicate intimately with each other (to understand the details of construction schedule, test and inspection method etc. and to settle problems timely, if any.).

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8.6 Imported Equipments

Imported equipments shall be inspected on arrival at the shipyard by the attendance of the Buyer's supervisor and/or the Builder's inspections. (The shop test of those equipments shall be done with the attendance of Classification Society's surveyor and/or the manufacturer's inspector.).

8.7 Inspection of Hull Construction

8.7.1 Hull Block Inspection

The hull block inspection shall be carried out at the time when the construction of each block is finished.

If any fittings are fitted to the hull block, the hull block inspection shall be carried out without dismantling these fittings unless they make the inspection impossible.

8.7.2 Hull Internal Inspection

The internal inspection of the hull construction work in tanks and engine room, etc., shall be carried out when all works affecting strength and tightness of the hull construction are completed, if outfitting works in these spaces are left unfinished, the final inspection of these works shall be carried out when all outfitting works are completed.

8.7.3 Tank Test

In principle, each tank shall be tested by filling water up to the test head after finishing the internal inspection before launching.

But for tanks, which cannot apply water test before launching, due to problems in building process, shipyards facility, etc., only leak test shall be applied in lieu of water test, subject to agreement of classification society's surveyer.

NOTE:

(1) Leak Test

The leak test shall be conducted by either of these methods namely, "Air test", "Vacuum test", or "Air leakage test for fillet welds" at assembly and/or at erection stage after finishing welding works prior to application of coating. However, this test may be conducted after application of the coating, subject to agreement of classification society's serveyor.

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(a) Vacuum Test

The vacuum tester, as shown in the photograph, shall be used for detecting air leakage through butt welded joint and fillet welded joint, by creating inside the tester by an air ejector.

If any defect, such as blow holes, exists, the air leaking through the weld bead into the vacuum compartment can be easily detected by soap water solution applied on the surface in advance.

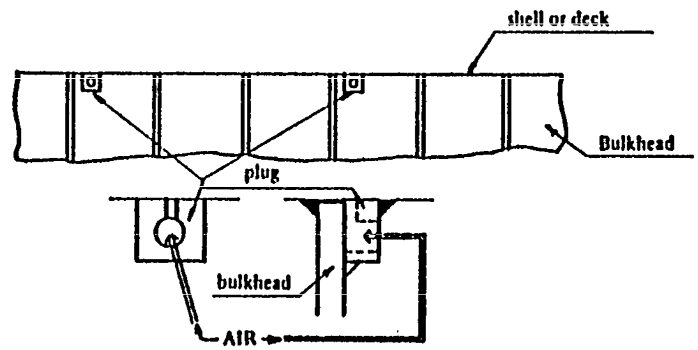
This test shall be applied to leakage test for

1. butt welded joints on double bottom, shell plating and bulkheads.
2. welded part of restored provisional access holes for workers.
3. fillet welded joint at tank boundary.

(b) Air leakage test for fillet welding

This method is used for detecting the leakage through fillet welds.

Compressed air shall be injected into the slit under fillet welds through a hole provided in the connection piece as shown in figure below. The air leakage through fillet welds can be detected by soap water solution.



(2) Structural Test

The structural test shall be confirmed by water testing the tanks, but for tanks which leak test has been applied, water test shall be conducted under the following condition;

(a) Working stages removed
(b) Consisted in remaining water
(c) Painting works finished

The structural test may be omitted for the 2nd and/or succeeding vessels of the same series, subject to agreement of classification society's surveyor.

8.7.4 Non-Destrictive Testing

For the purpose of quality check and the security of welded joints, the following non-destructive test shall be applied to the welded Joints designated by the Classification. Society and any other parts considered necessary by the Builder.

a. Radiographic Examination
b. Ultrasonic Testing
c. Magnetic Particle Examination
d. Dye Penetrant Examination

8.8 Material Test

Material test shall be carried out *for the* items required by the Classification Society rules, and shall be Inspected with the attendance of the Classification Society and/or the manufacturer's surveyors.

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SHIN-OTEMACHI BLDG.,
2-1,2 CHOME, OTEMACHI, CHIYODA-KU, TOKYO

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LIST OF INSPECTION AND TESTING
(FOR GENERAL)

CONTENTS

Remarks:

In this List O, C and R. markes show as follows.

O: To be witnessed by the Buyer's supervisor

C: To be witnessed by the Classification surveyor

R: Test records to be submitted to the Buyer's supervisor.

⊗: In case of issue of certificates for unmanned and/or automatic system

1. HULL PART

A. Hull Structural Construction

No.	Inspection Item	C	O	R	Remarks
1.	Block inspection for hull structure below main deck including main deck accommodation. (After completion of hull structural work for the block)	o			
2.	Internal inspection for hull structural tanks and spaces below main deck including main deck accommodation. (After completion of hull structural work for the tanks)	o	o		
3.	Hydrostatic test or air leak test of tanks, vacuum test & air leakage test for weld joint at tight boundary. (According to the rule of classification society.)	o	o		
4.	Flooding test for pump room, ref. hold and ref. chamber	o			
5.	Hose test for bulkheads, decks and access holes	o			
6.	Radiographic examination (According to the standard of JIS)	o			
7.	Keel sight (Before launching)	o	o	o	
8.	Measurement of molded depth (Before launching at [illegible])	o	o	o	
9.	Draft marks (Before launching)	o	o		
10.	Dead weight measurement	o	o	o	
11.	Bottom inspection in drydocking	o	o		
12.	Inclining experiment (Upon substantial completion and at the finished light condition)	o	o	o	
13.	Freeboard mark	o	o		
14.	Tonnage Deduction mark	o			
15.	General inspection (Before completion)		o		

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D. Hull Outfitting

No.	Inspection Item	Kind or Test or Inspection	In Shop C O R	On Board C O R	Remarks
L	Forgnig & Casting				
	1) Stem frame & rudder casting	Mag & ultra sonic test	0		
		Rough turn final Insp.	0 0		
	2) Rudder stock	Fitting Insp.	0 0		
	3) Rudder pintle	Fitting Insp.	0 0		
		Fitting Insp.	0		
	4) Reamer bolt for tudder	**Final Insp.**	0 0		
		Fitting Insp.		0	
2.	Stern frame	Int. insp.	0		
		Ah lest	0		
		Final isnp.	0 0		After Assembly
		Bush fitting insp.		0 0	
		Alignment insp. of rudder center line		0 0	
3.	Rudder	Int. Insp.	0		
		Ah test	0		
		Alignment Insp.	0		With stock & **pintle**
4.	Steerting gear arrangement				
	1) Steering gear	Running test (no load)	0		
		Parts inspection before assembly			

No.	Inspection Item	Kind of T Inspec
	2) Hydmrlic pipe	HYdrosta
	3) Tiller	Rough tu insp.
	4) TIM	Steering
	5) Safety valve	Working
5.	Mooring Arrangement	
	1) windlass	Running (no load
		Anchori
	2) Mooring winch	Running (no load
		Operatio (no toac
	3) Anchor	Drop &
		Identific marking
	4) Anchor chain	Proof t
		Drcak t
		Identifi marking
	5) Tow line	Proo
		Identifi markin
	6) Hawser	proof t
		Identifi markin

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
6.	Hatch cover & Door								
	1) Cargo hatch cover	Final insp.	o						
		Operation test				o	o		
		Hose test				o	o		
	2) W.T. hatch	Hydrostatic test, hose test or air test				o	o		
	3) W.T. Door (Below 1st tier)	Hose test				o	o		
7	Cargo Gear & Rigging Arrangement								
	1) Mast, derrick post & boom	Final inspection	o						
		Proof load test				o	o		
	2) Cargo winch	Running test	o		o				
		Working test				o	o		
	3) Loose gear	Load test				o	o		
	4) Cargo & Topping fall etc.	Load test				o	o		
	5) Misc. davits (1 ton & over)	Load test				o	o		
	6) Deck crane	Running test	o		o				
		Proof load test				o	o	o	
8.	Ventilation & Air Con. System								
	1) Mecha. vent. fan	Running test					o	o	
	2) Air conditioner (Mach.)	Running test			o				
		Hydrostatic test	o						

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
	3) Air conditioner (System)	Press. & leak test				o	o		
		Heating & Cooling test				o	o	o	
		Safety device test				o	o	o	
9	Side Scuttle & Window								
	1) Below 1st tier	Hose test				o	o		
	2) Others	Hose test					o		
10	Life Saving Equipment								
	1) Boat davit & winch	Load test	o						
	2) Life boat	Final inspection	o						
		Speed trial	o		o				
	3) Life boat with davit	Operation test				o	o	o	
	4) Safety equipment	Identification of marking				o	o		
	5) Other equipment	Identification of marking				o	o		
	6) Life raft	Fitting inspection	o						approved type
11	Piping System								
	1) Valve (Group 1 specified by Classification Rule)	Hydrostatic test	o						in scope of Rule requirement
	2) Cargo, stripping, bilge & ballast line in tank	Hydrostatic test				o	o		

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
	3) Heating coil in cargo tank & F.O. tank	Hydrostatic test				o	o		
	4) F.O. Transfer line	Hydrostatic test				o	o		
	5) All misc. pipe line in living quarter	Flooding or Hydrostatic test				o	o		In scope of Rule requirement
	6) Gas devourer & ejector	Running test					o		
	7) Bilge system	Suction test				o	o	o	
12.	Fire Fighting Arrangement								
	1) Fire pump & emergency fire pump	Running test	o		o				
		Starting test				o	o		
		Working test				o	o		
	2) Steam smothering	Load test				o	o		
	3) Foam liquid tank	Hydrostatic test	o						
		Final inspection	o						
	4) Foam fire extinguishibg system	Load test				o	o	o	
	5) CO_2 pipe line	press. test				o	o		
		Operation test by air				o	o		
	6) Fire line	Confirmation				o	o		
	7) Regulation of fire protection (SOLAS)	Inspection & operation				o	o		
	8) Equipment	Identification of marking				o			
13.	Accommodation Space								
	1) Laundry equipments	Working test					o		
	2) Galley equipments	Working test					o		
	3) All running System	Running test					o		
	4) Fire proof space	Final inspection				o	o		
	5) Finished inspection						o		
14.	Provision Refrigerating Plant								
	1) Ref. machinery (Compressor etc.)	Hydrostatic test	o						
		Running test	o		o				
	2) System	Press. & Leak test				o	o		
		Cooling test				o	o	o	
		Insulation test					o	o	
		Safety device test				o	o	o	
15.	Others								
	1) Suez search light door	Hose test				o	o		
	2) Tanks	Final inspection					o		
	3) Pilot ladder	Operation test				o	o		
	4) Accomm. ladder	Operation test					o		

2. MACHINERY PART

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
1.	Main Diesel Engine								
	1) Crank shaft	Final inspection	o		o				
	2) Coupling bolt of crankshaft	Final inspection	o						
	3) Thrust shaft	Final inspection	o		o				
	4) Crosshead pin	"	o		o				
	5) Connecting rod	"	o		o				
	6) Piston rod	"	o		o				
	7) Cyl. cover & insert	Hyd. test & Final inspection	o		o				
	8) Cyl. liner & jacket	"	o		o				
	9) Piston crown	"	o		o				
	10) Tie rod	Fitting inspection						o	
	11) Holding down reamer bolt	Fitting inspection						o	In case of jack fitting
	12) Chock liner	Fitting inspection				o	o		By feeler gauge, After tightened
	13) L.O. piping system	Flushing inspection					o		
	14) Crank case & L.O. sump tank	Cleaning inspection					o		After flushing
	15) Main diesel engine & related equipment after assembling	Running test	o	o	o				
		Safety device test	o	o	o	o	o	o	
		Governor test	o	o	o				
		Alignment inspection				o	o	o	Deflection reading

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
		Sea trial				o	o	o	
		Overhaul inspection	o	o		o	o		
2.	Main Turbine								
	1) H.P. & L.P. rotor shaft	Dynamic balance test	o		o				
	2) Main wheel	Tooth contact inspection	o						
	3) H.P. & L.P. turbine 1st & 2nd pinion	Tooth contact inspection	o						
	4) H.P. & L.P. turbine casing	Hydrostatic test	o						
	5) Holding down reamer bolt	Fitting inspection						o	In case of jack fitting
	6) Chock liner	Fitting inspection				o	o		By feeler gauge after Tightening
	7) L.O. piping system	Flushing inspection					o		
	8) L.O. sump tank	Cleaning inspection					o		After flushing
	9) Main steam line	Steam flushing insp.					o		
	10) Sole run pipe	Fitting insp.			o				Record by photo
	11) Main condenser	Vacuum test					o	o	
	12) Main turbine & related equipment after assembling	Centering alignment					o	o	
		Tooth contact insp.				o	o		After sea trial
		Running test (no load)	o	o	o				
		Safety device test	o	o	o	o	o	o	
		Sea trial				o	o	o	
		Overhaul inspection	o	o					

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
	13) Remote control equipment	Simulation test							
3.	Shafting and Propeller								
	1) Intermediate shaft	Final inspection	o		o				
	2) Propeller shaft	Final inspection	o		o				
		Face-up inspection of cone part	o		o				With propeller
	3) Propeller	Static balancing test	o		o				
		Final inspection	o		o				
		Fitting inspection				o	o	o	
	4) Stern tube bearing	Final inspection	o		o				
		Fitting inspection (After final machining)				o	o	o	
		Checking of propeller shaft position					o	o	By wear down gauge
	5) Shafting	Sighting inspection					o	o	
		Alignment insp.				o	o	o	Jack up insp. may be applied
	6) Stern tube seal	Tightness test	o			o	o		Before launching
	7) Coupling reamer bolt and nut	Final inspection	o		o				
		Fitting inspection				o	o	o	
	8) Stern tube L.O. system	Flushing inspection					o		
4.	Main Boiler								
	1) Drum	Radio Graphic examination	o						
		Inspect. before annealing	o						

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
		Hyd. test	o						
	2) Header	Inspect. before annealing	o						
	3) Safety valve	Working test				o	o	o	
	4) A.C.C. & F.W.C. system	Safety device test				o	o	o	
		Operation test				o	o		At sea trial
	5) Main boiler & related equipment after assembling	Hyd. test	o			o	o		
		Overhaul insp.	o			o	o		After soda boiling in shop after sea trial
	6) Superheater (After ass.)	Hyd. test	o						
		overhaul insp.	o						After soda boiling
5.	Aux. Boiler								
	1) Safety valve	Working test				o	o	o	
	2) A.C.C. and F.W.C. system	Safety device test				o	o	o	
		Operation test				o	o		
	3) Aux. boiler & related equipment after assembling	Hyd. test	o			o	o		Water tube boiler only
		Overhaul insp.	o			o	o		After soda boiling in shop after sea trial.
6.	Exh. Gas Economizer	Hyd. test	o						After assembling
		Working test of safety valve				o	o	o	
7.	Electric Generator								
	1) Generator Diesel engine	Working test	o		o	o	o	o	
		Safety device test	o		o	o	o	o	
		Fitting inspection				o	o	o	Deflection reading
		Overhaul insp.	o						

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No.	Inspection Items	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
	2) Generator turbine	Working test	o		o	o	o	o	
		Safety device test	o		o	o	o	o	
		Tooth contact insp.				o	o		After sea trial
		Overhaul insp.	o						
	3) Emergency generator	Working test			o	o	o	o	
		Safety device test			o	o	o	o	
8.	Turbo Driven Pump								
	1) Cargo oil pump & Ballast pump	Running test	o		o				
		Overhaul insp.	o						
		Fitting insp.						o	
		Working test					o		
		Safety device test	o		o	o	o	o	
	2) Main feed pump	Running test	o		o				Except imported pumps
		Fitting insp.						o	
		Safety device test	o		o	o	o	o	
		Working test					o		
	3) Aux. feed pump	Running test	o		o				Except imported pumps
		Fitting insp.						o	
		Safety device test				o	o	o	
		Working test					o		
	4) Tank cleaning pump	Fitting insp.						o	
		Safety device test					o	o	
		Working test					o		

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
9.	Steam Driven Pump								
	1) Stripping pump	Running test & overhaul insp.			o				
		Working test					o		
10.	Motor Driven Pump								
	1) Cooling sea water pump (for diesel ship)	Running test	o		o				
		Overhaul insp.	o						
		Fitting insp.						o	
		Working test					o		
	2) Jacket cooling fresh water pump (for diesel ship)	Running test	o		o				
		Overhaul insp.	o						
		Fitting insp.						o	
		Working test					o		
	3) Piston cooling fresh water pump (for diesel ship)	Running test	o		o				
		Overhaul insp.	o						
		Fitting insp.						o	
		Working test					o		
	4) Reserve cooling water pump (for diesel ship)	Running test	o		o				
		Overhaul insp.	o						
		Fitting insp.						o	
		Working test					o		
	5) L.O. pump	Running test	o		o				
		Overhaul insp.	o						
		Fitting insp.						o	
		Working test					o		

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
	6) Ballast pump	Running test	o		o				
		Overhaul insp.	o						
		Fitting insp.						o	
		Working test					o		
	7) Main circulating pump (for turbine ship)	Running test	o		o				
		Overhaul insp.	o						
		Fitting insp.						o	
		Working test					o		
	8) Aux. circulating pump (for turbine ship)	Running test	o		o				
		Overhaul insp.	o						
		Fitting insp.						o	
		Working test					o		
	9) Main condensate pump (for turbine ship)	Running test	o		o				
		Overhaul insp.	o						
		Fitting insp.						o	
		Working test					o		
	10) F.O. burning pump (for turbine ship)	Running test	o		o				
		Overhaul insp.	o						
		Fitting insp.						o	
		Working test					o		
11.	Forced Draft Fan								
	1) Main forced draft fan (for turbine ship)	Running test	o		o				
		Overhaul insp.	o						
		Fitting insp.						o	
		Working test					o		
	2) Aux. forced draft fan	Fitting insp.						o	
		Working test					o		
12.	Air Compressor and Air Reservoir								
	1) Main air compressor	Air charging test	o		o	o	o	o	
		Overhaul insp.	o						
		Safety valve test	o		o	o	o	o	
		Safety device test	o		o	o	o	o	
	2) Aux. air compressor	Air charging test	o		o				
		overhaul insp.	o						
		Safety valve test				o	o	o	
		Safety device test					o	o	
	3) Main air reservoir	Hyd. test	o						
		Safety valve test				o	o	o	
	4) Aux. air reservoir	Hyd. test	o						In scope of rule requirement
		Safety valve test				o	o	o	
13.	Heat Exchanger								
	1) Jacket cooling fresh water cooler (For diesel ship)	Hyd. test	o						
	2) Piston cooling fresh water cooler (For diesel ship)	Do.	o						
	3) Aux. condenser	Do.	o						
	4) Main condenser (For turbine ship)	Do.	o						
	5) Feed water heater	Do.	o						In scope of rule requirement

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
	6) Lub. oil & F.O. heater	Do.	o						
14.	Misc. Aux. Machinery								
	1) Fresh water generator or distilling plant	Capacity test					o	o	
	2) Oily water separator	Operation test of discharge valve					o		
	3) Oil purifier	Running test	o		o				
		Safety device test	o			o	o		
		Operation test					o		
	4) Overhead crane	Running test	o		o				
		Operation test					o		
	5) Work shop machine	Operation test					o		
	6) Incinerator	Safety device test	o			o	o	o	
		Operation test					o		
	7) Aux. machinery automatic device	Operation test					o		
15.	Others								
	1) Valve (Group 1 specified by classification rule)	Hydrostatic test	o						In scope of rule requirement
	2) Fire extinguisher	General insp.				o	o		
	3) Emergency gear system	Working test				o	o		
	4) Tanks (in engine room)	Hydrostatic test	o						
		Cleaning insp.					o		L.O. & F.O. cleaned oil tank
	5) Hychrorator	Operation test					o		
	6) Spare & tool	Checking and insp.					o		
16.	Pipe								
	1) F.O. pipe line	Hydrostatic test	o			o	o		In scope of rule requirement
	2) Main steam pipe	Hydrostatic test	o			o	o		
	3) Main feed water line	Hydrostatic test	o			o	o		
	4) Heating coil in tank	Hydrostatic test	o						
	5) Bilge line	Suction test				o	o		
	6) Foam fire extinguishing line	Blow test				o	o		By sea water or air
	7) Steam smothering line	Operation test				o			
	8) Hydraulic oil pipe	Hydrostatic test	o			o	o		In scope of rule requirement

3. ELECTRIC PART

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
1.	A.C. Generator	Temperature rise test	0	0					
		Charactcsistic test	0	0					
		Over current test	0	0					
		Over speed test	0	0					
		Insulation resist test	0	0				o	
		High volt age test	0	0					
		Operation test					0	0	
2.	Teansformer (100KVA & over)	Temperature rise test	0	0					
		Insulation resist test	0	0				o	
		High voltage test	0	0					
		Operation test						o	
3.	Battery and charging device	Opertion test					0		
4.	Main switchboard	Temperature test test	0	0					
		Insulation resist test	0	0				o	
		High voltage test	0	0					
		Operation test				ⓧ	0	0	
		Safety device test	0	0		0	0	0	
5.	Motor for aux. machinery and control gear								
	1) Motor of 100 KW and over (for essential service)	Temperature rise test	0	0					LR: 7SKW & over DV: 10KW & over
		Insulation resist test	0					0	
		High millage test	0						
		Operation test						0	
	2) Motor less than 100 KW (for esscntial service)	Temperature rise test	o						
		Insulation resist test	0					0	
		High Voltage test	0 0						
		Operation test						0	
	3) Starter (for essential service)	Insulation teatst test	0					0	
		High voltage test	0						
		Operation test	0						
6.	**Accessories of Motor**								
	1) Emergency stop for motor	Operation test				0			
	2) Alram system for essential ma- chincsy's motor	Operation test				ⓧ	0		
	3) Sequential starting system motor	Operation test				ⓧ	0		
	4) Automatic chang- ing system for essential Servicc machinary	operation test				ⓧ	0		
	5) Automatic start & stop for water, oil & sir controlling machinery	Operation test					0		
	6)Alarm system for stewing gear motor	Operation test					0		
7.	**Insulation resistance for circuit**	**Measuring test**					**0**		

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
8.	Radio nautical, Interior Communication and Control Equipment								
	1) Radio equipment	Insulation resist. test			o	o		o	
		Operation test			o	o	o	o	
	2) Direction finder	Calibration				o	o	o	
	3) Echo sounder	Operation test					o		
	4) Electric ship log & under water log	Operation test						o	
	5) Radar	Operation test					o		
	6) Gyro compass & auto pilot	Operation test					o		
	7) Engine order telegraph	Operation test					o		
	8) Steam & air horn	Operation test					o		
	9) Rudder angle indicator	Calibration					o		
	10) Ref. chamber emergency calling bell	Operation test					o		
	11) Public addressor	Operation test					o		
	12) General alarm	Operation test				o	o		
	13) Electric temperature indicator	Operation test				⊗		o	
	14) Engineer's alarm device	Operation test				⊗	o		
	15) Tank liquid level detector	Operation test				⊗	o		
	16) CO_2 release alarm	Operation test				o	o		
	17) Fire alarm	Operation test				⊗	o		

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
	18) Extension alarm	Operation test				⊗	o		
	19) M/E control console	Operation test	⊗		o	⊗	o		
	20) Engine monitor & data logger	Operation test	⊗			⊗	o		
9.	Lighting Equipment								
	1) Electric navigation light	Operation test				o	o		
	2) Signalling and Warning lights								
	(1) Anchor light	Operation test				o	o		
	(2) Not under command light	Operation test				o	o		
	(3) Tanker light	Operation test					o		
	(4) Morse signal lights	Operation test					o		
	(5) Portable daylight signal light	Operation test				o	o		
	(6) Daylight signal light	Operation test				o	o		
	(7) Misc, signalling and warning lights	Operation test					o		
	3) General lighting								
	(1) Emergency and/or battery light	Operation test				o	o		
	(2) Boat light	Operation test				o	o		
	(3) Pilot ladder light	Operation test					o		
10.	Elevator	Level test					o	o	

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
		Operation test					o	o	
		Safety device test					o	o	

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4. AUTOMATIC AND/OR REMOTE CONTROL EQUIPMENT

No.	Inspection Item	On Board C	On Board O	On Board R	Remarks
1.	The main engine and its essential auxiliaries	⊗	o	o	
2.	Steam generator	⊗	o	o	
3.	Electric generating plant	⊗	o	o	
4.	Fuel oil systems		o		
5.	Bilge systems	⊗	o		
6.	Cargo pumping systems for tanker		o		
7.	Ballast systems		o		
8.	Deck machineries		o		
9.	Remote reading (control) equipment for draft, trim and heel		o		
10.	Inert gas systems		o		

5. PAINTING

No.	Inspection Item	On Board C O R	Remarks
1.	The surface of special paint In tank before removal of seaffolding	0	
2.	The surface of final coating for outside of bottom shell at final docking	0	
3.	*Sea chest* before before closed	0	

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LIST OF INSPECTION AND TESTING

(FOR "F"-SERIES)

CONTENTS

Remarks:

In this List O, C R. markes show as

O: To be witnessed by the Buyer's supervisor

C: To be witnessed by the Classification surveyor

R: Test records to be submitted to the Buyer's

⊗: In case of issue of certificates for m nn and/or automatic system

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1. HULL PART

A. HuII Structral Construction

No	Inspection Item	C	O	R	Remarks
1	Block Inspection for hull structure below main deck including main deck accommo-dalion, (After completion of hull structural work for the block)	0			
2.	Interal Inspection for hull strurctural tanks and spaces below main deck Including main deck accommodation. (After completion of hull structural work for the tanks)	0			
3.	Hydrostatlc test or air leakage test of tanks (According to the rule of classification socictles)	0			
4.	Hose test for bulkheads, decks	0			
5.	Radirographic exambiation	0			
6.	Keel sight (Befre Iaunching)	0		0	
7.	Measurement of molded depth (Before launching at)	0		0	
	Draft marks (Before Iaunching)	0	0		
9.	Dead weight measurement	0	0	0	
10,	Bottom inspaction In drydocking	0	0		
11.	Inclining experiment (Upon substantial complction and at the finished light condition)	0	0	0	1st ship only fot each clas
12.	Freeboard mark	0			
13.	Tonnage deduction mark	0			
14.	General Inspection (before completion)	0			

D. Hull Outfitting

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
1.	Forging & casting								
	1) Stern frame & rudder casting	Mag & ultra sonic test	o						
		Rough turn final insp.	o		o				
	2) Rudder stock	Final insp.	o		o				
	3) Rudder pintle	Final insp.	o		o				
		Fitting insp.	o						
	4) Reamer bolt for rudder	Final insp.	o		o				
		Fitting insp.				o			
2.	Stern frame	Int. insp.	o						
		Air test	o						
		Final insp.	o		o				After assembly
		Bush fitting insp.				o			
		Alignment insp. of rudder center line				o		o	
3.	Rudder	Int. insp.	o						
		Air test	o						
		Alignment insp.	o		o				with stock & pintle
4.	Steering gear arrangement								
	1) Steering gear	Running test (no load)	o		o				
	2) Hydraulic pipe	Hydrostatic test	o						
	3) Tiller	Rough turn final insp.	o		o				
	4) Trial	Steering test				o	o	o	
	5) Safety valve		o		o	o	o		
5.	Mooring Arrangement								
	1) Windlass	Running test. (no load)	o		o				
		Anchoring test				o	o	o	
	2) Mooring winch	Running test (no load)			o				
	3) Anchor	Drop & proof test	o						
		Identification of marking				o			
	4) Anchor chain	Proof test	o						
		Break test	o						
		Identification of marking				o			
	5) Tow line	Final insp.				o			
	6) Hawser	Final insp.				o			
6.	Hatch cover & Door								
	1) Cargo hatch cover	Final insp.	o						
		Operation test				o	o		
		Hose test				o	o		
	2) W.T. hatch	Hydrostatic, test hose test or air test				o	o		
	3) W.T. Door (Below 1st tier)	Hose test				o	o		
7.	Cargo Gear & Rigging Arrangement								
	1) Mast Derrik post & boom	Final insp.	o						

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
		Proof load test				o	o	o	
	2) Cargo winch	Running test	o		o				
		Working test				o	o	o	During cargo gear test
	3) Loose gear	Load test			o	o	o		
	4) Cargo & Topping fall etc.	Load test			o	o	o		
	5) Misc. davit (1 ton & over)	Load test				o		o	
	6) Deck crane	Running test	o		o				
		Proof load test				o	o	o	
8.	Ventilation & Air Con. System								
	1) Mecha. vent. fan	Running test						o	
	2) Air conditioner (Mach.)	Running test			o				
		Hyd. test	o						
	Air conditioner (System)	Press & leak test				o	o		
		Heating & Cooling test					o	o	
		Safety device test				o	o	o	
9.	Side Scuttle & Window								
	1) Below 1st tier	Hose test				o			
10.	Life Saving Equipment								
	1) Boat davit & winch	Load test	o						
	2) Life boat	Final inspection	o						
		Speed trial	o		o				
	3) [illegible]	[illegible]				o	o	o	

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
	4) Safety equipment	Identification of marking				o			
	5) Life raft	Fitting insp.				o			approved type
11.	Piping System								
	1) Valve (Group 1 specified by Classification Rule)	Hydrostatic test	o						in scope of Rule requirement
	2) Cargo, stripping, bilge & ballast line in tank	Hydrostatic test				o			
	3) Heating coil in F.O. tank	Hydrostatic test				o			
	4) F.O. Transfer line	Hydrostatic test				o			
	5) All misc. pipe line in living quarter	Flooding or Hydrostatic test				o			in scope of Rule requirement
	6) Bilge system	Suction test				o	o		
12.	Fire Fighting Arrangement								
	1) Fire pump & emergency fire pump	Running test	o		o				
		Working test				o	o		
	2) Foam liquid tank	Hydrostatic test	o						
	3) Foam fire Extinguish system	Operation test				o	o		
	4) CO_2 pipe line	Press. test				o			
		Operation test by air				o	o		
	5) [illegible]	Confirmation				o	o		
	6) [illegible]	[illegible]				o			

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
	7) Equipment	Identification of marking				o			
13.	Accommodation Space								
	1) Laundry equipments	Working test					o		
	2) Galley equipments	Working test					o		
	3) All running system	Running test					o		
	4) Fire proof space	Final inspection				o			
	5) Finished inspection						o		
14.	Provision Refrigerating Plant								
	1) Ref. Machinery (Compressor & etc.)	Hyd. test	o						
		Running test	o		o				
	2) System	Press. & Leak test				o			
		Cooling test					o	o	
		Insulation test					o	o	
		Safety device test				o	o	o	
15.	Others								
	1) Suez search light door	Hose test				o			
	2) Tanks	Final inspection					o		
	3) Pilot ladder	Operation test				o	o		
	4) Accomm. ladder	Operation test					o		

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2. MACHINERY PART

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
1 A.	Main Diesel Engine	(For Sulzer)							
	1) Crank shaft	Final inspection	o		o				
	2) Coupling bolt of crankshaft	Final inspection	o						
	3) Thrust shaft	Final inspection	o		o				
	4) Crosshead pin	"	o		o				
	5) Connecting rod	"	o		o				
	6) Piston rod	"	o		o				
	7) Cyl cover & Insert	Hyd. test & Final inspection	o		o				
	8) Cyl. liner & jacket	"	o		o				
	9) Piston crown	"	o		o				
	10) Fuel O. Pump & exhaust valve	Setting			o				
	11) Tie rod	Fitting inspection			o				
	12) Chock liner	Fitting inspection				o	o		By feeler After tig
	13) L.O. piping system	Flushing inspection					o		
	14) Crank case & L.O. sump tank	Cleaning inspection					o		After flu
	15) Main diesel engine & related equipment after assembling	Running test	o	o	o				
		Safety device test	o	o	o	o	o	o	
		Governor test	o	o	o				
		Alignment inspection			o	o	o	o	Deflectio reading

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
		Sea trial				o	o	o	
		Overhaul inspection	o	o		o	o		
1B.	Main Diesel Engine (For Pielstick)								
	1) Crank shaft	Final inspection	o		o				
	2) Coupling bolt of crankshaft	Final inspection	o						
	3) Piston rod	Final inspection	o						
	4) Piston pin	Final inspection	o						
	5) Gear	Final inspection	o						
	6) Cam shaft	Final inspection	o						
	7) Pump	Final inspection	o						
	8) Air cooler	Final inspection	o						
	9) Cyl. cover & insert	Hyd. test & final inspection	o						
	10) Cyl. liner & jacket	Hyd. test & final inspection	o						
	11) Tie rod	Fitting inspection	o						

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
2.	Shafting and Propeller								
	1) Intermediate shaft	Final inspection	o		o				
	2) Propeller shaft	Final inspection	o		o				
		Face-up inspection of cone part	o		o				With propeller
	3) Propeller	Static balancing test	o		o				
		Final inspection	o		o				
		Fitting inspection				o	o	o	
	4) Stern tube bearing	Final inspection	o		o				
		Fitting inspection (After final machining)				o	o	o	
		Checking of propeller shaft position					o	o	By wear down gauge
	5) Shafting	Sighting inspection						o	
		Alignment insp.				o	o	o	Jack up insp. may be applied
	6) Stern tube seal	Tightness test	o			o			Before launching
	7) Coupling reamer bolt and nut	Final inspection	o		o				
3.	Aux. Boiler								
	1) Safety valve	Working test				o	o	o	
	2) A.C.C. and F.W.C. system	Safety device test				o	o	o	
		Operation test				o	o		

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No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
	3) Aux. boiler & related equipment after assembling	Hyd. test	o						Water tube boiler only
		Overhaul insp.	o			o	o		After sea trial
4.	Exh. Gas Economizer	Hyd. test	o						After assembling
		Working test of safety valve				o	o	o	
5.	Electric Generator								
	1) Generator Diesel engine	Working test	o		o	o	o	o	
		Safety device test	o		o	o	o	o	
		Fitting inspection				o		o	Deflection reading
		Overhaul insp.	o						
	2) Emergency generator				o	o	o	o	
		Safety device test			o	o	o	o	
6.	Moto. Driven Pump								
	1) Cooling sea water pump	Running test	o		o				
		Overhaul insp.	o						
		Fitting insp.						o	
		Working test					o		
	2) Jacket cooling fresh water pump	Running test	o		o				
		Overhaul insp.	o						
		Fitting insp.						o	
		Working test					o		
	3) Piston cooling fresh water pump	Running test	o		o				
		Overhaul insp.	o						
		Fitting insp.						o	

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
		Working test					o		
	4) Reserve cooling water pump	Running test	o		o				
		Overhaul insp.	o						
		Fitting insp.						o	
		Working test					o		
	5) L.O. pump	Running test	o		o				
		Overhaul insp.	o						
		Fitting insp.						o	
		Working test					o		
	6) Ballast pump	Running test	o		o				
		Overhaul insp.	o						
		Fitting insp.						o	
		Working test					o		
7.	Air Compressor and Air Reservoir								
	1) Main air compressor	Air charging test	o		o	o	o	o	
		Overhaul insp.	o						
		Safety valve test	o		o	o	o	o	
		Safety device test	o		o	o	o	o	
	2) Aux. air compressor	Air charging test	o		o				
		Overhaul insp.	o						
		Safety valve test				o	o	o	
		Safety device test					o	o	

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
	3) Main air reservoir	Hyd. test	o						
		Safety valve test				o	o	o	
	4) Aux. air reservoir	Hyd. test	o						In scope of rule requirement
		Safety valve test				o	o	o	
8.	Heat Exchanger								
	1) Jacket cooling fresh water cooler	Hyd. test and final insp.	o						
	2) Piston cooling fresh water cooler	Do.	o						
	3) Aux. condenser	Do	o						
	4) Feed water heater	Do.	o						In scope of rule requirement
	5) Lub. oil & F.O. heater	Do	o						
9.	Misc. Aux. Machinery								
	1) Fresh water generator	Capacity test					o	o	
	2) Oily water separator	Operation test of discharge valve					o		
	3) Oil purifier	Running test	o		o				
		Safety device test	o			o	o		
		Operation test					o		
	4) Overhead crane	Running test	o		o				
		Operation test					o		
	5) Work shop machine	Operation test					o		
	6) Incinerator	Safety device test	o			o	o	o	

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
		Operation test					o		
	7) Aux. machinery automatic device	Operation test					o		
10.	Others								
	1) Valve (Group 1 specified by classification rule)	Hydrostatic test	o						In scope of rule requirement
	2) Fire extinguisher	General insp.				o	o		
	3) Emergency gear system	Working test				o	o		
	4) Tanks (In engine room)	Hydrostatic test	o						
		Cleaning insp.					o		L.O. & F.O. cleaned oil tank
	5) Spare & tool	Checking and insp.					o		
11.	Pipe								
	1) F.O. pipe line	Hydrostatic test	o			o			In scope of rule requiremen
	2) Heating coil in tank	Hydrostatic test	o						
	3) Bilge line	Suction test				o	o		
	4) Foam fire extinguishing line	Blow test				o	o		By sea water or air
	5) Steam smothering line	Operation test				o			
	6) Hydraulic oil pipe	Hydrostatic test	o			o			In scope of rule requiremer
	7) Starting air line	Hyd. test	o						
	8) Aux. boiler feed water discharge line	Hyd. test	o						

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
	9) Boiler blow off line	Hyd. test	o						
	10) Exhaust gas heater circulating water line	Hyd. test	o						

3. ELECTRIC PART

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
1.	A.C. Generator	Temperature rise test	o		o				
		Characteristic test	o		o				
		Over current test	o		o				
		Over speed test	o		o				
		Insulation resist test	o		o	o		o	
		High voltage test	o		o				
		Operation test				o	o	o	
2.	Transformer	Temperature rise test	o		o				
		Insulation resist test	o		o			o	
		High voltage test	o		o				
		Operation test						o	
3.	Main switchboard	Temperature rise test	o		o				
		Insulation resist. test	o		o			o	
		High voltage test	o		o				
		Operation test				⊗	o	o	
		Safety device test	o		o	o	o	o	
4.	Motor for aux. machinery and control gear								
	1) Motor of 100 KW and over (for essential service)	Temperature rise test	o		o				LR: 75KW & ov BV: 10KW & ov
		Insulation resist test	o		o			o	

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
		High voltage test	o		o				
	2) Motor less than 100 KW (for essential service)	Temperature rise test	o		o				
		Insulation resist test	o		o			o	
		High voltage test	o		o				
	3) Starter (for essential service)	Insulation resist test	o		o			o	
		High voltage test	o		o				
		Operation test	o		o				
5.	Accessories of Motor								
	1) Emergency stop for motor	Operation test				o	o		
	2) Alarm system for essential machinery's motor	Operation test				⊗	o		
	3) Sequential starting system motor	Operation test				⊗	o		
	4) Automatic changing system for essential service machinery	Operation test				⊗	o		
	5) Automatic start & stop for water, oil & air controlling machinery	Operation test					o		
	6) Alarm system for steering gear motor	Operation test				o	o		
6.	Radio nautical, Interior Communication and Control Equipment								
	1) Radio equipment	Insulation resist. test			o	o		o	
		Operation test			o	o	o	o	
	2) Direction finder	Calibration					o	o	

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No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
	3) Echo sounder	Operation test					o		
	4) Electric ship log & under water log	Operation test					o		
	5) Radar	Operation test					o		
	6) Gyro compass & auto pilot	Operation test					o		
	7) Engine order telegraph	Operation test					o		
	8) Steam & air horn	Operation test					o		
	9) Rudder angle indicator	Calibration					o		
	10) Ref. chamber emergency calling bell	Operation test					o		
	11) Public addressor	Operation test					o		
	12) General alarm	Operation test				o	o		
	13) Engineer's alarm device	Operation test				⊗	o		
	14) CO_2 release alarm	Operation test				o	o		
	15) Fire alarm	Operation test				⊗	o		
	16) Electric clock	Operation test					o		
	17) Extension alarm	Operation test				⊗	o		
	18) M/E control console	Operation test	⊗		o	⊗	o		
	19) Engine monitor & data logger	Operation test	⊗		o	⊗	o		
7.	Lighting Equipment								
	1) Electric navigation light	Operation test				o	o		

No.	Inspection Item	Kind of Test or Inspection	In Shop C	In Shop O	In Shop R	On Board C	On Board O	On Board R	Remarks
	2) Signalling and Warning lights								
(1)	Anchor light	Operation test				o	o		
(2)	Not under command light	Operation test				o	o		
(3)	Morse signal lights	Operation test				-	o		
(4)	Portable day-light signal light	Operation test				o	o		
(5)	Misc. signalling & warning light	Operation test					o		
	3) General lighting								
(1)	Emergency and/or battery light	Operation test				o	o		
(2)	Boat light	Operation test				o	o		

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4. AUTOMATIC AND/OR REMOTE CONTROL EQUIPMENT

No.	Inspection Item	On Board C	On Board O	On Board R	Remarks
1.	The main engine and its essential auxiliaries	⊗	o	o	
2.	Aux. boiler	⊗	o	o	
3.	Electric generating plant	⊗	o	o	
4.	Fuel oil systems		o		
5.	Bilge systems	⊗	o		
6.	Ballast systems		o		
7.	Deck machineries		o		
8.	Remote reading (control) equipment for draft, trim and heel		o		

5. PAINTING

No.	Inspection Item	On Board C	On Board O	On Board R	Remarks
1.	The surface of special paint in tank before removal of scaffolding		o		
2.	The surface of final coating for outside of bottom shell at final docking		o		
3.	Sea chest before being closed		o		

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TECHNOLOGY TRANSFER PROGRAM (TTP)

FINAL REPORT

QUALITY ASSURANCE SYSTEM

APPENDIX G

STANDARD AND TOLERANCE FOR KEEPING HIGH

ACCURACY AT IHI AIOI SHIPYARD

QUALITY ASSURANCE

VOLUME 2 APPENDICES

Prepared by:

Livingston Shipbuilding Company
Orange, Texas

March 3, 1980

APPENDIX G

STANDARD & TOLERANCE FOR KEEPING HIGH ACCURACY AT IHI AIOI SHIPYARD

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

February 1, 1979
IHI Engineering Group
Ref. No. HE010
M. Hatake
K. Chikara

The Activities For Accuracy Control At IHI AIOI Shipyard

The activities for keeping high accuracy as a part *of* quality control have been performing at every shipyard of IHI. The AIOI Shipyard has been developing an advanced Accuracy Control by the well organzied group which leads the production people and the organization of production field. It shall be considered one of the best ways *to* introduce the *actual activities* at the AIOI Shipyard as a model at which the activities here, Livingston shall aim.

The following two (2) methods have been taken at the AIOI Shipyard:

(1) Regular Control

This method is applied to the accuracy control for pieces of ship's hull and the facilities such as NC Burning Machine, Flame Planer and Welding Machines, and the Sampling Check Method is usually taken by the field workers and the results are analyzed by the control chart. The standard and tolerance, presented in the following pages, are involved in this category.

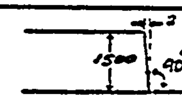
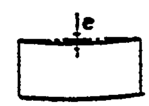
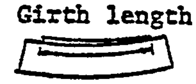
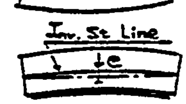
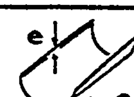
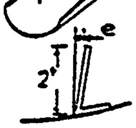
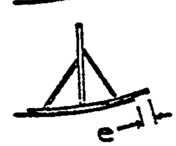
(2) Special Control

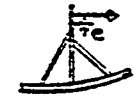
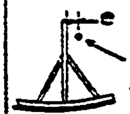
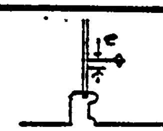
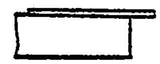
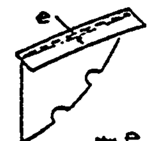
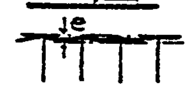
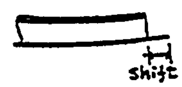
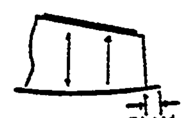
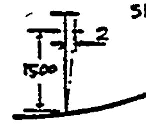
This method is applied to the actual ship according to the manuals which are specially prepared for the vital points.

The data for this control are measured by the members of the Accuracy Control Engineering and sometimes by the field workers, and this data is accumulated arid analyzed to take the suitable action for the next unit and the next ship.

The AIOI Shipyard gets a good result by combined use of the said two (2) methods.

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

SHOP	ITEMS	ALLOWABLE TOLERANCE	FREQUENCY OF MEASURING	REMARKS
Marking & Gas Cutting				
(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	
Flame planer	*Length & Width after cutting	$e = \pm$ 1.5/64"	5 pc/day	
(Flat shell plate flat plate)	*Straightness	$e = \pm$ 1/64"	2 pc/week	
	*Bevel Angle	$e = \pm$ 2.0 deg.	5 pc/day	
	*Normality (Right Angle)	$e = \pm$ 2/1500	2 pc/week	
Bending (Section)	*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	
(Plate)	*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"		

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

SHOP	ITEM	ALLOWABLE TOLERANCE	FREQUENCY OF MEASUR-ING	REMARKS
Assembly				
Marking	*Length of plates	$e = \pm 1/8"$ (curved)	All	
	*Width of plates	$e = \pm 1.5/16"$ (plane)	All	
	*Diagonal lenght of plates (squareness check)	$\Delta L = \pm 1/4"$ (curved) $\Delta L = \pm 1/8"$ (plane)	All	 $\Delta L = \ell_1 - \ell_2$
	*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	
Assembly				
	*Check line for gas cutting	$e = \pm 1/32"$	5 pc/day	
Gas Cutting				
	*Depth of bevel	$e = \pm 1/32"$	5 pc/day	
	*Bevel Angle	$e = \pm 2.0$ deg.	5 pc/day	
	*Straightness of plate edge	$e = \pm 1.5/32"$	20%	

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

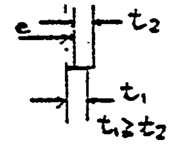
SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION Side Shell	*Positioning: (Length wise) Arrangement of butt between bottom shell and side shell	e = ± 1/8"	All units	Check frame space
	*Level: (Lengthwise) Check at the upper block end seam	e = ± 1/8"	All units	Check the bevel
	*Perpendicularly: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

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION	*Positioning: (Length wise)	e = ± 1/8"	All units	Measure on the rudder center Of Upper gud-geon
Grandly Assembled	Measure at afterend frame			
(Stern Part)	*Positioning; (Between left and right)	e = ± 1/8"	All units	Arrange with center girder at stern frame
	Fix on the center line of stern frame			. . -
	*Positioning: (Height Check the distance be tween flats	e = ± 1/4"	All units	Measure the dimension. from upper gudgeon 3 the flat
	*Connecting parts be-tween units: Check the bevels of seams and butts. Check the con-necting pares to shell	e = ± 1/4"	All units	

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION Supper structure	*Position of butts and walls (Lengthwise)	e = ± 1/4"	All units	Check frame space
	*Positioning: (Width wise) Relative positi-on to the ship's cen-ter line	e = ± 1/4"	All units	Check bevel at deck's seam
	*Positioning: (Height) Measure the dimension between decks	e = ± 1/8"	All units	Pay attention to finish cut at wall joint
	*Level: (Lengthwise and Widthwise)	e = ± 1/4"		Check the rou-ghness of the deck plate
	*Connecting parts be-tween units: Check the feet of walls and be-vels at butts and seams of walls	e = ± 1/8"	All units	Check the twist and unalignment at walls

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION Super structure (Grandly assembl-ed)	*Positioning: (Length wise) Check the posi-tion of front wall	e = ± 1/4"	All units	Check the easy continuity at front wall
	*Positioning: (Width wise) Relative posi-tion to the ship's center line	e = ± 1/8"	All units	Check the easy continuity at side walls
	*Positioning: (Height) Measure the dimension between decks	e = ± 1/8"	All units	Pay attention to finish cut at walls
	*Connecting parts be-tween units: Check un-alignment at the feet of walls	e = ± 1/4"	All units	Pay attention to alignment width

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION Curved Shell Unit	*Positioning: (Length wise) Alignment between a butt at bottom shell unit and a butt at side shell unit	e = ± 1/8"	All units	Check frame space
	*Level: (Lengthwise) Check at the upper block end seam	e = ± 1/8"	All units	Check the be-vel
	*Positioning: (Width) Check the dimension from the ship's center line	e = ± 1/4"	All Units	Plum down to the base lines (center line etc.) marked on the berth (or by transit)
	*Positioning: (Height) Check the gap of up-per end seams between units	e = ± 1/8"	All units	Check the re-lationship with the height of T.BHD
	*Connecting parts be-tween units.	e = ± 1/8"	All units	
	*Discrepancy of ship's center	e = ± 1/8"	All units	Measuring by transit

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASUREING	REMARKS
ERECTION T. BHD	Positioning: Alignment of plates of T. B H D	e = 1/3 * t2	All units	
	*Level: Check at the both end point of upper end seam	e = ± 1/4"	All units	heck the bevel
	*Perpendicular: Check at the outside stiffener	e = ± 1/4"		Plum down fro the top (or by transit)
	*Positioning: (Width Check the dimension from the center line marked the bottom shell	e = ± 1/8"	All units	
	*Connecting parts between units: Check the bevels at seams and butts	e = ± 1/8"	All units	
	*Positioning: (Height) Check the relations of upper end seams between units	e = ± 1/4"	All units	Check the alignment at the H.GIR

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION L. BHD	*Positioning: (Lengthwise) Shift dimension at the butt between the L. BHD and the bottom shell unit	e = ± 1/4"	All units	Check the frme space
	Level: (Lengthwise) Check at the upper and seam . :	e = ± 1/8"	All units	Check the bevel
	*Perpendicular: Check at the for-end frame of the unit.	e = ± 1/4"	All units	Plum down `fron the top
	*positioning: (Height:) Check the gap at the upper end seam between units	e = ± 1/8"	All units	Check the relationship with the height of T. BHD
	*Connecting parts between units: Check the bevels at seams and butts	e = ± 1/8"	All units	

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION Upper Deck	*Positioning: (Length wise) Check shift dimension at butts between upper deck and side shell/L. BHD	e = ± 1/4"	All units	Check the frame space
	*Positioning: (Width) Check the relationship with the ship's center Line	e = ± 1/8"	All units	
	*Connecting parts between units: Check the bevels at seems and butts	e = ± 1/8"	All units	

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION F'cle Deck & Poop Deck	*Positioning: (Lenght wise) Check the shift dim-ensions and bevels at the butts between the deck and shell plates /L.BHD	e = ± 1/4"	All units	Check the fram space
	*Positioning: (Width) Check the relationship with the ship's center	e = ± 1/4"	All units	Plum down from the top of the upper deck
	*Level: (Transverse) Check the knuckle at the pillars and BHD	e = ± 1/4"	All units	Check the stra-tness both at pillars and BHD
	*Positioning: (Height) Check the height at the pillars and BHD	e = ± 3/8"	All units	Check the con-nection to oth-er pieces.
	*Connecting parts be-tween units: Check the bevels at seams and bu tts	e = ± 1/8"		

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION 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 = ± 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 = ± 1/8"		*Plum down from upper gudgion 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) ± 1.5/16 Height ± 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 = ± 1/8"		

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION Grand Assembly At Cant. Frame	*Positioning: (Lengthwise) Check the dimension and bevels at the but	e = ± 1/4"		Check the frame space
	*positioning: (Transverse) Check the relationship with-the ship's center	e = ± 1/8"		Check the continuity with the forward unit
	*Rudder center: Check the dimensions, transverse, and lenghtwise with the upper gudgeon	e = ± 1.5/16″		Check the relationship wit rudder center at upper gudgeon
	*Rudder center: (Height) Check the dimensions between the flat top and the upper gudgeon	0 ~ 1/4″		Dimension from the steering gear flat top o uppper gudgeon top
	*Level: (Lengthwise). Check at the top on the center Line	e = ± 1/8"		

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION Grand Assembly At the Bow Construction	*Positioning: (LengTH wise) Check at the after and frame, with plating	$e = \pm 1/4''$		d o w n
	*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 eight 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 = ± 1/64"	5 times/day	
	*Roughness of cut surface		5 times/day	
	*Bevel angle		5 times/day	

LSCO. Report No. - 2123-5 .1-4-1

TECHNOLOGY TRANSFER PROGRAM (TTP)

FINAL REPORT

QUALITY ASSURANCE SYSTEM

Appendix H

Schedule And Particulars of Inspection and Testing (Bulk Carrier)

QUALITY ASSURANCE

VOLUME 2 APPENDICES

Prepared by:

Livingston Shipbuilding Company
Orange, Texas

March 3, 1980

APPENDIX H

SCHEDULE & PARTICULARS OF INSPECTION & TESTING (BULK CARRIER)

BIBLIOGRAPHY

FOR APPROVAL

~~FOR RETURN~~

APPROVED
with reference to definitions in contract
and remarks in letter dated 24 JUNI 1975
Arnesen, Christensen & Co. A/S

IKS 1
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Note : Revised parts are shown in red.
Notation in this particulars are as follows:

LR : To be witnessed by surveyor to LRS for Classification
OW : To be witnessed by owner's inspector
IHI : To be witnessed by IHI Shipyard inspector
* : Manufacture test record to be checked
\# : To be attend at the option of owner's inspector

MANAGER		S.NO. 2581/2582	WORK NO. 241-2581/2582	QUANTITY 2
DEPUTY MANAGER		32270/36670 MTDW BULK CARRIER		
CHIEF		SCHEDULE & PARTICULARS OF INSPECTION & TESTING (1st revised)	CLASSIFICATION LRS	SCALE
ENGR IN CHARGE				
CHECKED BY	K. Kaiho		DRAWING NO. K0000101	
DRAWN BY				
DATE DRAWN		DATE ISSUED		

Ishikawajima-Harima Heavy Industries Co., Ltd.
QUALITY CONTROL DEPARTMENT. AIOI SHIPYARD

TOTAL NO. OF SHEETS: 20

GENERAL

1. All inspections and tests are to be carried out in accordance with the Rule of Lloyd's Register of Shipping (LRS) and other Rules as required by the specification, and also IHI's "SPAIS" & "QISSP".

2. All items described in this "Particulars of Inspection & Testing" to be tested and inspected by the Owner's Supervisor and the application to be applied to the Owner's Supervisor by the Builder in advance.
(Remarks : To be followed the our ref. AK-019)

3. Material tests which are required by the L.R.S. Rule to be tested and inspected in the presence of L.R.S. surveyor and makers.

4. When Owner's Supervisor is inconvenience and/or not available for inspection and test of some items, the inspection to be observed by the surveyor of society and/or builder's inspector. Record of these items will be submitted to the Owner.

5. Until the arrival and residence of authorized Owner's Supervisor at IHI Aioi Shipyard. All inspections and tests for any item of which work has been started shall be left to L.R.S. Surveyor and/or builder's inspector. The result of which if passed, shall be accepted by Owner. Record of these items will be submitted to the Owner.
(Remarks : To be followed the our ref. AK-019)

1 HULL PART SHOP TEST & INSPECTION ITEM

ITEM	KIND OF INSPECTION	WITNESSED BY LR	WITNESSED BY OW	WITNESSED BY IHI	REMARKS
1 Stern frame					
1) Casting block	Material test	O		*	
	Rough turn final inspection	O	O	O	
2) Stern frame block (After assembly)	Internal inspection	O		O	
	Air test	O	O	O	
	Final inspection	O	O	O	
2 Rudder					
1) Casting block	Material test	O		*	
	Rough turn final inspection	O	O	O	
2) Rudder block	Internal inspection	O		O	
	Air test	O	O	O	
	Alignment inspection	O	O	O	(With stock)
3) Rudder stock	Material test	O		*	
	Final inspection	O	O	O	
4) Rudder pintle	Material test	O		*	
	Final inspection	O	O	O	
5) Reamer bolt for rudder	Material test	O		*	
	Final inspection	O	O	O	

Ishikawajima-Harima Heavy Industries Co., Ltd.

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
6) Rudder carrier	Final inspection			0	
3 Anchor & mooring					
1) Anchor	Material test	0		*	
	Proof test & final inspection	0	0	0	
2) Anchor chain	Material test	0		*	
	Proof test & final inspection	0	0	0	
3) Hawser	Proof test			*	(Maf. certificate)
4 Deck machinery					
1) Steering gear	Shop test &final inspection	0	0	0	(At no load)
2) Windlass	Shop test & overhaul inspection	0	#	0	(At no load)
3) Mooring winch	Shop test & overhaul inspection	0	#	0	(At no load)
4) Emergency fire pump	Shop test & overhaul inspection	0		0	
Cargo winch (Delete)					
5 Mast & post	Final inspection			0	
6 Cargo gear					
1) Deck crane (Revise)	Final inspection	0	0	0	
7 Hatch cover					
1) Cargo hatch cover	Final inspection	0	0	0	

(5) b

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
8 Accommodation ladder & winch	Final inspection			0	
9 Life saving equipment					
1) Life boat	Shop test & final inspection	0	0	0	
2) Boat davit & winch	Load test & final inspection	0	0	0	
3) Life raft		0		*	(HK certificate)
10 Ventilation & air conditioning system					
1) Mechanical ventilator fan	Shop test			*	(Maf. record only)
2) Air conditioner (machine)	Shop test & final inspection			0	
11 Refrigerating plant (machine)	Shop test & final inspection			0	

Ishikawajima-Harima Heavy Industries Co., Ltd.

11 HULL PART ON BOARD TEST & INSPECTION ITEM

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
1 Hull steel construction					
1) Hull steel blocks	Final inspection	0	#	0	
2) Tanks, Cargo hold & void spaces	Internal inspection	0	0	0	
3) Tanks, Cargo hold & Void spaces	Hydraulic test	0	0	0	(include air test)
4) Tanks, Cargo hold & Void spaces	Final inspection		0	0	
5) Bulkhead, Decks & Acces holes	Hose test	0	#	0	
6) Refrigerating chamber	Flooding test	0	#	0	
2 Hull outfitting					
1) Life boat with davit	Load & handling test	0	0	0	
2) Miscellaneous davits	Load & handling test		0	0	
3) Deck crane & boom	Load & handling test	0	0	0	
4) Deck machine					
(1) Windlass	Anchoring test	0	0	0	
(2) Mooring winch	Operation test		0	0	(No load)
Cargo winch (Delete)					
5) Mechanical ventilator	Working test		0	0	

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
6) Air conditioning system	Working test		0	0	
7) Ref. machine for ref. provision chamber & air conditioning system	Pressure test of piping (For ref. provision chamber)		0	0	
	Vacuum test		0	0	
	Cooling test		0	0	
	Heating test (For air con. system)		0	0	
	Operation test		0	0	
	Insulation test (For ref. provision chamber)		0	0	
8) Accommodation ladder	Handling test		0	0	
9) Galley & laundry equipment	Working test		0	0	
10) Cargo hatch cover	Hose test & operation test	0	0	0	
11) Water tight hatch & door	Hose test	0	0	0	
12) Side scuttle	Hose test	0	0	0	
13) Anchor & chain cable	Identification of marking	0		0	(Before installation
14) Emergency fire pump	Working test	0	0	0	
3 Others					
1) Bottom inspection	Check	0	0	0	(Before launching & in dry docking)
2) Keel sight	Measurement	0	0	0	(Before launching

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
3) Molded depth	Measurement	0	0	0	(Before launching)
4) Draft mark	Check	0	0	0	(Before launching)
5) Ship's name	Marking inspection		0	0	(Before launching)
6) Freeboard mark	Check	0	0	0	
7) Inclining experiment & light weight determination		0	0	0	
8) Sea trial	Builder's trial & official trial	0	0	0	
9) Legal equipment	Check	0	0	0	
10) Accommodation quarter	Final inspection		0	0	
11) Painting	Painting inspection		0	0	(According to the IHI's "QISSP")

111 MACHINERY PART SHOP TEST & INSPECTION ITEM

ITEM	KIND OF INSPECTION	WITNESSED BY, LR	OW	IHI	REMARKS
1 Main diesel engine					
1) Final inspection after finishing by machine					
Crank shaft, thrust shaft & coupling bolt for crank shaft		0	0	0	
Crosshead pin		0	0	0	
Connecting rod		0	0	0	
Piston rod		0	0	0	
2) Hydraulic test after finishing by machine					
Cylinder jacket with cylinder liner		0	0	0	
Piston crown		0	0	0	
Cylinder cover		0	0	0	
3) Shop trial	Load test	0	0	0	
	Safety device test	0	0	0	
	Governor test	0	0	0	
4) Overhaul inspection after shop trial					
Dismounting 1 cylinder cover		0	0	0	
Withdrawing 1 working piston		0	0	0	
Disassembling 1 crosshead bearing		0	0	0	
Disassembling 1 crank pin bearing		0	0	0	

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
Disassembling 1 crank journal bearing		0	0	0	
Dismounting 50% of fuel injection valves for spray test		0	0	0	
2 Shafting & propeller					
1) Propeller	Final inspection	0	0	0	
2) Propeller shaft	Final inspection	0	0	0	
	Face-up inspection of cone part	0	0	0	(With cone gauge)
3) Intermediate shaft	Final inspection	0		0	
4) Stern tube bearing	Final inspection			0	
5) Coupling reamer bolt & nut	Final inspection	0		0	
3 Auxiliary boiler	Hydraulic test & final inspection	0	0	0	
4 Exhaust gas economizer	Hydraulic test & final inspection	0	0	0	
5 Diesel generator engine	Load test & safety device test	0	0	0	
	Overhaul inspection	0	0	0	
6 Compressor					
1) Main air compressor	Shop test & overhaul inspection	0	0	0	
2) Emergency air compressor	Shop test	0		*	(Maf. record only)
7 Air reservoir					
1) Main air reservoir	Hydraulic test & final inspection	0	0	0	

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
2) Aux. air reservoir	Hydraulic test & final inspection	0		0	
8 Aux. machines					
1) Cooling sea water pump	Shop test & overhaul inspection	0	0	0	
2) Jacket cool. fresh water pump	Shop test & overhaul inspection	0	0	0	
3) Piston cool. fresh water pump	Shop test & overhaul inspection	0	0	0	
4) Ballast pump	Shop test & overhaul inspection	0	0	0	
5) L.O. pump	Shop test & overhaul inspection	0	0	0	
6) Bilge separator & sludge pump	Shop test & overhaul inspection	0	0	0	
Pumps being not described in above are inspected & tested by IHI.					
9 Oil purifier					
1) Heavy F.O. purifier	Shop test & overhaul inspection	0	#	0	
2) Diesel oil purifier	Shop test & overhaul inspection	0	#	0	
3) L.O. purifier	Shop test & overhaul inspection	0	#	0	
10 Heat exchanger					
1) Jacket cool. fresh W. cooler	Hydraulic test & final inspection	0	#	0	
2) Piston cool. fresh W. cooler	Hydraulic test & final inspection	0	#	0	
3) L.O. cooler	Hydraulic test & final inspection	0	#	0	
4) Distilling plant	Hydraulic test & final inspection		#	0	
Heat exchangers beeing not described in above are inspected & tested by IHI.					

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
11 Miscellaneous machinery					
1) Bilge oil separator	Hydraulic test & final inspection		#	0	
2) Incinerator	Shop test			0	
3) Overhead crane	Shop test			0	
4) Universal machine tool	Shop test			0	

IV MACHINERY PART ON BOARD TEST & INSPECTION ITEM

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
1 Main diesel engine	Fitting inspection	0	0	0	(Check of crank shaft deflection)
	Flushing insp. of L.O. system		0	0	
	Cleaning insp. of crank case & L.O. sump. tank		0	0	(After flushing)
	Setting of fuel oil valves		0	0	
	Safety device test	0	0	0	
	Operation test of remote control system	0	0	0	
	Sea trial	0	0	0	(According to the test method)
	Overhaul inspection (Overhaul items are to be determined by discussion between Owner & IHI after sea trial)	0	0	0	
2 Shafting & propeller					
1) Propeller	Fitting inspection	0	0	0	
	Face-up inspection of cone part	0	0	0	
2) Stern tube bearing	Final inspection (After final machining)	0	0	0	(At IHI shop)
	Fitting inspection	0	0	0	

ITEM	KIND OF INSPECTION	WITNESSED BY LR	GW	IHI	REMARKS
3) Shafting	Sighting inspection	O	O	O	
	Alignment inspection	O	O	O	
4) Stern tube oil seal	Leakage test	O	O	O	
5) Stern tube L.O. system	Flushing inspection		O	O	
6) Coupling reamer bolt & nut	Final inspection	O		O	(At IHI shop)
	Fitting inspection	O	O	O	(Cold shrinkage bolts fit)
3 Aux. boiler					
1) Safety valve	Working test	O	O	O	
	Accumulation test	O	O	O	
2) A.C.C. & F.W.C. system	Safety device test	O	O	O	
	Working test	O	O	O	(At sea trial)
3) Aux. boiler & related equipment after assembling	Hydraulic test	O	O	O	
4 Exh. gas economizer					
1) Safety valve	Working test	O	O	O	(At sea trial)
5 Diesel generator	Fitting inspection	O	O	O	(Check of crank shaft deflection)
	Official test	O	O	O	(According to the test method)

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
6 Rudder & steering gear					
1) Rudder center line	Sighting inspection	0	0	0	
2) Gudgeon bush	Fitting inspection	0	0	0	(Include clearance measurement)
3) Gudgeon part	After boring inspection	0	0	0	
4) Coupling reamer bolt	Fitting inspection	0	0	0	(Cold shrinkage bolts fit)
5) Safety valve for steering gear	Working test	0	0	0	
6) Steering gear	Steering test	0	0	0	(At sea trial)
7) Rudder carrier & pintle	Clearance inspection	0	0	0	
7 Air compressor					
1) Air compressor	Air charging test	0	0	0	
	Auto. start & stop test	0	0	0	
2) Safety valve	Working test	0	0	0	
3) Safety device	Operation test	0	0	0	
8 Air reservoir					
1) Safety valve	Working test	0	0	0	
9 Miscellaneous aux. machine					
1) Essential machinery					
(1) Cooling sea water pump	Centering inspection		0	0	

Ishikawajima-Harima Heavy Industries Co., Ltd.

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
(2) Jacket cool. fresh W. pump	Centering inspection		0	0	
(3) Piston cool. fresh W. pump	Centering inspection		0	0	
(4) Ballast pump	Centering inspection		0	0	
(5) L.O. pump	Centering inspection		0	0	
2) Aux. machinery auto. device					
(1) Automatic change-over test	Operation test	0	0	0	
(2) Remote start & stop	Operation test	0	0	0	
3) Oil purifier	Operation test		0	0	
4) Bilge oil separator	Operation test		0	0	
5) Incinerator	Safety device test	0	0	0	
	Operation test		0	0	
6) Overhead crane	Operation test		0	0	
7) Universal machine tool	Operation test		0	0	
8) Distilling plant.	Capacity test		0	0	(At sea trial)
10 Other test & inspection					
1) Emergency control gear for F.O. tanks	Working test	0	0	0	
2) F.O. & L.O. tanks	Cleaning insp. (before filling)		0	0	(Clean tank only)

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
3) Spare & tool	Check & inspection		0	0	
4) Dry dock inspection					
(1) Propeller	General inspection	0	0	0	
(2) Stern tube bearing	Wear down gauging	0	0	0	

V PIPING (SHOP TEST & ON BOARD TEST, INSPECTION ITEM)

	ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
A.	SHOP TEST					
1	Pipes	Hydraulic test	0		0	(According to the LR Rule)
B.	ON BOARD TEST & INSPECTION					
1)	F.O. pipe line	Hydraulic test	0	0	0	
2)	Heating coil in F.O. tank	Hydraulic test	0	0	0	
3)	Bilge & ballast line in tank	Hydraulic test		0	0	(Hull piping)
4)	Misc. pipe line inside ceiling	Hydraulic test	0	0	0	
5)	Fire & wash deck line	Working test	0	0	0	
6)	CO2 pipe line	Pressure test	0	0	0	
		Blow test	0	0	0	(By air)
7)	Bilge line	Suction test	0	0	0	
8)	Hydraulic line for deck machinery	Working test	0	0	0	(Include L.O. flushing)
9)	Air vent pipe line	Flooding test		0	0	

VI ELECTRIC PART SHOP TEST & INSPECTION ITEM

	ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
1	Electric generator	Shop test & final inspection	0	O	0	
2	Switchboard	Shop test & final inspection	0	O	0	
3	Motor for aux. machinery (75KW & over)	Shop test & final inspection	0		*	(Maf. record only)
4	Starter (For essential machinery)	Shop test & final inspection			0	
5	Radio equipment	Shop test & final inspection		0	0	

VII ELECTRIC PART ON BOARD TEST & INSPECTION ITEM

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
1 Electric generator	Load test & safety device test	0	0	0	
2 Switchboard	Actual service test & safety device test	0	0	0	
3 Motor & control gear	Actual service test			0	
4 Lighting equipment					
1) Navigation light	Lighting test	0	0	0	
2) Signal light	Lighting test		0	0	
3) General light	Lighting test		0	0	
5 Nautical & interior communication system	Actual service test			0	
6 Radio equipment	Synthetic operation test	0	0	0	
7 Electric cable	Insulation resistance test			0	
8 Emergency stop system for motor	Operation test	0	0	0	
9 Indicator system	Confirmation test		0	0	

GENERAL:

1. All inspections and tests are to be carried out in accordance with the Rule of Lloyd's Register of Shipping (LRS) and other Rules as required by the specification, and also IHI's "SPAIS" & "QISSP".

2. All items described in this "Particulars of Inspection & Testing" to be tested and inspected by the Owner's Supervisor and the application to be applied to the Owner's Supervisor by the Builder in advance.

3. Material tests which are required by the L.R.S. Rule to be tested and inspected in the presence of L.R.S. surveyor and makers.

4. When Owner's Supervisor is inconvenience and/or not available for inspection and test of some items, the inspection to be observed by the surveyor of society and/or builder's inspector. Record of these items will be submitted to the Owner.

5. Until the arrival and residence of authorized Owner's Supervisor at IHI Aioi Shipyard. All inspections and tests for any item of which work has been started shall be left to L.R.S. Surveyor and/or builder's inspector. The result of which, if passed, shall be accepted by Owner. Record of these items will be submitted to the Owner.

1 HULL PART SHOP TEST & INSPECTION ITEM

TEM	KIND OF INSPECTION	WITNESSED BY LR	OW	1111	REMARKS
1 Stern frumo					
1) Casting block	Material test	o		M	
	Rough turn final inspection	0	o	o	
2) Stern frume block (After asembly)	Internal inspection	0		o	
	'Air test"	0		o	
	Final inspection	0	0	0	
2 Rudder					
i) Casting block	Material test	0		*	
	Rough turn final inspection	0	0	o	
2) Rudder block	Internal inspection	0		0	
	Air test	0		0	
	Allgnment inspection	0	0	0	(with stock)
3) Rudder stock	Materiul test	0		*	
	Final inspection	0	0	o	
4) Ruddor pintle	Material lost	0		*	
	Final inspection	0		0	
5) Rcumor bolt for rudder	Material test	0		*	

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Ishikawajima-Harima Heavy Industries Co., Ltd.

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
6) Rudder carrier	Final inspection			0	
3 Anchor & mooring					
1) Anchor	Material test	0		*	
	Proof test & final inspection	0		0	
2) Anchor chain	Material test	0		*	
	Proof test & final inspection	0		0	
3) Hawser	Proof test			*	(Maf. certificate)
4 Deck machinery					
1) Steering gear	Shop test &final inspection	0	0	0	(At no load)
2) Windlass	Shop test & overhaul inspection	0		0	(At no load)
3) Mooring winch	Shop test & overhaul inspection	0		0	(At no load)
~~4) Cargo winch~~	~~Shop test & overhaul inspection~~	~~0~~		~~0~~	
4 5) Emergency fire pump	Shop test & overhaul inspection	0		0	
5 Mast & post	Final inspection			0	
6 Cargo gear					
1) ~~Derrick boom & post~~ DECK CRANE	Final inspection	0		0	
7 Hatch cover					
1) Cargo hatch cover	Final inspection	0	0	0	

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
8 Accommodation ladder & winch	Final inspection			O	
9 Life saving equipment					
1) Life boat	Shop test & final inspection	O	O	O	
2) Boat davit & winch	Load test & final inspection	O		O	
3) Life raft		O		*	(HK certificate)
10 Ventilation & air conditioning system					
1) Mechanical ventilator fan	Shop test			*	(Maf. record only)
2) Air conditioner (machine)	Shop test & final inspection			O	
11 Refrigerating plant (machine)	Shop test & final inspection			O	

11 HULL PART ON BOARD TEST & INSPECTION ITEM

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
1 Hull steel construction					
1) Hull steel blocks	Final inspection	0		0	
2) Tanks, Cargo hold & void spaces	Internal inspection	0	0	0	
3) Tanks, Cargo hold & Void spaces	Hydraulic test	0	0	0	(Include air test)
4) Tanks, Cargo hold & Void spaces	Final inspection		0	0	
5) Bulkhead, Decks & Acces holes	Hose test	0		0	
6) Refrigerating chamber	Flooding test	0		0	
2 Hull outfitting					
1) Life boat with davit	Load & handling test	0	0	0	
2) Miscellaneous davits	Load & handling test		0	0	
3) Deck crane & boom	Load & handling test	0	0	0	
4) Deck machine					
(1) windlass	Anchoring test	0	0	0	
(2) Mooring winch	Operation test		0	0	(No load)
(3) Cargo winch	Load test	0	0	0	
5) Mechanical ventilator	Working test		0	0	

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Ishikawajima-Harima Heavy Industries Co., Ltd.

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
6) Air conditioning system	Working test		0	0	
7) Ref. machine for ref. provision chamber & air conditioning system	Pressure test of piping (For ref. provision chamber)		0	0	
	Vacuum test		0	0	
	Cooling test		0	0	
	Heating test (For air con. system)		0	0	
	Operation test		0	0	
	Insulation test (For ref. provision chamber)		0	0	
8) Accommodation ladder	Handling test		0	0	
9) Galley & laundry equipment	Working test		0	0	
10) Cargo hatch cover	Hose test & operation test	0	0	0	
11) Water tight hatch & door	Hose test	0	0	0	
12) Side scuttle	Hose test	0	0	0	
13) Anchor & chain cable	Identification of marking	0		0	(Before installation)
14) Emergency fire pump	Working test	0	0	0	
3 Others					
1) Bottom inspection	Check	0	0	0	(Before launching & in dry docking)
2) Keel sight	Measurement	0	0	0	(Before launching

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
3) Molded depth	Measurement	0	0	0	(Before launching)
4) Draft mark	Check	0	0	0	(Before launching)
5) Ship's name	Marking inspection		0	0	(Before launching)
6) Freeboard mark	Check	0	0	0	
7) Inclining experiment & light weight determination		0	0	0	
8) Sea trial	Builder's trial & official trial	0	0	0	
9) Legal equipment	Check	0	0	0	
10) Accommodation quarter	Final inspection		0	0	
11) Painting	Painting inspection		0	0	(According to the IHI's "QISSP")

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Ishikawajima-Harima Heavy Industries Co., Ltd.

111 MACHINERY PART SHOP TEST & INSPECTION ITEM

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
1 Main diesol engine					
1) Final inspection after finishing by machine					
Crank shaft, thrust shaft & coupling bolt for crank shaft		0	0	0	
Crosshead pin		0	0	0	
Connecting rod		0	0	0	
Piston rod		0	0	0	
2) Hydraulic test after finishing by machine					
Cylinder jacket with cylinder liner		0	0	0	
Piston crown		0	0	0	
Cylinder cover		0	0	0	
3) Shop trial	Load test	0	0	0	
	Safety device test	0	0	0	
	Governor test	0	0	0	
4) Overhaul inspection after shop trial					
Dismounting 1 cylinder cover		0	0	0	
Withdrawing 1 working piston		0	0	0	
Disassembling 1 crosshead bearing		0	0	0	
Disassembling 1 crank pin bearing		0	0	0	

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
Disassembling 1 crank journal bearing		0	0	0	
Dismounting 50% of fuel injection valves for spray test		0	0	0	
2 Shafting & propeller					
1) Propeller	Final inspection	0	0	0	
2) Propeller shaft	Final inspection	0	0	0	
	Face-up inspection of cone part	0	0	0	(With cone gauge)
3) Intermediate shaft	Final inspection	0		0	
4) Stern tube bearing	Final inspection			0	
5) Coupling reamer bolt & nut	Final inspection	0		0	
3 Auxiliary boiler	Hydraulic test & final inspection	0	0	0	
4 Exhaust gas economizer	Hydraulic test & final inspection	0	0	0	
5 Diesel generator engine	Load test & safety device test	0	0	0	
	Overhaul inspection	0	0	0	
6 Compressor					
1) Main air compressor	Shop test & overhaul inspection	0		0	
2) Emergency air compressor	Shop test	0		*	(Maf. record only)
7 Air reservoir					
1) Main air reservoir	Hydraulic test & final inspection	0	0	0	

TEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
2) Aux. air roservoir	HIydraullo test & final inspection	O		o	
8 Aux. muchines					
1) Coding sea water pump	Shop test & overhaul inspection	O	0	0	
2) Jucket cool. fresh water pump	Shop test & overhaul inspection	O	0	0	
3) Piston cool. fresh water pump	Shop test & overhaul inspection	O	0	0	
4) Ballust pump	Shop test & ovurhaul inspection	O	0	0	
5) L.O. pump	Shop test & overhaul inspection	O	0	0	
Pumps booing not described in above are inspected & tested by IHI.					
9 011 purlllor					
1) Heavy F.O. purifior	Shop test & ovcrhaul inspection	O		0	
2) Diesal 0il purifier	Shop test & overhaul inspection	O		0	
3) L.O. purifier	Shop test & ovorhaul inspection	O		0	
10 Hent exchanger					
1) Jacket 0001. f'resh W. cooler	Hydraulic test & final inspection	O	l	O	
2) Piston cool. fresh W. cooler	Hydraulic test & final inspection	O		0	
3) L.o). cooler	Hydraulic last & final inspection	0		0	
4) Distiling plant	Hydraulic last & final inspection			**0**	
Hent exchangers beeing not described in above are inspected & tested by IHI.					

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ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
11 Miscellaneous machinery					
1) Bilge oil separator	Hydraulic test & final inspection			0	
2) Incinerator	Shop test			0	
3) Overhead crane	Shop test			0	
4) Universal machine tool	Shop test			0	

IV MACHINERY PART ON BOARD TEST & INSPECTION ITEM

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
1 Main diesel engine	Fitting inspection	0	0	0	(Check of crank shaft deflection)
	Flushing insp. of L.O. system		0	0	
	Cleaning insp. of crank case & L.O. sump. tank		0	0	(After flushing)
	Setting of fuel oil valves		0	0	
	Safety device test	0	0	0	
	Operation test of remote control system	0	0	0	
	Sea trial	0	0	0	(According to the test method)
	Overhaul inspection (Overhaul items are to be determined by discussion between Owner & IHI after sea trial)	0	0	0	
2 Shafting & propeller					
1) Propeller	Fitting inspection	0	0	0	
	Face-up inspection of cone part	0	0	0	
2) Stern tube bearing	Final inspection (After final machining)	0	0	0	(At IHI shop)
	Fitting inspection	0	0	0	

ITEM	KIND OF INSPECTION	WITNESSED BY LR	GW	IHI	REMARKS
3) Shafting	Sighting inspection	0	0	0	
	Alignment inspection	0	0	0	
4) Stern tube oil seal	Leakage test	0	0	0	
5) Stern tube L.O. system	Flushing inspection		0	0	
6) Coupling reamer bolt & nut	Final inspection	0		0	(At IHI shop)
	Fitting inspection	0	0	0	(Cold shrinkage bolts fit)
3 Aux. boiler					
1) Safety valve	Working test	0	0	0	
	Accumulation test	0	0	0	
2) A.C.C. & F.W.C. system	Safety device test	0	0	0	
	Working test	0	0	0	(At sea trial)
3) Aux. boiler & related equipment after assembling	Hydraulic test	0	0	0	
4 Exh. gas economizer					
1) Safety valve	Working test	0	0	0	(At sea trial)
5 Diesel generator	Fitting inspection	0	0	0	(Check of crank shaft deflection)
	Official test	0	0	0	(According to the test method)

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
6 Rudder & steering gear					
1) Rudder center line	Sighting inspection	O	O	O	
2) Gudgeon bush	Fitting inspection	O	O	O	(Include clearance measurement)
3) Gudgeon part	After boring inspection	O	O	O	
4) Coupling reamer bolt	Fitting inspection	O	O	O	(Cold shrinkage bolts fit)
5) Safety valve for steering gear	Working test	O	O	O	
6) Steering gear	Steering test	O	O	O	(At sea trial)
7) Rudder carrier & pintle	Clearance inspection	O	O	O	
7 Air compressor					
1) Air compressor	Air charging test	O	O	O	
	Auto. start & stop test	O	O	O	
2) Safety valve	Working test	O	O	O	
3) Safety device	Operation test	O	O	O	
8 Air reservoir					
1) Safety valve	Working test	O	O	O	
9 Miscellaneous aux. machine					
1) Essential machinery					
(1) Cooling sea water pump	Centering inspection		O	O	

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
(2) Jacket cool. fresh W. pump	Centering inspection		0	0	
(3) Piston cool. fresh W. pump	Centering inspection		0	0	
(4) Ballast pump	Centering inspection		0	0	
(5) L.O. pump	Centering inspection		0	0	
2) Aux. machinery auto. device					
(1) Automatic change-over test	Operation test	0	0	0	
(2) Remote start & stop	Operation test	0	0	0	
3) Oil purifier	Operation test		0	0	
4) Bilge oil separator	Operation test		0	0	
5) Incinerator	Safety device test	0	0	0	
	Operation test		0	0	
6) Overhead crane	Operation test		0	0	
7) Universal machine tool	Operation test		0	0	
8) Distilling plant	Capacity test		0	0	(At sea trial)
10 Other test & inspection					
1) Emergency control gear for F.O. tanks	Working test	0	0	0	
2) F.O. & L.O. tanks	Cleaning insp. (before filling)		0	0	(Clean tank only)

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
3) Spare & tool	Check & inspection		0	0	
4) Dry dock inspection					
(1) Propeller	General inspection	0	0	0	
(2) Stern tube bearing	Wear down gauging	0	0	0	

V PIPING (SHOP TEST & ON BOARD TEST, INSPECTION ITEM)

ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
A. SHOP TEST					
1 Pipes	Hydraulic test	O		O	(According to the LR Rule)
B. ON BOARD TEST & INSPECTION					
1) F.O. pipe line	Hydraulic test	O	O	O	
2) Heating coil in F.O. tank	Hydraulic test	O	O	O	
3) Bilge & ballast line in tank	Hydraulic test		O	O	(Hull piping)
4) Misc. pipe line inside ceiling	Hydraulic test	O	O	O	
5) Fire & wash deck line	Working test	O	O	O	
6) CO2 pipe line	Pressure test	O	O	O	
	Blow test	O	O	O	(By air)
7) Bilge line	Suction test	O	O	O	
8) Hydraulic line for deck machinery	Working test	O	O	O	(Include L.O. flushing)
9) Air vent pipe line	Flooding test		O	O	

VI ELECTRIC PART SHOP TEST & INSPECTION ITEM

	ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
1	Electric generator	Shop test & final inspection	O		O	
2	Switchboard	Shop test & final inspection	O		O	
3	Motor for aux. machinery (75KW & over)	Shop test & final inspection	O		*	(Maf. record only)
4	Starter (For essential machinery)	Shop test & final inspection			O	
5	Radio equipment	Shop test & final inspection		O	O	

VII ELECTRIC PART ON BOARD TEST & INSPECTION ITEM

	ITEM	KIND OF INSPECTION	WITNESSED BY LR	OW	IHI	REMARKS
1	Electric generator	Load test & safety device test	0	0	0	
2	Switchboard	Actual service test & safety device test	0	0	0	
3	Motor & control gear	Actual service test			0	
4	Lighting equipment					
	1) Navigation light	Lighting test	0		0	
	2) Signal light	Lighting test			0	
	3) General light	Lighting test			0	
5	Nautical & interior communication system	Actual service test			0	
6	Radio equipment	Synthetic operation test	0	0	0	
7	Electric cable	Insulation resistance test			0	
8	Emergency stop system for motor.	Operation test	0		0	
9	Indicator system	Confirmation test			0	

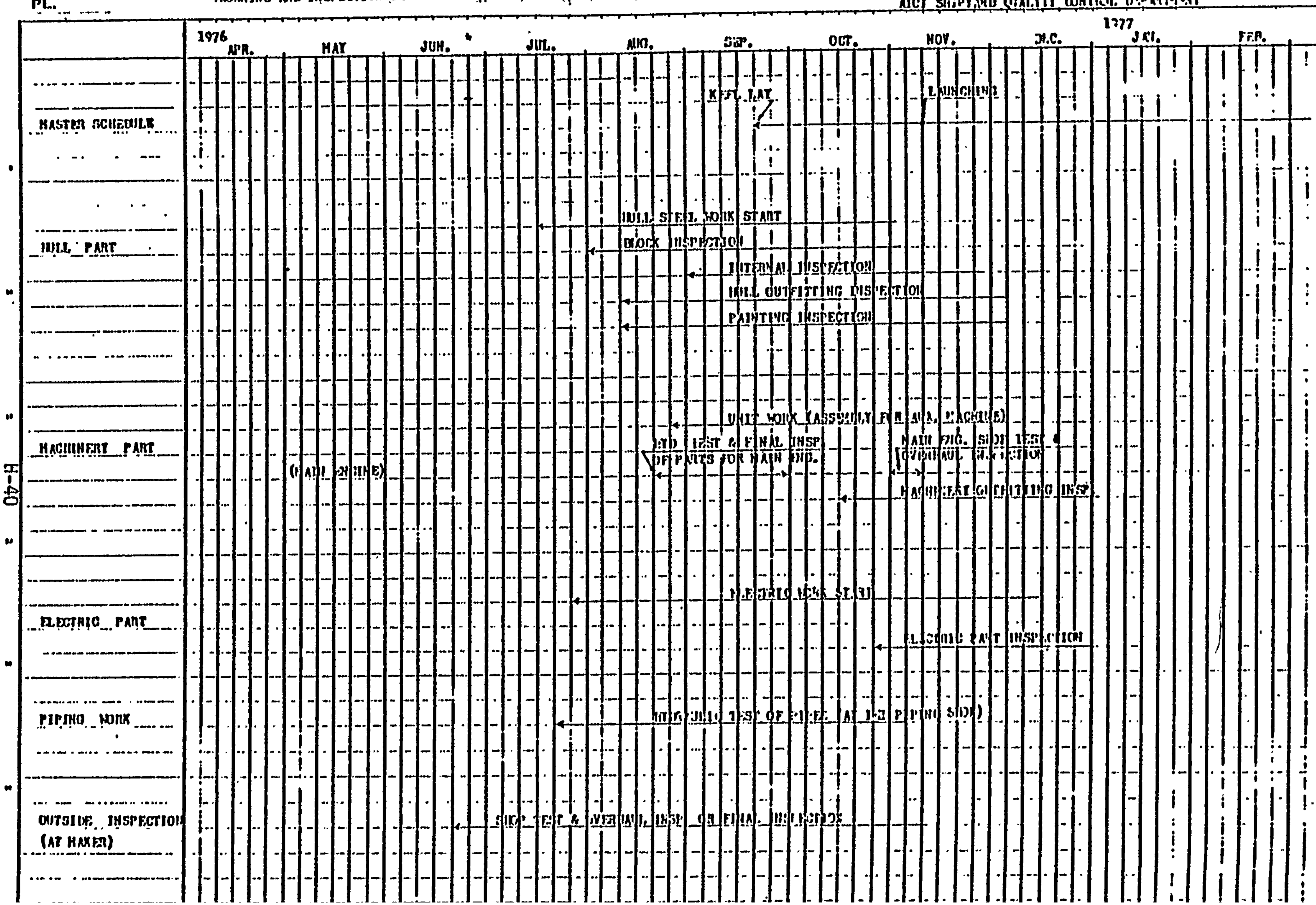
S No. 2581 (FUTURE-32)

ISHIKAWAJIMA HARIMA HEAVY INDUSTRIES CO., LTD.
INSPECTION DEPARTMENT
AIOI SHIPYARD QUALITY CONTROL DEPARTMENT

PL.

WORKING AND INSPECTION SCHEDULE

MAY, 19, 1976



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Mar. 11, 1976

S No. 2501 (FUTURE-32)

INSPECTION SCHEDULE

PL.

REMARKS:
←→ ; INSP. SCHEDULE

ISHIKAWAJIMA HARIMA HEAVY INDUSTRIES CO. LTD.
INSPECTION DEPARTMENT
AIOI SHIPYARD QUALITY CONT. DEPT.

1976: Jun. · Jul. · Aug. · Sep. · Oct. · Nov. · Dec. — 1977: Jan.

ITEM	KIND OF INSPECTION	INSPECTION PLACE
Stern frame	Final inspection	Kawasaki Steel Works, Ltd.
Rudder	"	"
Rudder stock	"	"
Steering gear	Shop test	Kawasaki Heavy Ind. Co., Ltd.
Steel hatch cover	Final inspection	IHI Aioi No.1 Works
Life boat	Final inspection	Ishihara Dockyard Co., Ltd.
Main diesel engine	Hyd. test & Final insp.	IHI Aioi No.2 Works
Aux. boiler	"	"
Exh. gas economizer	"	"
Propeller	Final insp.	Kobe Steel Works.
Propeller shaft	"	Kawasaki Steel Works, Ltd.
Stern tube bearing	"	Standard Metal Industries Co., Ltd.
Gene. diesel engine	Shop test & overhaul insp.	Daihatsu Diesel Mfg. Co.
Cool. sea water pump	Shop test & overhaul insp.	Shinko Kinzoku Ind. Co. Ltd.
Jacket cool. F.W.P.	"	"
Piston cool. F.W.P.	"	"
Ballast pump	"	"
L. O. pump	Shop test & overhaul insp.	Kawasaki Heavy Ind. Co., Ltd.
Main air reservoir	Hyd. test	IHI Aioi No. 2 Works
Radio telegraph	Final insp.	Tokyo Shibaura Elec. Co. Ltd.

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LSCo. Report No. - 2123-5 .1-4-1

TECHNOLOGY TRANSFER PROGRAM (TTP)

FINAL REPORT

QUALITY ASSURANCE SYSTEM

Appendix I

Procedure of Official Sea Trial

(Bulk Carrier)

QUALITY ASSURANCE

VOLUME 2 APPENDICES

Prepared by:

Livingston Shipbuilding Company
Orange, Texas

March 3, 1980

APPENDIX I

PROCEDURE OF OFFICIAL SEA TRIAL (BULK CARRIER)

BIBLIOGRAPHY

(21)

2 - 2B

CONFERRED WITH	
HULL DESIGN SEC.	[illegible]
HULL ARRANGE SEC.	[illegible]
ELEC. DESIGN SEC.	[illegible]
Q.C. NO.2, NO.3 SEC.	[illegible]
MACH. NO.2 FITT. SEC.	[illegible]
DOCK MASTER	[illegible]

Ishikawajima-Harima Heavy Industries Co., Ltd.

SHIPS DESIGN DEPT. (A101), ENG. FITT. DESIGN GROUP

INDEX

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1. GENERAL INSTRUCTION FOR SEA TRIAL

This sea trial is to be executed to ensure the performance of the vessel at sea.

1. Test Condition and Place

		7.03
D		

NOTE : 1. Above condition for official sea trial is to be applied only for speed trial.

2. Draft measuremnt shall be done by reading draft mark with the eye from a boat before the dcparture of sea. trial.

3. Specific gravity and temperature of sea water to be measured before the departnre of sea trial.

4. Displacement of the vessel is to be estimated by numerical table.

2. Test Item

It depends on this drawing and trial schedule.

B. DESCRIPTION OF EACH TRIAL AND TEST

1. Progressive speed trial :

1.1 Test Method

Time elapsed over a course of running of 1.0 mile is to be measured by Radio Wave Measuring Speed System (MARSMEC-2), and the mean speed at each Horse power is to be calculated.

Main engine output and main shaft RPM are as below :

	M/E output	Main Shaft RPM	Rated Brake Horse Power (PS)
	Normal (90% [illegible]	abt. 151	10,260
*	MCR	abt. 157	11,400

* marked test is to be conducted only for first vessel.

NOTE : 1. Two(2) consecutive runs alternative in direction is to be excuted in each series of run at the same speed and to be uninterrupted and performed in sequence.

2. Estimated main engine barred range is as follows and this range is to be quickly passed.

   | 78 | rpm — | 92 | rpm

3. Main shaft revolution may be changeable in order to keep the above rated brake horse power as possible.

4. During approaching running and speed measurement, the rudder movement for course adjustment has to be within 3° and its frequency be minimized.

5. Max. allowable revolution is | 162 | rpm.

6. Main engine speed is to be controlled by governer regulating system.

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1.2 Communication

<table>
<tr><th>ITEM</th><th>W/H ⇄ C/R</th><th>GENERAL
(From W/H)</th></tr>
<tr><td>RPM adjusted</td><td rowspan="6">Direct
telephone</td><td rowspan="6">Public
addresser</td></tr>
<tr><td>Ready for course in</td></tr>
<tr><td>Course in</td></tr>
<tr><td>Ready for course out</td></tr>
<tr><td>Course out</td></tr>
<tr><td>End</td></tr>
</table>

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1.3 Data to be measured

Undermentioned items are to be measured and recorded. Allotment

(1) Course, weather, sea condition, wind velocity, wind direction and water depth (Hull part)

(2) Elapsed time over a course of a mile given by Radio Wave Measuring Speed System (MARSMEC-2). (Hull part)

(3) Main Engine output is measured by "MAIHAK" torsion meter at each load as soon as course in completed and determined by following equation.

(a) Brake Horse Power

$$BHP = \frac{1}{0.71620} \times N \times \frac{1}{n} \times \Sigma T$$

BHP : Brake Horse Power (PS)

N : Main shaft revolution (RPM)

T : Heading of torque meter on MAIHAK torsion meter

n : Number of reading torque meter (Ton-meter)

(4) Measurement of main shaft revolution (Mach. part)

At the time of speed test, mean revolution for 3 minutes after course in is measured by integration type of electronic digital counter for official sea trial.

(5) Measurement in Engine Room (Mach. part)

Instruments equipped in the Control Room is to be measured once as each N/E output run and local instruments and M/E cylinder maximum pressure to be measured once at the time of 4/4 max. output Where, refer to PAGE (26) "D. Other measuring position of machinery part" with regard to local measuring position.
The local instruments to be measured that normal output
The following data in C/R are to be obtained at each run.

- o Load indicator
- o T/C revolution
- o Seavenging air pressure

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2. Endurance and Fuel oil consumption test

2.1 Test Method

(1) Endurance test at normal output

This test shall be conducted for a period of (4) hours by using (HEAVY) fuel oil. During this test, (2) hours fuel oil consumption measurement is to be carriedout.

2. Data to be measured

allotment

Under-mentioned items are to be measured and recorded.

(1) M/E output is to be measured two(2) times totally, once at fuel oil consumption test and once at other internal. (MACH. PART)
Equation for calculation of momentary output is shown on B - 1.3 item of progressive speed trial. Calculation method for M/E mean output is as below :

mean output

$$= \left(\frac{\text{total mean revolution during F.O. consumption test}}{\text{mean revolution for 3 minutes at output measuring}}\right)^3 \times \text{momentary output}$$

(2) Main shaft revolution is to be obtained as 3 minute's mean revolution at output measuring by using temporary integration type of electronic digital revolution counter. The total mean revolution is also to be calculated from start to the end of F.O. consumption test. by reading a integrating counter, using clock on maneuvering stand in C/R. (MACH. PART)

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(3) Fuel oil consumption is measured by reading of ship's flow meter from start to the end of test and the consumption rate converted to low calorific value (10,200) Kcal/kg is obtained by the following formula.

$$GR = \frac{Q \times S \times C \times H \times K \times 1000}{h \times P \times HL}$$

GR = F.O. consumption rate	gr/PS.hr
Q = Difference of reading between $\boxed{2}$ hours	ℓ
S = Specific weight of fuel oil	kg/ℓ
C = Error of flow meter	
H = Low calorific value of used F.O. at the trial.	Kcal/kg
h = Elpased time for test	$\boxed{2}$ hours
P = Mean brake horse power	PS
K = Volume conversion coefficient of F.O.	
HL = Standard low calorific value	10,200 Kcal/kg

Fuel oil is to be analysed at No.1 Aioi work's chemical testing group and table be issued.

(4) Test Condition

a) Main engine governor control is to be limited by fuel linkage limiting screw.

b) The vessel is to run as straight as possible for measuring main engine output.

(5) Measurement in E/R

Instruments in C/R is to be measured at each M/E output measurement.
Local instruments is to be measured once during this test.
Local measuring position is referred to "2. Measuring position of machinery side" on page (26).

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Ishikawajima- Harima Heavy Industries Co., Ltd.

3. Crash Stop Astern Test

3.1 Test Method

With the ship under full ahead going at normal RPM, "Full astern" is ordered, and revised to planned full astern revolution abt. (127)rpm. Until astern revolution is settled ship continues to run. After astern revolution settled, full speed astern test is carried out as described in item 4.

3.2 Communication

Order	Inter-communication	Means	Remarks
Preparation over	E/R to W/H	telephone	
Ready for astern	W/H to E/R	telephone	(stand by)
Order of astern	W/H to E/R	telegraph	(astern full)
Settlement of astern RPM	E/R to W/H	telephone	
Completion of measuring	E/R to W/H	telephone	
Finish of full speed astern test	E/R to W/H	telephone	

3.3 Data to be measured

Undermentioned items are to be measured and recorded. (allotment)

* (1) Time, weather, wind velocity, wind direction and sea conditions at "Full Astern" order. (HULL PART)
* (2) Change of ship's speed from "Full Astern" order to astern speed settlement (by throwing wooden piece) (HULL PART)
* (3) Change of ship's course from "Full Astern" order to astern speed settlement by gyro compass. (HULL PART)

(4) Mentioned items on diagram of next page.

* marked items is to be measured only for first vessel.

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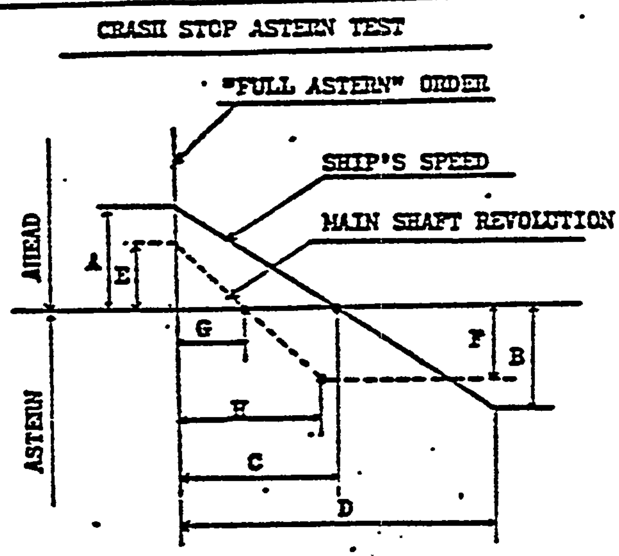
Diagram for Crash Astern Test



	CRASH STOP ASTERN TEST	allotment
A	Speed before "FULL ASTERN" order	HULL PART
B	Speed after astern revolution settled	"
C	Time unitl ship's stop from "FULL ASTERN" order	"
D	Time until astern speed settled from "FULL ASTERN" order	"
E	Main shaft revolution before "FULL ASTERN" order	MACH. PART
F	Main shaft revolution after astern revolution settled	"
G	Time until shaft stop from "FULL ASTERN" order	"
H	Time until shaft revolution settled from "FULL ASTERN" order	"

4. Full Speed Astern Test

4.1 Test Method

This test is to be conducted for about 15 minutes after the settlement of astern shaft revolution during crash astern test.

4.2 Data to be measured

Undermentioned items are to be measured and recorded. (alloterent)

(1) Main, shaft revolution is to be measured once by temporary integration type of electronic digital counter for ses trial after revolution (Mach part) settled.

(2) Other general measurement are to be taken once by only instruments equipped in control room after revolution settled.

5. Minimum Revolution Test

5.1 Test Method

During running, main shaft revolution is gradually decreased until minimum revolution enough to keep all cylinder running smoothly is to be found, and confideration run at minimum revolution is carried out for about one(l) minute.

5.2 Data to be measured (allotment)

Minimum revolution is to be found by temporary integration type of electronic digital counter for official sea trial. (Q.C. 2)

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6. Starting Test

6.1 Test Method

Before this test, air vessel for test is to be charged up to rated pressure (25 kg/cm^2 G) and air is not to be charged any more during this test. Main engine is to be started continuously for ahead & astern alternately until main engine cannot be started.

6.2 Data to be measured :

Undermentioned items are to be measured and recorded.	allotment
(1) The number of starting for ahead & astern until the starting becomes impossible.	(Q.C 2)
(2) The minimum pressure of making start possible	(")
(3) Air pressure before and after each start	(")

NOTE : 1. One of the two air vessels is to be used for this test.

2. This test is to be carried under cold condition of main engine after warming up is over.

7. Torsional Vibration & *hull Vibration* Test (only for first vessel)

7.1 Test Method

Each vibration amplitude is to be meesured contineously by increasing revolution appropriately from minimum revolution to maximum revolution in accordance with the following revolution.

Nearly around critical revolution and normal revolution, detailed measurement every one(1) revolution shall be conducted.

50, 52, 53, 54, 55, 56, 57. 58. 59. 60. 62, 65. 67, 70
72, 74. 75, 76. 77. 78. 79. 80. 81, 82, 83, 84, 85, 86
88, 90, 92, 94. 96. 98, 99, 100, 101, 102. 103, 105, 107
110. 112, 115, 117. 120, 121, 122. 123, 124. 125, 126, 127,
128, 130, 132, 133. 134. 135, 136. 138, 139. 140, 141, 142
143, 144. 145. 146. 147. 148. 149. 150. 151. 152. 153, 154, 155 157.

Estimated barred range 78 **rpm** — 92 **rpm**

7.2 Data to be measured

Undermentioned items are to be measured and recorded. (allotment)

• **M/E rpm**	**MACH. PART**
o Amplitude & frequency of torsional vibration (Geiger Torsiongraph)	MACH. PART
o Amplitude & frequency of hull vibration (Vibrometer)	**HULL PART**

8. Turning Test (only for first vessel)

8.1 Test Method

During ahead going at normal output, this test is to be carried out by turning the vessel around smoke signal buoy with rudder angle 35°.
Azimuth angle to the buoy is to be measured by temporary slit set at two points and ships heading angle to be measured by gyrocompass.
Starboard side turning and port side turning shall be carried out once respectively.

Measurement is to be carried out at the bellow heading angle.

Heading angle at the order, 5°, 15°, 30°, 60°, 90°, 120°, 150°, 180°, 210°, 240°, 270°, 300°, 330°, 360°

NOTE : Ship shall be run straight and the rudder is to be held amidship before "Move Rudder" order.

8.2 Data to be measured

Undermentioned items are to be measured and recorded.	(allotment)
(1) Weather, wind velocity, wind direction and sea condition.	(HULL PART)
(2) Time and direction at "Move rudder" order	(")
(3) Time elapsed from the order to each ship's heading angle.	(")
(4) Azimuth angles to the buoy at each ship's heading angle.	(")
(5) Time elapsed and actual rudder angle from the order to finish of moving rudder 35°.	(")
(6) Main shaft revolution based on speed meter in wheel house at each ship's heading angle.	(")

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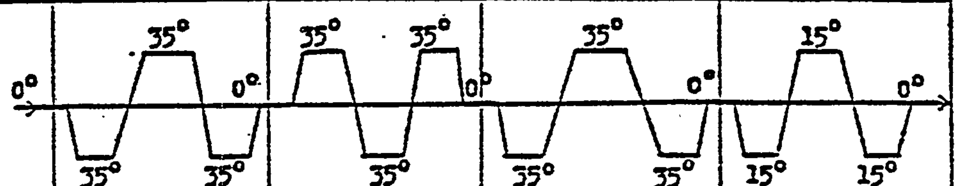
9. Steering Gear Test

9.1 Test Method

This test is to be carried out according to the following procedure. Changing method of moving rudder and steering gear is to be followed to the order from Deck master.

Position of steering	Wheel house	Wheel house	Wheel house	Steering gear room
Test No.	1	2	* 3	3
Steering method	Hand steering	same	same	Trick wheel on steering gear
Power unit for steering	No.1	No.2	No. 2	Stop
Pump unit of steering gear	No.1	No.2	No. 1 & 2	No.2
Procedure: Port / Amid / Starboard				
Time required for rudder movement at tiller (35° - opp. 30°)	within 28 seconds	—	—	(15°-opp.-15°)
M/E output	MCR	MCR	MCR	(Half speed)

* marked test is to be conducted only for first vessel.

9.2 Data to be measured

Undermentioned items are to be measured and recorded.	allotment
(1) Date, time of start and finish of the test, weather, wind velocity, wind direction, sea condition and ship's speed at start of the test.	(HULL PART)
(2) Time required for each moving rudder at steering wheel and tiller.	(Q.C. 1)
(3) Actual rudder angle.	(")
(4) Maximum and steady oil pressure in hydraulic cylinder.	(")
(5) Voltage and maximum ampere of motor for hydraulic oil pump.	(Q.C. 3)

10. Anchoring Test

10.1 Test Method

(2) This test is to be conducted at more than $\boxed{30}$ **meters of sea water depth.**

(2) Each anchor is to be let go down gradually to the surface of the water-

(3) Onside anchor is to be let go down until four(4) groups of chains with braking it several times.

(Where, a group of chains is equal to 27.5 m)

Then working condition of the brake is to be confirmed.

(4) Another anchor is to be tested under same way as (3).

(5) One side anchor is to be hoisted by two groups of chains.

(6) Another anchor is to be hoisted also by two groups of chains.

(7) Boths anchors are to be hoisted until clear of water. sumultaneously.

(8) Each anchor is hoisted into hawse pipe independently and confirm whether both anchor are held exactly when anchor stoppers are locked.

10.2 Data to be measured

undermentioned items are to be measured sod recorded.	allotment
(1) Place, date, time of start and finish of the test, weather, sea condition wind velocity, wind direction and water depth (by echo sounding equipment)	(HULL PART)
(2) Velocity and elapsed time of a series of hoisting on "test method" 10.1 (5), (6) & (7).	**(HULL PART, Q.C. 1)**
(3) Voltage and ampere of motor for hydraulic oil pump.	(Q.C. 3)

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11. Exh. Gas Economizer Evanoration Test (only for first vessel)

11.1 Test Method

Heavy fuel oil burning unit and feed water supply for auxiliary boiler are stopped at main engine normal output and set the steam pressure of auxiliary boiler (7.0) kg/cm^{2}G. And quantity of evaporation is to be calculated by measuring water level of boiler drum at start and finish of the test.

Time required for test is to be 15 minutes.

Calcurated formula is as below :

$$W = \frac{\pi D^2}{4} \times \ell \times \frac{1}{V} \times \frac{60}{t} \times 1000$$

W	:	Evaporation	(kg/h)
D	:	Steam drum inside dia.	(m)
ℓ	:	Variation level	(m)
V	:	Specific volume of boiler water	(lit/kg)
t	:	Measuring time	(minute)

11.2 Data to be measured

Undermentioned items are to be measured and recorded. allotment

(1)	Main engine output	(MACH.PART)
(2)	Steam pressure of auxiliary boiler	(")
(3)	Water level of level guage of auxiliary boiler.	(")

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12. Fresh Water Generator Capacity Test (only for first vessel)

12.1 Test Method

The following capacity and density of salinity are to be confirmed during 30 minutes at main engine normal output.

Capacity (21) TON/DAY ($\boxed{875}$ l/h = $\boxed{14.6}$ l/min)
density of salinity Below (10) PPM

12.2 Data to be measured and allotment

Undermentioned items are to be measured and recorded. allotment

(1) Pressure of feed water	(Q.C. 2)
(2) Pressure in shell	(")
(3) Pressure at ejector inlet	(")
(4) Pressure at distilled water pump outlet	(")
(5) Temperature in shell	(")
(6) Temperature of jacket cooling water inlet and outlet.	(")
(7) Temperature of cooling sea water inlet and outlet.	(")
(8) Heading of flow meter	(")
(9) Density of salinity	(")

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13. Other Test

13.1 Magnet compass adjustment

Deviation of magnet compass is to be adusted and confirmed at sailing off.

13.2 Echo sounder adjustment

Echo sounder adjustment is to be carried out at sea trial conveniently by comparing with the depth on chart.

13.3 Direction finder adjustment

The adjustment should be conducted as follows :

1) A radio station boat to be run clockwisely and anticlockwisely around the ship in stand-still sending signal wave about 410 KHz continuously.

   Meanwhile the direction to the boat to be detected from the ship by means of "Direction Finder" and vessel detector at every 5 degrees.

2) The distance between the ship and the boat will be kept 1 – 1.2 Kilometers.

13.4 Auto pilot test for rudder operation

Working of total unit is to be confirmed by continuing to run ahead for about 30 minutes.

13.5 Underwater log adjustment

Given results of indicated value of magnetic log speed indicator is to be recorded at progressive speed trial. Then error adjustment shall be done on the basis of above values.

13.6 Auxiliary boiler accumulation test (only for first vessel)

Confirm the pressure in boiler drum is less than 110 % (8.8 kg/cm^2) of restricted pressure under below condition for 15 minutes.

(1) Oil burning of auxiliary boiler shall be maximum loaded condition when exhaust gas economizer is under maximum loaded condition of main engine.

(2) All of the stop valves shall be closed except for valves on steam supply line to necessary machineries for maneuvering of main engine and auxiliary boiler.

Then, safety valve of auxiliary boiler is blasted. The pressure in boiler drum at this time shall be measured and examined within 110 % of restricted pressure.
Where, feed water necessary for maintaining the safety level of water in boiler drum may be fed to auxiliary boiler in this case.

13.7 Exh. gas economizer safety valve test

The action and setting of the exh. gas conomizer safety valve to be confirmed.
Set press. 12.0 Kg/cm^2

C. M/E SAFETY DEVICE & OTHER TEST

1. M/E Emergency Trip Test by Manual

Push the emergency stop button on control stand and confirm the stop condition.

2. M/E Safety Cut-Out Test & Overriding Test

Make the cut-out condition by the following set points and confirm the stop condition.

	SET POINT	NORMAL
* Bearing L.O. low press.	1.2 kg/cm^2	1.5-2.5 kg/cm^2
* Jacket cooling F.W. low press.	2.5 "	3 - 4 "
Piston cooling F.W. low press.	3.0 "	3.5-5 "

Also, confirm resetting to be possible by moving the speed setting lever to "STOP" position after restoring of the failed low press.

Furthermore, confirm that override of main engine is effective by pushing the emergency run button without restoration of the failed pressure of Jacket and/or Piston cooling water.

NOTE : The actual confirmation to be carried out ~~by the cases with * marked.~~

3. M/E Aux. Blower Operation Test

Confirm the aux. blower to be operated automatically by the scavenging pressure.

Auto. start	0.36 kg/cm^2
Auto. stop	0.44 kg/cm^2

D. MEASURING POSITION IN MACHINERY SIDE

allotment

1. Main Engine (Mach. part)

1.1 Load indicator position

1.2 Governor indicator

1.3 Pressure

o Jacket cooling water
o Piston cooling water
o Bearing L.O.
O Cross head L.O.
o Fuel valve cooling water
o Scavenging air
o Starting air (only for starting test)
o Differencial air pressure of air cooler
o Back pressure at exh. gas common pipe

1.4 Temperature (Hach. part)

o Fuel oil inlet
o Lub. oil inlet
o Thrust bearing
o Piston cool. water islet
o Piston cool. water out of each cylinder
o Jacket cooling water inlet
0 Jacket cooling water out. of cash cylinder 2 common out.
o Fuel valve cooling water in. & out.
0 Air cooler outlet air
o Cooling sea water inlet & outlet of air cooler
o Erh. gss of common main pipe

2. Turbo Charger for Main Engine (Mach. part)

2.1 Pressure

l Blower inlet air pressure

2.2 Temperature

- Blower air inlet & outlet
- l Cooling fresh water inlet
- Cool. fresh water inlet & outlet of casing
- Turbine side L.O.
- o Blower side L.O.

3. Diesel Generator (Mach. part)

3.1 Output (KW, voltage, current & frequency

3.2 Revolution

3.3 Load indicator

3.4 Pressure

- O Cooling fresh water
- o Lub. oil
- o Fuel oil
- o Charging air (air cooler outlet)

3.5 Temperature

- o Cooling fresh water inlet
- o Cooling fresh water out, of each cylinder
- 0 Brh. gas outlet of each cylinder
- o T/C cool. water out. of turbine & blower side
- o Cooling fresh water in. & out. of F.W cooler
- o Cooling sea water outlet of F.W. cooler
- o Bearing

3.6 Opening indicator for air operated temp. control valve

4. Other Auxiliary Machine

4.1 Inlet & outlet Pressure and motor ampere for pump (Mach. part & Q.C. 3)

- Cooling sea water pump
- Jacket cooling water pump
- Piston cooling water pump
- Inb. oil pump
- **Fuel valve cooling water pump**
- Fuel oil booster pump
- Stern tube L.O. pump
- Aur. feed water pump
- Boiler water circulating pump
- Sea water service pump
- Cross head L.O. pump

4.2 Temperature (Mach. part)

- Jacket fresh water cooler (fresh water in. & out.) (cool. sea water out.)
- Piston fresh water cooler (fresh water in. & out.) (cool. sea water out.)
- Lub. oil cooler (inb. oil in. & out.) (cool. sea water out.)
- Atmos. condenser (hotwell temp.) (cool. sea water out.)
- H/E fuel oil heater (fuel oil in. & out.)
- H/E fuel valve heater (fresh water in. & out.)
- Cooling sea water pump out.

4.3 Opening indicator for air operated temp. control valve (Mach. part)

- Jacket
- **Piston**
- **Lub. oil**

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(Mach. part)

5. Other Tcmperature

5.1 Engine room

5.2 Control rooom

5.3 Atmosphere

5.4 Sea water (sea water service pump suction)

(Mach. part)

5. Other Temperature

5.1 Engine room

5.2 Control room

5.3 Atmosphere

5.4 Sea water (sea water service pump suction)

E. ABSTRUCTED RESULTS OF SEA TRIAL

KIND OF TRIAL	TRIAL NO.	SPEED (KNOT)	RPM	BHP	POSI. OF SPEED SETTING HANDLE x/	POSI. OF LOAD INDICATOR x/	PRESSURE kg/cm^2								TEMPERATURE °C						CHARGER RPM	F.O. CONSUMP.
							GOVERN. SPEED SETTING AIR	WORK CYL. MAX.	CYL. COOL. WATER	FUEL VALVE COOL. WATER	MAIN GEAR. LUB. OIL	PISTON COOL.	CHARG. AIR	CROSS HEAD LUB. OIL	CYL. COOL. WATER IN.	CYL. COOL. WATER OUT.	PISTON COOL. WATER IN.	PISTON COOL. WATER OUT.	SEA WATER	T/C EXH GAS INLET		

WEATHER		DRAFT (M)			DISPLACEMENT (K TON)	REMARKS	
SEA CONDITION		AFT.	FORE.	TRIM			
PLACE							
WEIGH ANCHOR		KIND OF FUEL					
CAST ANCHOR							

BUILDER