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TECHNOLOGY TRANSFER PROGRAM (TTP)

FINAL REPORT

STANDARDS

STANDARDS
VOLUME 2 APPENDICES

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TABLE OF CONTENTS

APPENDIX A

STANDARDIZATION

AND

MODULARIZATION IN SHIPBUILDING

UNIVERSITY OF MICHIGAN

SHIPBUILDING SHORT COURSE

October 27-31, 1980

STANDARDIZATION AND MODULARIZATION IN SHIPBUILING

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CONTENTS

A P " ' FP

Transverse Frame Space L=Lbp

Space (mm) / L(m)	Spa	Se	Sm: Tanker & Ore C.	Sm: Bulk C. Cargo	Spf
90≤L<100	600	700	3,800	not stand-ardized	2,000-2,400
100≤L<120	700	750			
120≤L<150					
150≤L<200	800	800	4,600	800	2,440-3,000
200≤L<250		900	4,800		
250≤L<290	900		5,000		
290≤L<320			5,300		
320≤L			5,100 (Hor.Main)		3,000-3.300

Longitudinal Space B=Breadth mld.

Space (mm) / B (m)	Longl. Space: Deck & Bottom	Longl. Space: Side
B<16	not Standardized	
16≤B<23	750	750
23≤B<32.2	800	800
32.2≤B<54.5	850	850
54.5≤B	940	850

Figure 3. Standard frame space modules.

But , in spite of these obstacleks, the shipbuilders have tried, slowly but steadily, to introduce standarixation into shipbuildinq. Looking through the past record of SNAME's, it is very interesting to discover that "standardization" for shipbuilding had been discussed as early as 1900. Even then, the concept of standard ships had been proposed, and suggestions were made to standardize ships in the same manner as automobiles, giring them nicknames like “Ford ships,” “Buick Ships,'' Dodge ships,''and so on.

This concept of stancdard ships did come to realization in the two Wcrld Wars, especially during World War II when the United States played the major role in mass-producing thousands of freighters and tankers, well known as “Liberty ships,” “Victory ships,” and “T2’s”. Japan also produced series of “wartime standard ships,” ranging up to 10,O00 DWT. These ships were highly rationalized in design and were mass-produced simultaneously in several shipyards to fulfil the huge demand of tonnage required in wartime transportation.

But after the war, the concept of standard ships gradually receded. The requirements for individual ship designs became so diversified and sophisticated that the shipbuilder had to retreat to the traditional “tailored” design to satisfy the various requirements of their clients. But in the early 1960’s, the booming demand for new ship construction offered a good opportunity to the shipbuilders to reintroduce standardization to rationalize and improve their productivity.

Naturally, the standardization started from components and then expanded to modular units, systems, and eventually to whole ship designs.

In the late 1960’s, most leading European and Japanese shipyards presented series of standard ships, mostly tankers, bulk carriers, and multi-purpose cargo ships, into the market. But since the oil crisis, triggered by the Suez War in 1973, a deep depression in the shipping market again reduced the demand for standard ships.

It is quite obvious that standard ships will be meaningless to the ship yard unless they have sufficient orders to build them continuously in series. But this does not mean that standardization must be wiped out from shipbuilding. Irrespective of the ship’s type, size, or sophistication, there are many components, equipment groups, or systems which still have similar *or* common features that could be standardized or modularized.

II. BASIC CONCEPT OF STANDARDS AND MODULES

The terms "standard" and "module" used in this text have the following meaning:

A "standard" is a basic element, component, or unit used for hardware, or, a basic rule or criterion used for software, that should not be changed, irrespective of the system they belong to.

A "module" is a basic groug or formation of standard and optional components that could be used as a complete unit or could be replaced partially by other standard or optional components. in other words, a "module" is an integrated, predetermined group of components and/or output data which could be retrieved by a simple input code.

Basically, a "standard" is a fixed concept which should be strictly followed by the designer or worker. It identifies the quality and the design philosophy of the product and it could be classified into:

- Material standards, which include:
  - Raw material, such as steel plates, sections, pipes, etc.
  - Basic components, such as bolts, nuts, flanges, valves, pipe pieces, gaskets, cables, ropes, paints, etc.
  - Standard fittings and units, such as anchors, chains, doors, ladders, mooring fittings, cargo blocks, furnitures, pumps, motors, etc.

A material standard may refer to an item that is manufactured, or to one that is purchased as a finished product.

- Engineering standards, which include:
  - Design standards, such as design criteria, specifications, etc., for systems or hardware.
  - Production engineering standards, such as procedures and processes of lofting, fabrication, welding, outfitting work, etc.
  - Inspection standards, such as accuracy, testing methcds and procedures, quality control, etc.

On the other hand, "modules" are more diversified and flexible than "standards." A module provides basic system models, units, machiney and

III. STANDARDIZATION IN THE JAPANESE SHIPBUILDING INDUSTRY

The Japanese shipbuilding industry fully realized the necessity of establishing shipbuilding standards in the late 1940's when Japanese shipbuilders began to revive and strengthen their shipbuilding capacity. Under the auspices of the Society of Naval Architects of Japan, (SNAJ) , the major shipyards jointly formed several working groups and committees to establish design standards, hull construction standards, outfitting standards, testing and inspecticn standards, etc., as a common basis for design and production. In parallel, national marine standards were established by the Japan Marine Standards Association in coordination with the shipbuilding and pertinent marine industries, and the standards thus established formed part of the Japanese industrial Standard (JIS), enacted by the Ministry of TransPort. JIS standards cover various marine camponents, equipment, machinery, electric and electronic appliances, test procedures, etc., as well as materials and components that could be used in common with other industries.

Marine JIS standards are classified into the following:

- Fittings (about 190 items), covering Varios mooring fittings, anchors, anchor cables, davits, derricks, hatch covers, manholes, steel doors, round scuttles, windows, ventilators, ladders, life boats and davits, galley equipment, pipe fittings, cargo blocks, navigation equipments, etc.
- Engines and Valves (about 190 items), covering design criteria, material specifications, and test codes for various machinery, instruments, valves, strainers, filters, pipe flanges and joints, tools, etc.
- Electric Appliances & Navigational Instruments (about 110 items), covering various electric lamps, lights, projectors, batteries, signal lamps, engine telegraphs, switches, distribution boards, etc.

These JIS standard fittings and components are manufactured by specialized manufacturers in accordance with JIS specifications and, after testing and type approval, these manufacturers are authorized to distribute their products stamped with a "JIS" mark.

In addition to these national standards and volunatory consensus standards of the marine industry, most shipyards have established their own supplementary .standards in areas which are not covered by the former two categories, mainly, to rationalize product%on processes and facilities. Figure 1 shows a sample of in-house standards currently adopted by IHI.

These standards are basically organized into two main categories: "IS," which are “Basic Standards,” and “SD,” which are the “Standard Drawings.”

“IS” includes basic standards which must be strictly obeyed by the designers or the workers, and is further divided into “Material standards (SO)” and Engineering standards (SOT).”

In addition to the “IS” basic standards,, ”SD” provides the standard or guidance drawings for machinery and outfitting layouts, basic system modules, manuals and practices, etc., which can be utilized in routine design and production work. Besides the basic modules, “SD” allows some flexibility in application to meet individual requirements. Figure 2 shows the number of standards currently adopted in IHI*s shipbuilding operation.

These standards are controlled and up-dated by special control groups . in tile design department. Up-dating is mainly based on feedback from semice engineers aboard ships during the guarantee period, and also from the production line for improvement in productivity.

The number of standards is kept to a minimum by identifying and canceling those which are found to be obsolete *or* not worth keeping.

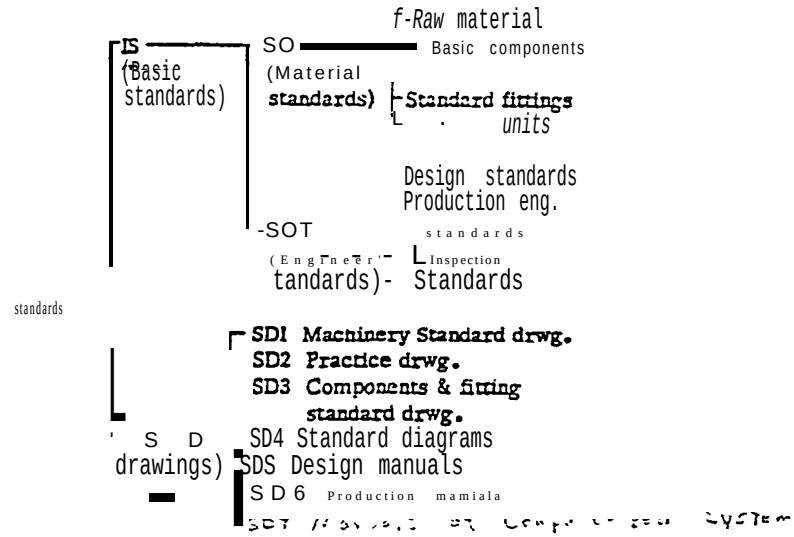


Figure 1. Classification of shipbuilding standards.

Classification of Standars				Nos.
IS	ISO	Material Standards	common Components	600
			Hull fittings	600
			Machinery fittings	200
			Electric fittings	
		Sub-total		1,600
	SOT	Design standards		1,100
		Production eng. standards		100
		Inspection standards		200
		Sub-total		1,400
SD		Machinery drawings		1,200
		Component and fitting, standard drawings		350
		Other guidance drawings		350
		Sub-total		1,900
Grand total				4,900

Figure 2. Numbers of standards in current practice.

IV. PROCEDURES OF STANDARDIZATION AND MODULARIZATION

Standardization . is 2 tedious and cumbersome job that requires full investigation of the ships' systems and their features to establish good and useful Standards. In a sense, "standards" are often misconceived as "cheap and poor quality" products, but this is not the way "standards" should be established. Standard materials should be of high quality and durable to assure a trouble-free and reliable product. The performance of these standards should be observed incessantly and improved or updated to debug any defects or to keep up with the state-of-the-art. It is also imporant to keep the number of standards to a minimum.

The first step to standardization is to identify basic material, components, and fittings that are commonly used in all types of ships. Most raw material specifications are specified by national standards or classification society rules, so it is only necessary to standardize sizes or thicknesses, based on manufacturers' standard market products, considering the frequency of usage, shop facilities, storage, etc. Canponents or fittings that are standardized end readily available in the market can be used directly as in-house standards. This concept can also be extended to basic machinery or equipment, such as pumps, motors, lifeboats, hatch covers, etc., selected from makers' standard models which are proven to be reliable from past experience. In this case, at least two manufacturers' models of similar characteristics should be selected to allow flexibility in purchasing.

Standards for design and engineering should be systematized and categorized into systems and/or production processes. Standard specifications and calculation formulae *or* sheets can be used to unify the design criteria, quality, functions, and *work* practices of the systems. Supplementary data and manuals to support these standards are also necessary to identify the rationale of the standardized" items. This assists the user in understanding the logic of the various standards, and in extrapolating to applications which are beyond the standards. The next step is to expand these standards into modules.

The ship's hardware consists of numerous systems involving thousands of structural and mechanical components. But most of these cmnponents can be

divided into a number of groups having similarity or commonality in their shapes, sizes, or characteristics.

A ship construction *can* also be categorized into several functions, such as hull structure, exterior and interior hull outfitting, machinery outfitting, and electrical outfitting. Also, the design phase of each category can be divided into “functional design” and “arrangement design.”

The functional design phase defines the system to perform the required functions, and can be sub-divided into:

(1) Determination of particulars.

(2) *System* design and function checks.

(3) Diagrammatic and skeleton design.

The arrangement design phase develops the physical aspects *of* the system as defined by the functional design. Arrangement design can be divided into the following steps:

(1) Allocation of machinery and equipment (such as general arrangement end machinery arrangement).

(2) Detailed structures, piping *arrangement,* access arrangement, etc., based on general arrangement and machinery arrangement plans.

(3) Development of working plans, such as composite plans, fitting plans, fabrication and manufacturing drawings, etc.

In modularizing the design, the systems involved must be carefully analyzed in relation to the design steps, and separated into “invariable” and “variable” elements. The “invariables” can then be formed into “standard modules” which will be mostly composed of Standard components described previously. The “variables” should be left flexible and easily changeable to meet specific design requirements. A series of “optional modules” could also be pre-established to serve as “variables.”

so by standardizing the components and cumbining them in suitable modular units, it is possible to establish a series of standard modules which can be applied in various systems having similar functions or characteristics. In order to meet the specific requirement of a client, these standard modules can be replaced or supplemented by other standardized optional modules. By this means, a *tailor-made design is available with minimum* effort without interfering with the standardization principle.

This way of standardization has been successfully applied in the automobile industry. In buying a new car, one can select the style among several brands using the same chassis, two doors or four doors, v6 or v8 engine, manual or automatic transmission, interior and exterior finishings, power windows, remote locks, AM/PM radios, stereos, etc.

V. TYPICAL APPLICATIONS OF STANDARDS AND MODULES

Standards and modules are not only useful as the basis of design, but are also useful as the basis for purchasing, material contro1, production processes, and quality control, integrated as a total system. The introduction of large computers will serve an important role in integrating the whole system.

The following are some typical applications of standards and modules in various stages from design to production.

5-1. BASIC DESIGN

At the basic design stage, the work is mostly concentrated on functional design. Therefore, engineering standards, specifically design standards, will play the predominant role at this stage.

standardization of ship construction specifications, hull-form characteristics, design criteria for various systems, structural analysis methods, calculation forms, etc., will insure consistency in design philosophy and ship's quality.

Standard modules will also help the designer to decide system arrangements speedily without making serious errors.

A. Frame Spacing and Hull Dimensions

The first example is the application to hull design which can be standardized or modularized in two ways. One is the "Frame space module" applied to longitudinal and transverse framing, and the other is the "Base ship module" which embodies modularization of hull dimensions.

Frame Space Modules. Figure 3 shows a list of "frame space modules." In the past, most designers selected the frame space for each ship design to obtain minimum steel weight. But the saving in steel weight is now not significant enough to contribute in reducing the ship's cost. On the contrary, soaring labor costs have become a more serious problem. So the philosophy has changed in recent years to reduce labor manhours radically by introducing mechanized and automated equipment in the fabrication and assembly stages of the hull construction process. But in order to use such equipment efficiently, the variety of frame spaces must be narrowed to a number of compatible

A P " ' FP

Transverse Frame Space L=Lbp

Space (mm) / L(m)	Spa	Se	Sm: Tanker & Ore C.	Sm: Bulk C. Cargo	Spf
90≤L<100	600	700	3,800	not stand-ardized	2,000-2,400
100≤L<120	700	750			
120≤L<150					
150≤L<200	800	800	4,600	800	2,440-3,000
200≤L<250		900	4,800		
250≤L<290	900		5,000		
290≤L<320			5,300		
320≤L			5,100 (Hor.Main)		3,000-3.300

Longitudinal Space B=Breadth mld.

Space (mm) / B (m)	Longl. Space: Deck & Bottom	Longl. Space: Side
B<16	not Standardized	
16≤B<23	750	750
23≤B<32.2	800	800
32.2≤B<54.5	850	850
54.5≤B	940	850

Figure 3. Standard frame space modules.

modules.

Of course, in selecting the frame space modules, the influence on hull Steel weight has to be carefully analyzed to restrain the weight increase to minimum. Also, the influence on outfitting, such as layout of cabins, pipe and cable ducts, etc., should be checked to assure that adequate space or accessibility is available by using the standard frame spaces.

Standard frame space modules permit the efficient use of rationalized and automated production facilities which, in turn, provide higher accuracy and quality in fabrication and assembly work. Figures 4, 5, and 6 show some of the machines used for fabricating and *assembling* steel structures in one of IHI's shipyards. These machines are all designed to match the frame space modules and, as a result, have played a great role in reducing manhours, not only by replacing man-power, but also by diminishing adjustment work due to their high accuracy in fabrication and assembly work.

Base Ship Modules. The "base ship module" concept is an extension of the "frame space module" applying to the selection of hull dimensions. This concept is useful in establishing "standard ship" designs, such as for tankers and dry bulk carriers. It is essential to conduct research in the worldwide shipping *market to seek* the demands of ship types, sizes, cargo flows, physical limitations in harbors, etc., to establish the characteristics of the "base ship . "

The "base ship" can be utilized as a basic hull form for a series of ship designs, and by selecting several sizes of "base ships" it would be possible to cover the major part *of the market* demand. *Each "base* ship" should be optimized in hull form and dimensional ratios but allowing some resiliency in length, depth and draft within predetermined limits to maintain the ship's functional properties. Figure 7 exemplifies how to modify the dimensions of a "base ship."

To decide hull dimensions for a specific requirement, a "base ship" having the nearest dimensions and functional properties is selected. TO modify the hull dimensions, the fore part and the aft part (including engine room) of the "base ship" remain unchanged, and the necessary modifications will be made on the ship's parallel body.

In order to obtain the required cargo capacity, draft, or deadweight, the

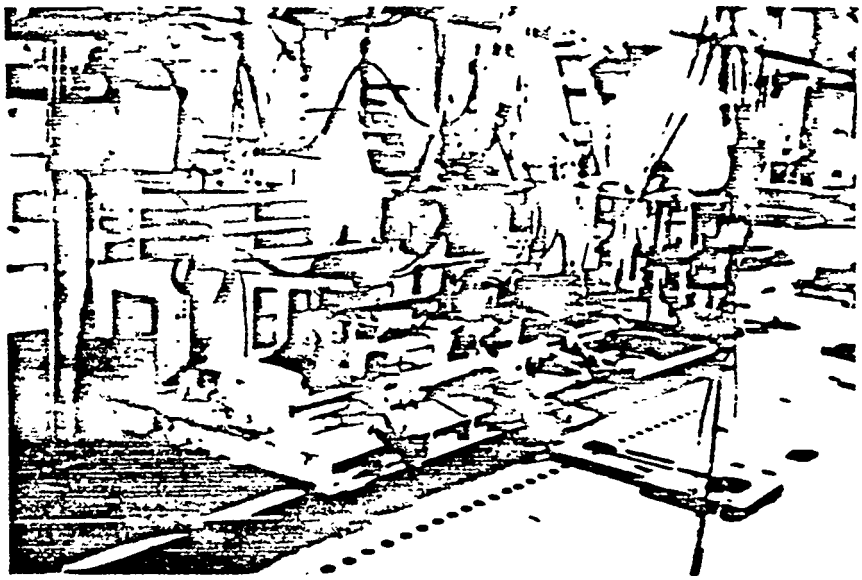


Figure 4. Multi slot machine.

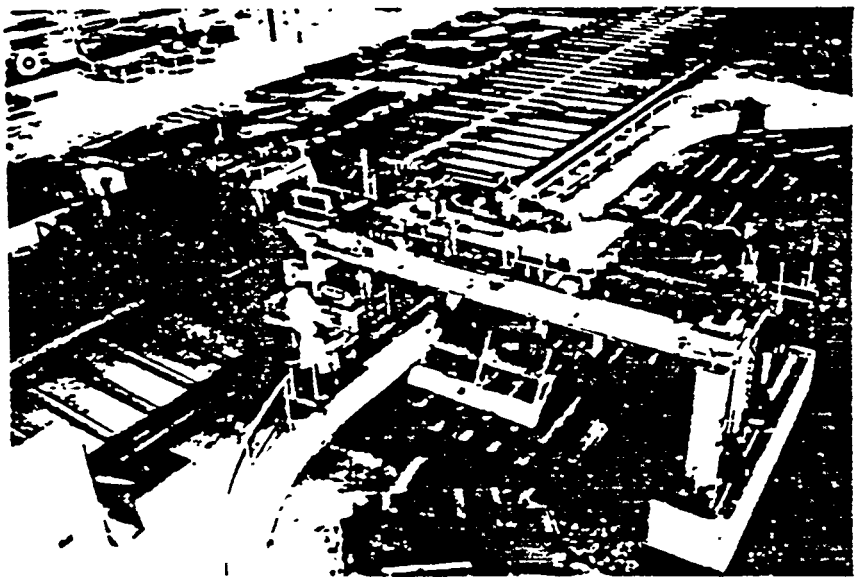


Figure 5. Submember assembly machine.

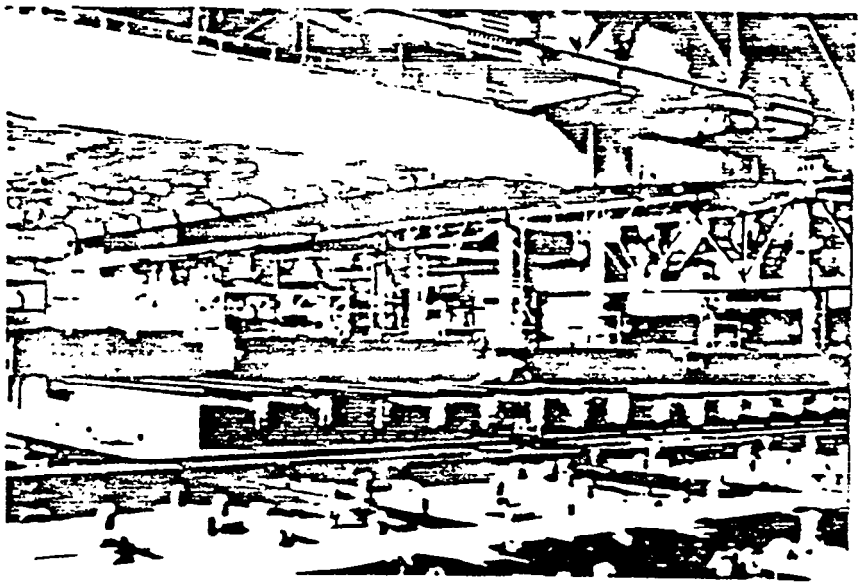


Figure 6. Longitudinal frame assembly machine.

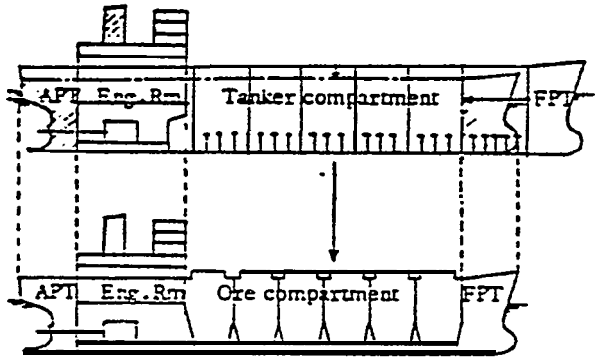


Figure 7. Example of base ship modification.

ship's length will be adjusted by adding or deducting multiples of transverse frame space modules, and similarly, the ship's depth will be adjusted by multiples of longitudinal frame space modules in the case of longitudinally framed ships.

The limitations of extension or reduction of the ship's length or depth will be predetermined by checking the influence on the hull weight and speed to avoid extraordinary deviations. Figure 8 shows a chart of the typical base ship variation limits.

The cargo compartment will also be left interchangeable so that any type of cargo section, such as for a tanker, ore carrier, or bulk carrier, can be inserted. Figure 7 shows the base-ship tanker modified to an ore carrier.

The midship section of the cargo compartment will be modularized to match with the frame space module and the standard ship's breadth, which is usually limited by the breadth of the building berth or the building dock. In other words, for *a* fixed ship's breadth, the hatch breadth of a bulk carrier or an ore carrier, or the disposition of longitudinal bulkheads of a tanker or an ore carrier, will remain unchanged irrespective of the adjustment in the ship's length or depth.

By adopting these base ship" modules, the designer can easily select the required dimensions and cargo sections based on pre-studied data, so there is no necessity to start from scratch. This permits great savings in design work without impairing the ship's functions.

At IHI, the advantage of "base ship" modules was enhanced by adopting the "working unit" in hull erection *work.* Figure 9 shows a "working unit" designed for work in the wing tanks of a standard VLCC. The "working unit" is a mobile construction machine designed to incorporate hydraulic clamping devices, automatic welding equipment, movable stages (or scaffolding), and other necessary appliances required for hull erection. The unit is designed to fit within the structural configuration of the "base ship", and travels on portable rails laid on the floor of the hull structure. The unit moves lengthwise in accordance with a predetermined construction schedule so all work must be completed and inspected before the unit moves to the next position. Careful planning of production seqences and time scheduling is

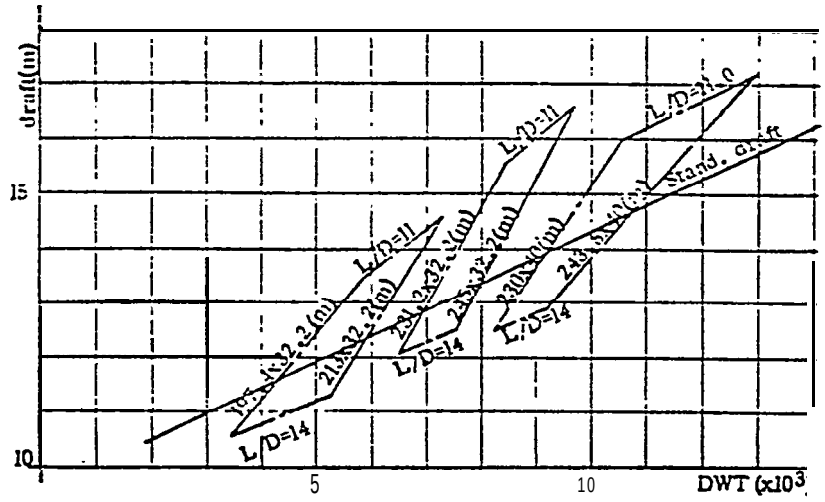


Figure *8.* Example of base ship variations.

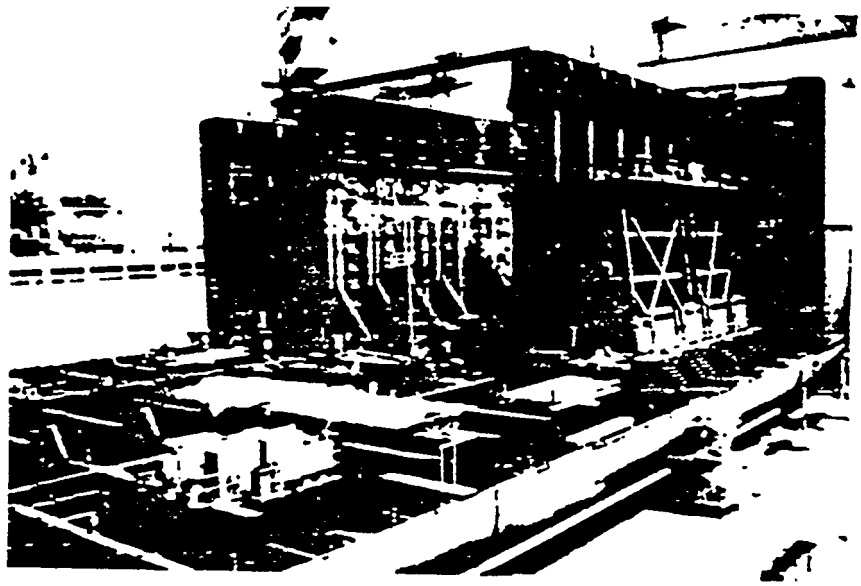


Figure *9. working unit.*

required for smooth and punctual operation.

By using these "working units", the following advantages were obtained:

(1) All portable scaffolding in the cargo compartment could be omitted. In the case of a VLCC, about 15,000 stage planks had been required.

(2) Working and production procedures, such as sub-dividing work zones, and sequencing of fitting-welding-painting-inspection *work* flow, became established. Also, production scheduling, material handling, work force *deployment, testing and* inspection scheduling, etc., could be precisely controlled.

(3) All work can be executed on safe-guarded platforms, so this safe working *environment* led to improvements in productivity and quality.

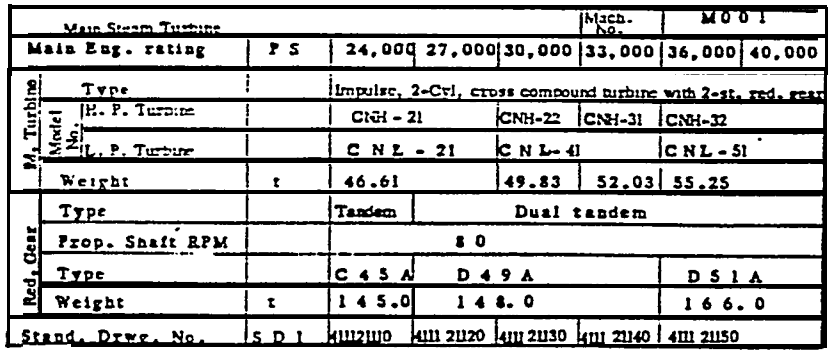
B. Machinery Modules

When the engine power required for the propulsion plant has been decided, the machinery designer starts planning its associated machinery, piping systems, and their layout. The following are some examples of the modules utilized in machinery design.

Propulsion Engine Particular Modules. The systems and ancillary machinery pertinent to the type of main engine are virtually invariable. Therefore, the particulars of pumps, heat exchangers, etc., can be pre-determined and standardized without interfering with other systems. Some options could be left to meet specific requirements of the clients, such as number of standby pumps, purifiers, and so on.

Figures 10 to *13* show examples of the particular module for propulsion steam turbines with some of its pertinent ancillary machinery. Similar modules can also be established for diesel propulsion plants, classified by engine types and ratings. All modules are stored in the computer data bank, so when the main engine is selected, the designer can automatically obtain all ancillary machinery particulars by simply inputting the key data into the program.

Machinery Layout Modules. The physical arrangement of machinery and equipment in the engine room will be laid out as soon as their particulars are decided. Most of the machinery is grouped into systems, such as cooling

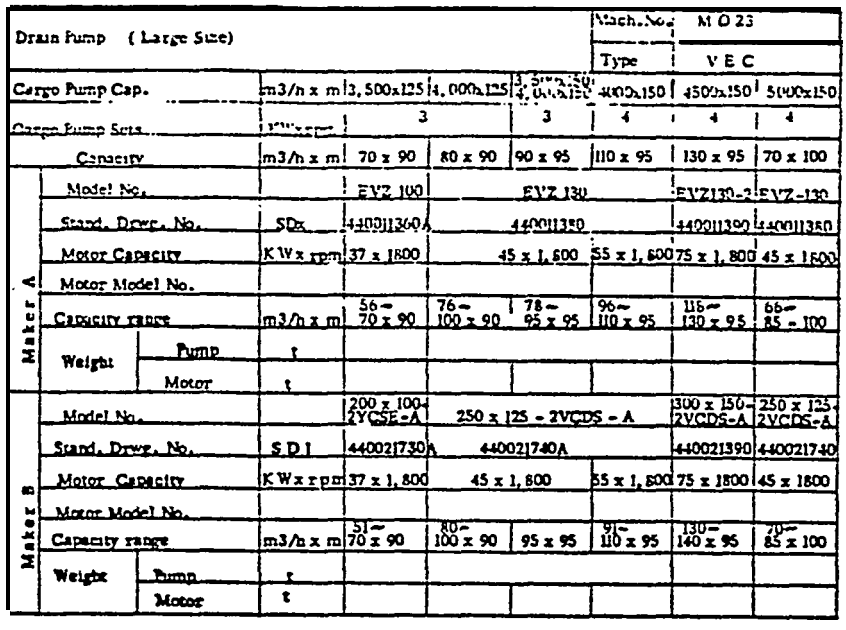


Main Steam Turbine					Mach. No.	M 0 0 1	
Main Eng. rating	P S	24,000	27,000	30,000	33,000	36,000	40,000
M. Turbine — Type		Impulse, 2-Cyl, cross compound turbine with 2-st. red. gear					
M. Turbine — Model No. — H. P. Turbine		CtGH - 21		CNH-22	CNH-31	CNH-32	
M. Turbine — Model No. — L. P. Turbine		C N L - 21		C N L- 41		C N L - 51	
M. Turbine — Weight	t	46.61		49.83	52.03	55.25	
Red. Gear — Type		Tandem	Dual tandem				
Red. Gear — Prop. Shaft RPM		8 0					
Red. Gear — Type		C 4 5 A	D 4 9 A			D 5 1 A	
Red. Gear — Weight	t	1 4 5.0	1 4 8. 0			1 6 6. 0	
Stand. Drwg. No.	S D 1	4111 2110	4111 21120	4111 21130	4111 21140	4111 21150	

Figure 10. Typical machinery particular module.

Main Condenser Pump						Mach.No.	M O 21	
						Type	V E C	
Main Eng. Rating		P S	24,000	27,000	30,000	33,000	36.000	40.000
Capacity		m3/h x m	70 x 95	75 x 95	85 x 100	90 x 100	100 x 100	110 x 105
Maker A — Model No			E V Z 130					EVZ 131-2
Maker A — Stand. Drwg. No		S D 1	4400113801					4400113911
Maker A — Motor capacity		KW x rpm	37 x 1800	45 x 1800		55 x 1800		75 x 1800
Maker A — Motor Model No.			225S	225M		250M		280S
Maker A — Capacity range		m3/h x m	70 x 95	71 x 95 90 x 95	66 x 100 85 x 100	86 x 100	100 x 100	103 x 105 130x105
Maker A — Weight	Pump	t	0,59					0,64
Maker A — Weight	Motor	t	0. 25	0. 28		0. 3 4 5		0.46
Maker B — Model No.			250x125-2VCDS-A					
Maker B — Stand. Drwg. No.		SD1	440021740A					
Maker B — Motor capacity			37 x 1800	45x1800		55x1500		
Maker B — Motor Model No.			225S	225M		250M		
Maker B — Capacity range		m3/g x m	70x95	71x95	85 x 1800	86 x 100	100 x 100	110 x 105
Maker B — Weight	Pump	t	0.61					
Maker B — Weight	Motor	t	0 .25	0.28		0.345		0.46

Figure 11. Typical machinery particular *module.*



Drain Pump (Large Size)						Mach. No.	M 0 23		
						Type	V E C		
Cargo Pump Cap.		m3/h x m	3,500x125	4,000x125	3,500x150 4,000x150	4000x150	4500x150	5000x150	
Cargo Pump Sets			3		3	4	4	4	
Capacity		m3/h x m	70 x 90	80 x 90	90 x 95	110 x 95	130 x 95	70 x 100	
Maker A	Model No.		EVZ 100		EVZ 130		EVZ130-2	EVZ-130	
	Stand. Drwg. No.	SDx	440011360A		440011380		440011390	440011380	
	Motor Capacity	KWx rpm	37 x 1800		45 x 1, 600	55 x 1, 800	75 x 1, 800	45 x 1600	
	Motor Model No.								
	Capacity range	m3/h x m	56~ 70 x 90	76~ 100 x 90	78~ 95 x 95	96~ 110 x 95	116~ 130 x 95	66~ 85 ~ 100	
	Weight Pump	t							
	Weight Motor	t							
Maker B	Model No.		200 x 100- 2YCSE-A	250 x 125 - 2VCDS - A			300 x 150- 2VCDS-A	250 x 125 2VCDS-A	
	Stand. Drwg. No.	S D 1	440021730A	440021740A			440021390	440021740	
	Motor Capacity	KWx rpm	37 x 1, 800	45 x 1, 800		55 x 1, 800	75 x 1800	45 x 1800	
	Motor Model No.								
	Capacity range	m3/h x m	51~ 70 x 90	80~ 100 x 90	95 x 95	91~ 110 x 95	130~ 140 x 95	70~ 85 x 100	
	Weight Pump	t							
	Weight Motor	t							

Figure 12. Typical machinery particular module.

Drain Pump (Mid-Size)						Mach. No.	M 0 2 3		
						Type	V E C		
Cargo Pump Cap.		m3/h x m	3500x125	4000x125	3500x150 4000x150	4000x150	4500x150 5000x150	5000x150	
Cargo Pump Sets			3		3	4	4	4	
Capacity		m3/h x m	40 x 90	50 x 90	50 x 95	60 x 95	70 x 95	70 x 100	
Maker A	Model No.		E V Z 100					EVZ130	
	Stand. Drwg. No.	S D 1	440011360A					440011380	
	Motor Capacity	KWxrpm	30 x 1, 800			37x1, 8 0 0		45x 1, 800	
	Motor Model No.							225 M	
	Capacity range	m3/h x m	40~55 x 90		50 x 95	51~70 x 95		66 85 x100	
	Weight Pump	t							
	Weight Motor	t							
Maker B	Model No.		200 x 100 - 2VCSE-A					250x125- 2VCDS-A	
	Stand. Drwg. No.	SD1	440021730					440021740	
	Motor Capacity	KWxrpm	3 0 x 1, 800			37 x 1, 800		45 x 1800	
	Motor Model No.								
	Capacity range	m3/h x m	40~50 x 90		50 x 95	51~70 x 95		70~ 85 x 100	
	Weight Pump	t							
	Weight Motor	t							

Figure 13. Typical machinery particular module.

systems, fuel oil systems, L.o. Systems, purifier systems, etc. , to facilitate pre-outfitting in "units."

These individual machinery units are standardized as basic modules. The machinery arrangement of the engine room is designed by arranging these individual modules considering the piping layout, accessibility for maintenance and repairs, and margins for optional requirements. Figure 14 shows part of the machinery layout module of a standard steam driven VLCC.

Modification of an engine room arrangement can be done simply by modifying or replacing the basic modules. Figure 15 exemplifies a modification by adding one drain pump without interfering with the arrangement of other machinery .

Piping Layout Modules. Piping layout modules are developed either as a complete system or a partial unit in connection with the machinery layout modules. Figure 16 is the piping layout module corresponding to the machinery layout module shown in Figure 14. Figure 17 is a partial piping layout module of the drain tank and pumping system which was shown in Figure 15 (B), consisting of one atmospheric drain tank, three drain pumps, piping and instrumentation, assembled in one unit.

5-2. DETAIL DESIGN

The major work at the detail design stage is to convert the system-oriented drawings developed at the basic design stage to zone-oriented drawings. Systems are sub-divided into zones by composite drawings, and work packages (or pallets) are grouped for each zone. Detailed manufacturing drawings of larger machinery and/or outfitting modules are developed at this stage for on-block outfitting by combining or modifying basic modules.

Figure 18 shows the actual unit module of Figure 17. These units are accompanied with corresponding material lists which include the required material data for the module. Material and components of each unit are supplied to the workshop in pallets and assembled there into a camplete package.

"Patterns" and "Panels"

"Patterns" and "panels" are the terms used at IHI for basic modules of

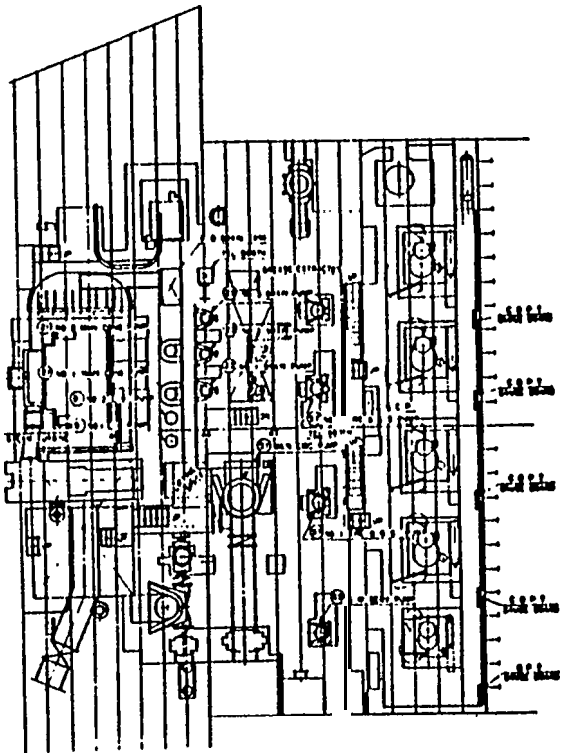


Figure 14. Machinery arrangement module.

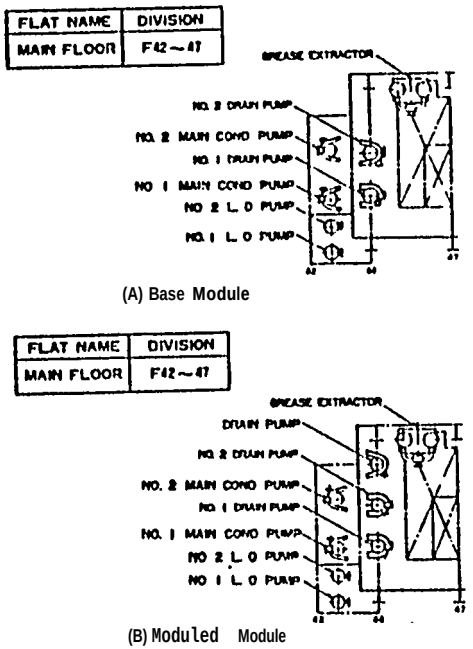


Figure 15. Modification of module. One additional drain pump is added in the modified module.

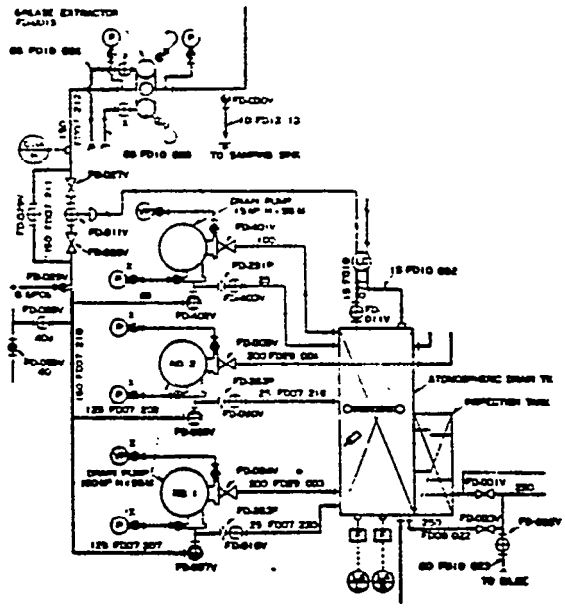


Figure 17. Pipe layout module.

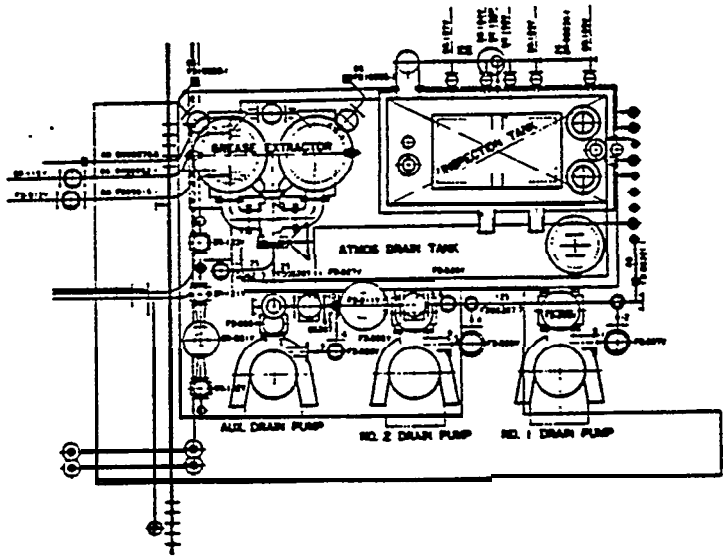


Figure 18. Example of unit equipment.

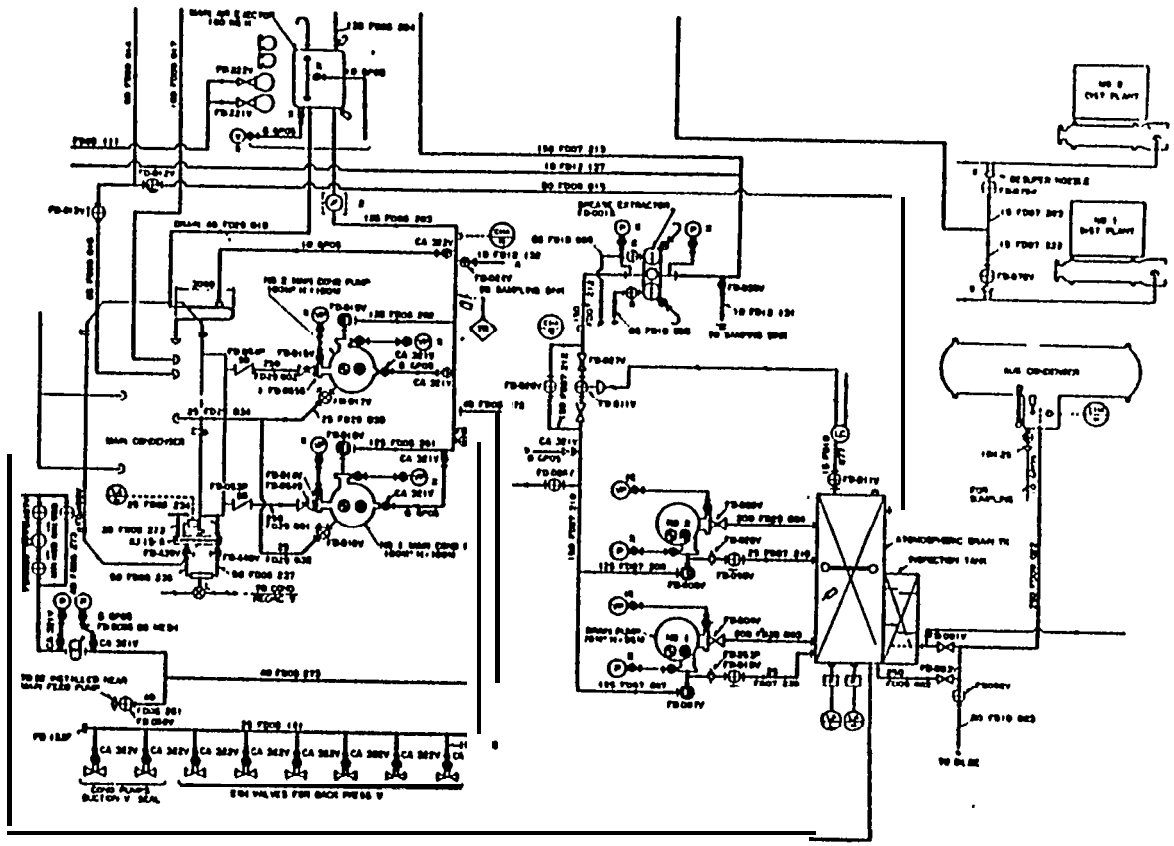


Figure 16. Piping layout module corresponding to the machinery layout module of Figure 14.

various systems. A "pattern" is a conceptual module, such as a partial piping diagram of a system that could be applied to different sizes and types of ships. For example, Figure 19 shows a "pattern" of the compressed air system diagrammatic on the main deck that matches the material ordering zone. The "pattern" is further divided into "panels" which are individual elementary modules of specific configurations, such as A, B and C, and are composed of a group of standard components. Virtually, the "panel" is an "invariable" module, but allowing selection in sizes and pipe detailing and painting to conform with the specifications, and the "pattern" is a "variable" module which could be modified by different combinations of "panels".

The "panel" includes an arrangement plan, a list of material size range, quantities of standard fittings, complete descriptions of pipes and fittings, standard guidance for pipe details and painting, etc., and is filed as the shipyard's standard. For a specific design, the designer retrieves this information from the file, selects the sizes of standard fittings and pipes and, if necessary, modifies the standard guidance to meet specifications requirements, adds non-standard materials and, finally, incorporates them in the material list.

Figure 20 shows patterns and panels of various systems integrated into a composite plan of a specific work zone (pallet). At this stage, exact dimensions, spacing, etc., are defined and entered into the drawings, and a material list of the pallet is created.

By using these patterns and panels, the detail design can be highly rationalized and simplified. Various combinations of patterns and panels of different systems can create machinery and piping layout modules as previously described for utilization in basic design.

5-3. MATERIAL PURCHASING

Material purchasing is a function that plays an important role in acquiring the required material for the ship's construction and feeding it to the production line at the appropriate time. Purchase orders and pertinent specifications must be prepared and distributed to the subcontractor with proper

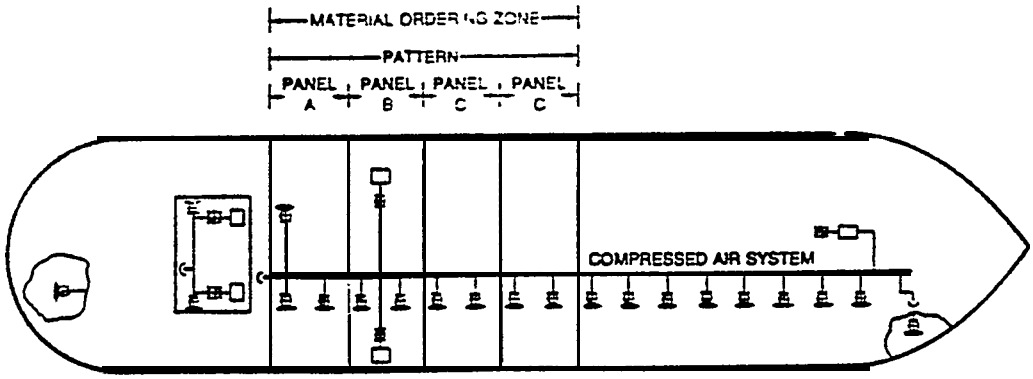


Figure 19. Patterns and panels.

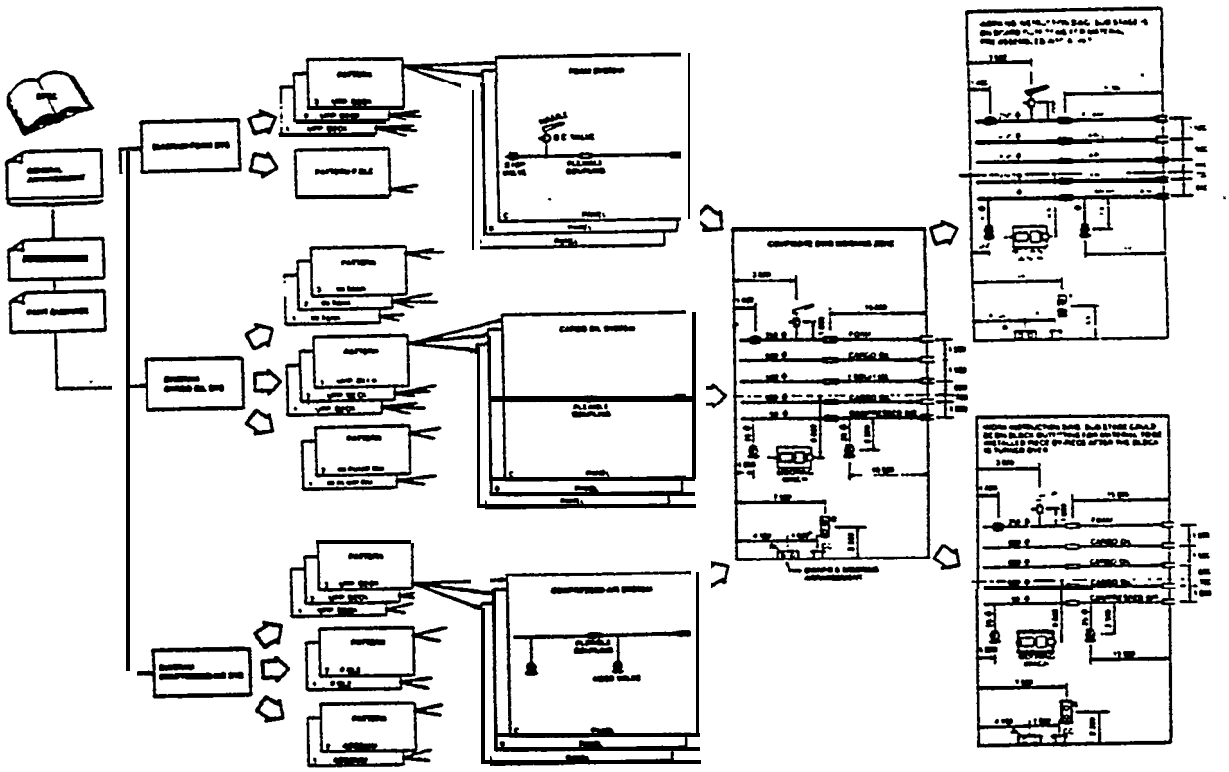


Figure 20. Application of patterns and panels.

consideration of the production schedule and the lead time required for manufacturing and delivery of the material. Also, efforts must be made to minimize stock so that the stockyards or warehouses are not overstocked with redundant material.

Material purchasing is considered as part of the "planning" process, wheareas purchase specifications and manufacturing drawings must be issued by the design department. The issuance of these documents must be precisely scheduled and controlled to meet with the pallet schedules.

Usually, such work as preparation of purchase specifications, evaluation of vendors' proposals, etc., needs a long time before the orders are placed and also requires a great deal of paper work to finalize the contract with the vendors. The time and effort for these works can be considerably reduced if these materials are pre-approved and filed as part of the shipyard's standards.

For example, the Propulsion Engine Particular Module identifies the ancillary machinery required for the propulsion machinery. In this case, the machinery and equipment required for these modules could be pre-selected from several standard catalogue models of competent vendors. These models can be evaluated beforehand by extensive shop tests under shipyard supervision, and those eligible could be registered and filed as supplementary shipyard "standards." Specifications, drawings, test protocols, etc., could all be pre-approved by the shipyard. So, purchase orders can be extremely simplified by issuing a standard purchase order format and simply stating the required model number, quantity and delivery date to the vendor.

5-4. PRODUCTION

AS discussed previously, standardization and modularization will enhance productivity by allowing automated fabrication or assembly machinery to be introduced into the production line. Production scheduling and control can be conducted more precisely and accurately by using statistical records of standard work packages as yardsticks. Standard procedures and/or manuals for welding, pipe fabrication, tolerance, quality assurance, etc., can be used by both designers and workers and they could simplify instructions on individual working drawings.

5-5. COMPUTERIZATION

The rapid progress of computer technology has led to wide application of computers for design and production in the shipbuilding industry. Many shipyards are now using computers for design calculations and analysis, No machines for gas cutting and pipe fabrication, etc. Consequently, shipyards have reslized improved productivity and product quality. But the benefits of computerization cannot be fully enjoyed unless the individual computer processes from design to production are interfaced and integrated to form a "total system."

The total system interrelates design, material control, production, scheduling, and accounting systems. Without standardization, this massive system cannot be established rationally.

In order to file and process the massive data for an integrated system, a large computer and sophisticated software become essential. But shipyards which have little output capacity, or those who have to deal with a variety of one-of-a-kind ships, may not be able to afford to apply full computerization. But at least there are some systems or objects which can still be standardized or modularized to suit small computers, and may provide some benefit.

VI. ADVANTAGES OF STANDARDIZATION AND MODULARIZATION

In conclusion, the concept of “standards” and “modules” is a viable technique to improve shipyard productivity without sacrificing the features of tailor-made designs. This is particularly important when it is realized that the combined use of computers and automated facilities is probably the best approach to modernizing the shipbuilding industry.

Standards and modules are now successfully applied to all ships built at IHI. The greatest achievement of standard ship designs were the F-series ships, nicknamed “Freedom,” “Freedom Mark II,” “Fortune,” "Friendship," and "Future-32," that were developed in the late 1960’s. These ships included various standard options for the client’s selection, and were mass-produced in specially equipped shipyards to maximize production efficiency. For example, IXI’s Tokyo shipyard produced a Freedom ship, (a multi-purpose cargo ship of about 14,000 DWT) in approximately 80 days, and by adopting pre-election and shifting methods, one building berth launched one ship in every 4 weeks.

A total of about 230 ships Of the F-series have been built by IHI since 1967.

The standard tankers and bulk carriers also followed the same concept and the following advantages have been obtained:

(1) Reduction of Manhours. Figure 21 shows the design and production manhours of one of the standard F-series. Figure 21 (A) shows the design manhour curve compared with an unstandardized ship. It may be surprising that the design effort of the first ship required far more manhours than the unstandardized ship, but this reflects the elaborate initial planning required to implement the use of modules in connection with the production sequences, and to facilitate the exercising of various options without interfering with the base design. Figure 21 (B) shows the 1earning curve of the total Production manhours. The manhours dropped steeply to about 80% by the 5th ship and stabilized at about 55% by the 25th ship.

(2) Reduction in construction period. Compared with a similar unstandardized Ship the construction period could be reduced by almost one-half-

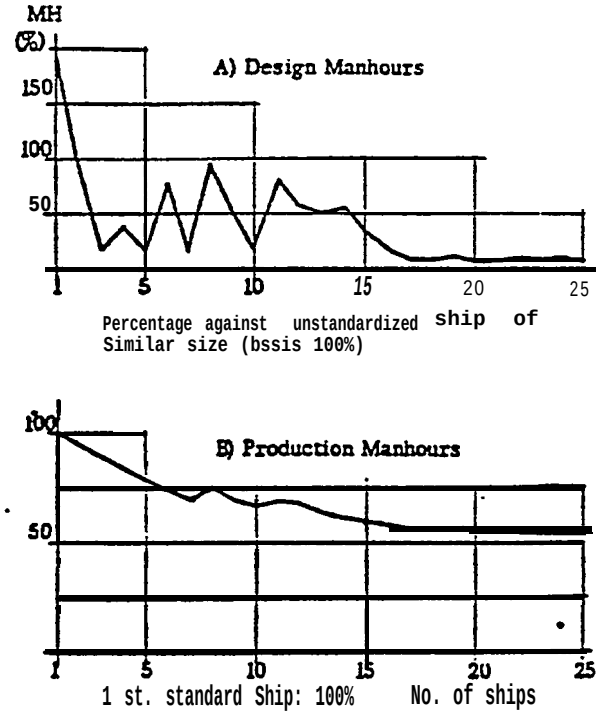


Figure 21. Learning curves of design and production manhours .

(3) Higner quality and reliability of products. Standards and modules are all based on long and proven experience in actual operation. Therefore, they assume high quality and reliability. also, by standardization, equal function and quality could be maintained irrespective of the designer's skill.

(4) Establishment of an integrated design-to-production computer system.

It is true that these advantages are most fully enjoyed in series-built standard designs or vessels of conventional types. Since the standards and modules are confined to systems or items that are most commonly used, there is difficulty in applying them in very special designs, such as systems required for liquified gas carriers, specialized chemical carriers, or other sophisticated ships, since these requirements will occur very seldan. But even then, systems having conventional features can still incorporate standardized and modularized equipment and, thus, contribute to reduction of design and production manhours.

APPENDIX B

F - SHIPBUILDING

F - SHIPBUILDING

General

Glossary of Terms for Shipbuilding (Machinery Part: General)

Glossary of Terms for Shipbuilding (Machinery Part-Propulsion Machinery and Boilers)

Glossary of Terms for Shipbuilding (Machinery Part-Auxiliary Machinery and Equipments)

Glossary of Terms for Shipbuilding (Machinery Part-Instrumentation)

Glossary of Terms for Shipbuilding (Machinery Part-Fittings)

Glossary of Terms for Shipbuilding (Machinery Part: Testing, Working Practice, Miscellaneous)

Glossary of Terms for Shipbuilding (Electric Part)

Small Ships' Schemes of Heat or Sweat Insulation for Pipes

Terminology and Definition of Output of Propulsion Machinery Installed in Ships

Fittings of the Machinery of Ships to be Supplied by Manufacturers

Terminology of Pressure used in Ships

Sea Water Temperature for Designing Marine Heat Exchangers

Coiled Springs for Marine Machinery

Equipment and Adjusting Pressure of Escape Valves for Ship Machinery

Application Standard for Use of Copper Pipes in Ships

Test Code of Propelling Machinery at Sea Trials

Shop Test Code for Marine AC Electric Overhead Travelling Cranes in Engine Room

Standard of Machine Tools Facility in Ships

Size of Spare Part Boxes for Marine Use

Small Ships' Supply Standard for Hull INventory Articles

Hull Parts

Small Ships' Rudder Carriers

Bollards

Cast Iron Dog Type Chain Cable Compressors

Cast Iron Deck End Rollers

Steel Plate Deck End Rollers

Hull Parts (Continued)

Closed Chocks

Open Chocks

Mooring Pipes

Spindle Type Hand Steering Gears

Ships' Hand Steering Wheels

Chain Type Hand Steering Gears

Leading Blocks for Chain Type Hand Steering Gear

Fair-leads

Cast Steel Dog Type Chain Stoppers

Cast Steel Tongue Type Chain Cable Stoppers for Grade 2 Chain Cable

Panama Chocks

Simple Type Bollards

Small Size Cast Iron Deck End Rollers

Small Size Steel Plate Deck End Rollers

Small Size Fairleads

Ships' Horizontal Rollers

Ships' Small Size Cast Steel Cable Compressors (Dog Type)

Ships' Small Size Stand Rollers

Cable Clenches

Fairleaders with Horizontal Rollers

Roller Tongue Type Chain Cable Stoppers for Grade 2 Chain Cable

Roller Dog Type Chain Cable Stoppers for Grade 2 Chain Cable

Double Type Cross Bitts for Tug Boats

Turnbuckles for Lumber Lashing

Chains for Lumber Lashing

Ships' Davits for General Use

Ships' Cranes for General Use

Ships' Cargo Hooks

Ships' Chains for General Use

Ships' Derrick Booms

Ships' Derrick Topping Brackets

Ships' Derrick Gooseneck Brackets

Hull Parts (Continued)

Boom Rest Head Pieces
Ships' Light Load Derrick Topping Brackets
Ships' Light Load Derrick Gooseneck Brackets
Snips' Light Load Derrick Booms
Hatch Cleats
Hatch Batten
Hatch Wedge
Ships' Manholes
Ships' Non-watertight Steel Doors
Ships' Butterfly Nuts
Hatch Boards
Watertight Sliding Doors
Ships' Watertight Sliding Door Indicators
Fittings for Ships' Weather-tight Steel Doors
Ships' Ullage Holes
Ships' Steel Weather-tight Doors
Hatch Locking Bars
Oiltight Hatch Covers
Ships' Steel Small Hatch Covers
Fittings of Ships' Steel Small Hatch Covers
Ships' Ratchet Spanners
Simple Type Hatch Cleats
Marking of Hatch Boards
Marking of Hatchway Beams
Marine Small Size Manhole
Fittings for Small Ships' Weather-tight Steel Door
Covers for Tank Cleaning Holes
Small Ships' Steel Weather-tight Doors
Small Ships' Non-Watertight Steel Doors
Ships' Cabin Hollow Doors
Ships' Weather Hollow Doors
Ships' FRP Doors for Provisions Refrigerating Chamber
Ships' Bronze Side Scuttles

Hull Parts (Continued)

Ships' Hinged Square Windows
Ships' Light Construction Non-opening Scuttles
Deck Lights
Mushroom Ventilators
Gooseneck Ventilators
Cowlhead Ventilators
Tempered Glasses for Ships' Side Scuttles
Air Hatch Covers
Ships' Aluminum Alley Side Scuttles
Ships' Sliding Windows
Ships' Wall Ventilators
Ships' Flame Arresters
Ships' Wind Scooper for Slide Scuttle
(Wind Scoopers) Anti-Mosquito Gauze of Side Scuttle for Marine Use
Ships' Galley Windows
Ships' Non-Opening Rectangular Windows
Ships' Extruded Aluminum Alloy Rectangular Windows
Ships' Footsteps
Ships' Steel Vertical Ladders
Steel Deck Ladders
Small Size Steel Accommodation Ladders
Ships' Wooden Handrail
Ships' Handrail Stanchions
Steel Wharf Ladders
Aluminum Alloy Wharf Ladders
Bulwark Ladders
Pilot Ladders
Panama Canal Pilot Platforms
Embarkation Ladders
Aluminum Alloy Accommodation Ladders
Ships' Mouth Pieces for Voice Tube
Mechanical Telegraphs

Hull Parts (Continued)

Fittings for Steam Whistle

Lifeboats

Radial Type Boat Davit

ships' Cross Bitts

Ships' Punkah-Louvre

Ships' Rice Boilers

Ships' Steam Water Boilers

Ships' Oil Burning Cooking Ranges

Hinged Caps of Sounding Pipes

Deck Pieces for Sounding Pipes

Pipe Head Caps

Pipe Head Spanners

Ships' Bottom Plugs

Ships' Drain Plugs

Deck and Bulkhead Pieces for Transmission Shaft

Ships' 5 kgf/cm^2 and 10 kgf/cm^2 Deck and Bulkhead Pieces for Pipe Connection

Universal Joints of Transmission Shafts in Cargo Oil Tanks

Goose Neck Air Pipe Heads (Ball Float Type)

Scupper Fittings for Ships' Refrigerating Chambers

Gratings of Ships' Scupper Pipes

Ships' Cast Iron Pipe Sleeve Type Expansion Joints

Ships' Cast Steel Pipe Sleeve Type Expansion Joints

Self-closing Parallel Cook Heads for Short Sounding Pipe

self-closing **Gate** Valve Heads for Short Sounding pipe

Ships' Oil Suction Bellmouths

Ships' Steel Pipe Bands

Ships' U-Bolts for Steel Pipe

Bonnet Type Air Pipe Heads

Ships' Deck Stands for Controlling Valves

Remote Handling Fittings for Valves on Small Ships' Forepeak Bulkhead

Remote Handling Fittings for Valves in Small Ships' Cargo Oil Tank

Hull Parts (Continued)

Ships' Deck and Bulkhead Pieces for Small Size Copper Tubes
Ships' Foot Valves
Eronze Vertical Storm Valves
Cast Steel Vertical Storm Valves
Bronze Screw-down Vertical Storm Valve
Cast Steel Screw-down Vertical Storm Valves
Ships' Hand Piston Pumps
Hand Winches for Accommodation Ladders
Anchors
Cast Steel Anchor Chain Cables
Electrically Welded Anchor Chain Cables
Tools for Anchor Chain Cables
Buoy Shackles
Anchor Stoppers
Anchor Buoys
Anchor Stoppers (Small Size)
Rigging Screw
Chain Slings
Chain Stoppers
Small Size Chain Slings
Ships' Eye Plates
Ships' Ring Plates
Sunken Link Plates
Horn Cleats
Ships' Wire Rope Stay Eye Plates
Ships' Cargo Guy Cleats
Ships' Small Size Snatch Blocks
Ships' Sheaves
Ships' Steel Guy Blocks with Swivels for Fibre Rope
Lifeboats' Steel Blocks
Ships' Steel Cargo Blocks
Ships' Snatch Blocks
Ships' External Bound Blocks

Hull Parts (Continued)

Ships' Steel Blocks for Fibre Rope Guy
Ships' Steel Blocks for Signal Flags
Ships' Internal-Bound Blocks
Ships' Steel Cargo Lifting Blocks for Topping Units
Ships' Cast Steel Cargo Blocks with Roller Bearings
Ships' Steel Plate Cargo Lifting Blocks with Roller Bearings
Ship's Wire Reels
Ships' Steel Wire Sockets
Application Standard of Steel Wire Rope for Marine Use
Application Standard of Hemp Rope for Ship Use
Ship's Wire Nippers for Topping Lifts
Ship's Small Size Wire Reels
Application Standard of Steel Wire Rope for Small Ship
Application Standard of Hemp Rope for Small Ship
Fastening Method of Wire Ropes to Drum for Ship Use
Application Standard of Ships' Canvas
Ships' Hatch Beam Slings
Ships' Small Size Wire Nippers for Topping Lift
Ships' Small Size Steel Blocks
Ships' Fire Axes
Jacobs' Ladder
Ships' Clinometers
Ships' Bells
Ships' Toggle Pins
Ships' Chainlets
Ships' Ring of Chainlet
Ships' Eye Plates for Chainlet
Dredger's Anchors
Dredger's Sheaves for General Use
Dredger's Discharge Pipes
Dredger's Floaters

Engine Parts

Shop Test Code for Marine Steam Turbines for Propelling Use

Water Cooled Four Cycle Marine Diesel Engines for Propelling Use

Marine **Hot-Bulb** Engines for Propelling Use

Shop Test Code for Marine Internal Combustion Engines for Propelling Use

Water Cooled Spark Ignition Marine Engines for Propelling Use

Water Cooled Four Cycle Marine Diesel Engines for Electric Generator

Fuel Injector of Marine Small Diesel Engine

Fixing Parts of Ships' Small Propellers

Morison Furnaces for Marine Use

Size of Dry Combustion Cylindrical Boilers for Marine Use

Fire Bar for Marine Use

Forged Steel 20 kg/cm^2 Reflex Type Water Gauges with Cocks for Marine Boilers

Forged Steel 20 kg/cm^2 Reflex Type Water Gauges with Valves for Marine Boilers

Forged Steel 63 kg/cm^2 Transparent Type Water Gauges with Valves for Marine Boilers

Shop Test Code for Marine Centrifugal Oil Purifiers

Ships' Steam Cargo Winches

Marine DC Electric Cargo Winches

AC Electric Mooring Winches

Steam Mooring Winches

Hydraulic Mooring Winches

Steam Anchor Windlasses

DC Electric Anchor Windlasses

AC Electric Anchor Windlasses

Hydraulic Anchor Windlasses

Shop Test Code for Hydraulic Steering Gears for Ships

Shop Test Code for Oil Pressure Pumps of Hydraulic Steering Gears for Ships

Ship's Small Size Fuel Oil Heaters

Tachometers for Marine Engine

Application Standard of Pressure Gauges on Board

Standard for Thermometers Arrangement in Ship's Machinery Space

Identification of Piping Systems for Marine Use

Engine Parts (Continued)

Marine Turnbuckles with Eye Bolts

Pressure Gauge Boards for Marine Auxiliary Machines

Standard Velocity of F1ow in pipes **of ship Machinery**

Application Standard of Gaskets and Packings to Piping System for Marine Machinery

Marine Ventilation Dampers

Marine Can Water Filters

Distance Pieces for Ship's Hull

Marine Duplex Oil Strainers

Marine Mud Boxes

Marine Rose Boxes of Steel Plate

Application for Wire Gauge of Oil Strainer for Marine Use

Marine Duplex Oil Strainers (H Type)

Marine Simplex Oil Strainers

Marine Thermometer Pickets

Marine 5 kgf/cm^2 Level Gauges with Valves

Marine Oil Level Gauges with Self Closing Valves

Marine 16 kg/cm^2 Water Gauges with Valve

Marine Flat Glass Oil Level Gauges

Marine Self Closing Valves for Oil Level Gauges

Marine Float Level Gauges

Marine Cylindrical Sight Glasses

Marine Steel Plate Hoppers

Marine Cast Iron 5 kg/cm^2 Y Type Steam Strainers

Marine Cast Iron 10 kg/cm^2 Y Type Steam Strainers

Marine Cast Steel 40 kg/cm^2 Y Type Steam Strainers

Marine Small Size Water Strainers

Marine Small Size Duplex Oil Strainers

Marine Steel Plate Simplex Oil Strainers

Double Bottom Tank Float Gauges for Coastal Ships

Marine Tube Type Drain Silencers

Marine Slit Type Drain Silencers

Starting Air Reservoirs Made of Steel Plate for Marine Use

Starting Air Reservoirs Made of Steel Tube for Marine Use

Engine Parts (Continued)

Gauges for Small Size Fuel Oil Tank
Application Standard for Marine Valves and Cocks
Marine Bronze 5 kg/cm² Globe Valves
Marine Bronze 5 kg/cm² Angle **Valves**
Marine Bronze 16 kg/cm2 Globe Valves
Marine Bronze 16 kg/cm² Angle Valves
Marine Cast Iron 5 kg/cm² Globe Valves
Marine Cast Iron 5 kg/cm² Angle Valves
Marine Cast Iron 10 kg/cm² Globe Valves
Marine Cast Iron 10 kg/cm² Angle Valves
Marine Cast Iron 16 kg/cm² Globe Valves
Marine Cast Iron 16 kg/cm² Angle Valves
Marine Cast Steel 5 kg/cm² Globe Valves
Marine Cast Steel 5 kg/cm² Angle Valves
Marine Cast Steel 20 kgf/cm² Globe Valves
Marine Cast Steel 20 kgf/cm² Angle Valves
Marine Cast Steel 30 kgf/cm² Globe Valves
Marine Cast Steel 30 kgf/cm² Angle Valves
Marine Cast Steel 40 kgf/cm² Globe Valves
Marine Cast Steel 40 kgf/cm² Angle Valves
Marine Cast Steel 10 kgf/cm² Globe Valves
Marine Cast Steel 10 kgf/cm² Angle Valves
Marine Malleable Iron 5 kgf/cm² Globe Valves
Marine Malleable Iron 5 kgf/cm² Angle Valves
Marine Malleable Iron 16 kgf/cm² Globe Valves
Marine Malleable Iron 16 kgf/cm² Angle Valves
Marine Forged Steel 40 kg/cm² Screwed Globe Valves (Union Bonnet Type)
Marine Forged Steel 40 kg/cm² Screwed Angle Valves (Union Bonnet Type)
Marine Forged Steel 40 kg/cm² Flanged Globe Valves (Union Bonnet Type)
Marine Forged Steel 40 kg/cm² Flanged Angle Valves (Union Bonnet Type)
Marine Cast Iron Hose Valves
Marine Bronze Hose Valves
Marine Hose Connections and Fittings
Marine Forged Steel Screwed Globe Valves for Compressed Air

Engine Parts (Continued)

Marine Forged Steel Screwed Angle Valves for Compressed Air
Marine Forged Steel Flanged Globe Valves for Compressed Air
Marine Forged Steel Flanged Angle Valves for Compressed Air
Marine Cast Steel Globe Valves for Compressed Air
Marine Forged Steel 100 kg/cm² Pressure Gauge Globe Valves
Marine Bronze 20 kgf/cm² Pressure Gauge Cocks
Marine Bronze 5 kg/cm² Globe Valves (Union Bonnet Type)
Marine Bronze 5 kg/cm² Angle Valves (Union Bonnet Type)
Marine Bronze 16 kg/cm² Globe Valves (Union Bonnet Type)
Marine Bronze 16 kg/cm² Angle Valves (Union Bonnet Type)
Marine Hull Cast Steel Angle Valves
Marine Bronze 5 kg/cm² Screw-Down Check Globe Valves
Marine Bronze 5 kg/cm² Screw-Down Check Angle Valves
Marine Cast Iron 5 kg/cm² Screw-Down Check Globe Valves
Marine Cast Iron 5 kg/cm² Screw-Down Check Angle Valves
Marine Bronze 5 kg/cm² Lift Check Valves
Marine Cast Iron 5 kg/cm² Lift Check Globe Valves
Marine Cast Iron 5 kg/cm² Lift Check Angle Valves
Marine Hull Cast Steel Gate Valves
Marine Cast Iron 5 kgf/cm² Gate Valves
Marine Cast Iron 10 kgf/cm² Gate Valves
Marine Hull Cast Steel Globe Valves
Marine Cast Steel 10 kgf/cm² Gate Valves
Marine Bronze 5 kg/cm² Rising Stem Type Gate Valves
Marine Bronze 10 kg/cm² Rising Stem Type Gate Valves
Marine Bronze 5 kgf/cm² Swing Check Valves
Marine Cast Iron 5 kg/cm² Swing Check Valves
Marine Cast Iron 10 kgf/cm² Swing Check Valves
Marine Cast Iron 10 kg/cm² Screw-Down Check Globe Valves
Marine Cast Iron 10 kg/cm² Screw-Down Check Angle Valves
Marine Cast Iron 16 kg/cm² Screw-Down Check Globe Valves
Marine Cast Iron 16 kg/cm² Screw-Down Check Angle Valves
Marine Brass 30 kg/cm² Stop Valves with Bite Joint(s)

Engine Parts (Continued)

Marine Bronze 5 kgf/cm² Flanged Cocks
Marine Bronze 16 kfg/cm² Cocks
Marine Bronze 2(! kgf/cm² Globe Valves
Marine Bronze 20 kgf/cm² Angle Valves
Marine Cocks with Locks
Marine Cast Iron 3 kg/cm² Globe Valves
Marine Cast iron 3 kg/cm² Angle Valves
Marine Bronze 3 kg/cm² Globe Valves
Marine Bronze 3 kg/cm² Angle Valves
Marine Cast Iron 3 kg/cm² Gate Valves
Marine Cast Iron 5 kg/cm² Suction Manifold Valves
Marine Cast Iron 5 kg/cm² Discharge Manifold Valves
Marine Fuel Oil Tank Self-Closing Drain Valves
Marine Fuel Oil Tank Emergency Shut-Off Valves
General Rules for Inspection of Marine Valves and Cocks
Marine Cast Steel 30 kg/cm² Flange Type Escape Valves
Marine Forged Steel 30 kg/cm² Screw Escape Valves
Marine Bronze 5 kg/cm² Screw-Down Check Globe Valves (Union Bonnet Type)
Marine Bronze 5 kg/cm² Screw-Down Check Angle Valves (Union Bonnet Type)
Marine Bronze 16 kg/cm² Screw-Down Check Globe Valves (Union Bonnet Type)
Marine Bronze 16 kg/cm² Screw-Down Check Angle Valves (Union Bonnet Type)
Marine Bronze 5 kg/cm² Lift Check Globe Valves (Union Bonnet Type)
Marine Bronze 5 kg/cm² Lift Check Angle Valves (Union Bonnet Type)
Marine Bronze 16 kg/cm² Lift Check Globe Valves (Union Bonnet Type)
Marine Bronze 16 kg/cm² Lift Check Angle Valves (Union Bonnet Type)
Marine Forced Steel 20 kg/cm² Screwed Globe Valves (Union Bonnet Type)
Marine Forged Steel 20 kg/cm² Screwed Angle Valves (Union Bonnet Type)
Brass 30 kg/cm² Unions with Bite Joint(s) for Marine Use
Marine 10 kg/cm² Brazed Unions for Copper Tube
Marine 10 kg/cm² Screwed Unions for Copper Tube
Marine 10 kg/cm² Welded Unions for Steel Pipe
Marine 10 kg/cm² Screwed Unions for Steel Pipe
Marine 20 kg/cm² Brazed Unions for Copper Pipe
Marine 20 kg/cm² Screwed Unions for Copper Pipe

Engine Parts (Continued)

Marine 40 kg/cm^2 Welded Unions for Steel Pipe

Marine 40 kg/cm^2 Screwed Unions for Steel Pipe

Marine 100 kg'cm^2 welded Unions for Steel Pipe

Marine 100 kg/cm^2 Screwed Unions for Steel Pipe

Level Gears for Marine Use

Marine Universal Joints

Marine Transmission Shaft Joints

Marine Transmission Shaft Loose Joints

Bearings for Marine Transmission Shaft

Remote Shut-Off Devices for Marine Fuel Oil Tank Emergency Shut-Off Valves

Marine Cast Steel 10 kg/cm^2 Screw-Down Check Globe Valves

Marine Cast Steel 10 kg/cm^2 Screw-Down Check Angle Valves

Marine Cast Steel 20 kgf/cm^2 Screw-Down Check Globe Valves

Marine Cast Steel 20 kgf/cm^2 Screw-Down Check Angle Valves

Marine Cast Steel Angle Valves for Compressed Air

Marine Steel Gratings

Marine Steel Ladders and Steel Handrails

Spare Parts for the Machinery of Ships

Tools and Outfits for the Machinery of Ships

Engine Stores for Coastal Ships

Beam Grabs for Marine Use

Special Tools for the Machinery of Ships

Fat-to-Face Dimensions of Marine T Pieces with Flanges

Marine Silver Brazing 5 kgf/cm^2 Pipe Flanges

Basic Dimensions of Steel Flanges for Marine Exhaust Gas Pipe

Electric Parts

Method of Watertight Testing for Marine Electric Appliances

General Rules on the Temperature Test of Electric Lighting Fittings (Incandescent Lamps) for Marine Use

Electric Parts (Continued)

Graphical Symbols for Electrical Apparatus (Power) for Marine Engineering Drawings

Graphical Symbols for Electrical Apparatus (Lighting Fittings and Accessories) for Marine Engineering Drawings

Graphical Symbols for Electrical Apparatus (Communication) for Marine Engineering Drawings

Lead-Acid Marine Batteries

Lamp Holders for Marine Use

Glass Globes for Marine Electric Lights

Front Glasses for Marine Electric Lights

Glass Globes for Marine Indicator Lamps

Lenses for Marine Morse Signal Lamps

Marine Lamps

Recessed Type Ceiling Lights for Marine Use (Non-watertight Type)

Ceiling Lights for Marine Use (Non-watertight Type)

Cargo Lights

Boat Deck Lights

Pendant and Bracket Lights for Marine Use

Watertight Type Hand Lamps for Marine Use

Watertight Type Wall Lights for Marine Use

Floodlighting Projectors for Marine Use

Berth Lights for Marine Use

Chart Table Lights

Flameproof Ceiling Lights for Marine Use

Flameproof Bulkhead Lights for Marine Use

Explosion-Proof Flash Lights for Marine Use (Dry Battery Type)

Hand Lamps for Marine Use (Non-watertight Type)

Portable Lamps (Simple Type) for Marine Use

Pendant Lights (Simple Type) for Marine Use

Cargo Lights (Simple Type)

Ballast for Fluorescent Lamp for Marine Use

Fluorescent Table Lamps for Marine Use

Fluorescent Wall Lights for Marine Use (Non-watertight Type)

Fluorescent Ceiling Lights for Marine Use (Non-watertight Type)

Fluorescent Ceiling Lights for Marine Use (Watertight Type)

Electric Parts (Continued)

Fluorescent Berth Lights with Spare Light for Marine Use
Watertight Type Passage Lights for Marine Use
Special Type Cargo Lights
Reflector Lamp Type Flood Lights for Marine Use
Special Type Cargo Lights
Reflector Lamp Type Flood Lights for Marine Use
high Pressure Mercury Vapour Lamp Type Flood Lights for Marine Use
Morse Signal Lamps for Marine Use
Keys for Morse Signal Lamps for Marine Use
Navigation Light Indicators
Call Bell Indicators for Marine Use
Daylight Signalling Lamps for Marine Use
Portable Daylight Signalling Lamps for Marine Use
Suez Canal Signalling Lamps
Navigation Light Indicators (Simple Type)
Search Lights for Marine Use
Watertight Type Electric Bells for Marine Use
Marine Electric Buzzers
Push Buttons for Marine Use
Electronic Horns for Marine Use
Electric Propeller Shaft Tachometers for Marine Use
Electric Rudder Angle Indicators
Electric Telegraphs for Marine Use
Small Size Electric Engine Telegraphs
General Rules of Radio Telegraph for Ships
Testing Methods of Radio Telegraph for Ships
Marine Watertight Cable Glands (for Electric Appliances)
Marine Cable Glands for Bulkhead and Deck
Electric Cable Clips for Marine Use
Electric Cable Hangers and Saddles for Marine Use
Protective Rubber-like Sheaths of Portable Cord for Marine Use
Small Size Terminals for Marine Use
Electric Terminal Blocks for Marine Use
Crimp Terminal Boards for Marine Use

Electric Parts (Continued)

Watertight Type Joint Boxes for Marine Use
Joint Boxes for Marine Use (Non-watertight Type)
Distribution Boards (Fuse Type) for Marine Use
Section Boards (Fuse Type) for Marine Use
Shore Connection Boxes for Marine Use
Simple Type Distribution Boards for Marine Use
Simple Type Section Boards for Marine Use
Distribution Boards with Circuit Breakers for Marine Use
Section Boards with Circuit Breakers for Marine Use
Shore Connection Boxes (Small Type) for Marine Use
Non Watertight Type Plugs for Maine Use
Watertight Type Plugs for Marine Use
Watertight Type Receptacles for Marine Use
Non-Watertight Type Receptacles for Marine Use
Non-Watertight Type Snap Switches for Marine Use
Watertight Type Small Switches for Marine Use
Small Toggle Switches for Marine Use
Unit Switches for Marine Use
Rotary Switches for Marine Use
Control Switches for Marine Flameproof Light
Dimmers for Marine Lamps
Dimmers for Marine Instrument Illumination
Magnetic Compasses for Marine Use

APPENDIX C

MATERIAL STANDARDS

IS-SO Common Part (A, B and C Type Code)
IS-SO Hull Part (Type-D Code)
IS-SO Machinery Part (Type-D Code)
IS-SO Electrical Part (Type-D Code)

ENGINEERING STANDARDS

IS-SOT Application of Standard of Materials (in direct correspondence to IS-SO Material Standards Numbering system)

IS-SOT - A Design Standard (General Facility and Work Plan)

IS-SOT - B Work Standard (Production Engineering Standards)

LIST OF IS-SO

COMMON PART

(A, B AND C - TYPE CODE)

IS-SO No.	NAME
001XXXX	PIPE (STEEL)
002XXXX	PIPE (NON-FERROUS)
0030XXX	VALVE (FC)
0031XXX	VALVE (FC/RUBBER LINING
0032XXX	VALVE (BC)
0033XXX	VALVE (SF)
0034XXX	VALVE (SC/BC TRIM)
0035XXX	VALVE (SC/SUS TRIM)
0040XXX	SHIP SIDE VALVE (SC)
0041XXX	SHIP SIDE VALVE (SC/RUBBER LINING)
0042XXX	SHIP SIDE VALVE (BC)
0045XXX	SPECIAL VALVE (JIS TYPE)
0048XXX	SAFETY VALVE (FOR C/O PIPE ETC.)
0051XXX	LEVEL CONTROL VALVE
0052XXX	FLOW CONTROL VALVE
0059XXX	OTHER VALVES AND COCKS
0060XXX	FLANGES (SS)
0061XXX	FLANGES (SF)
0063XXX	FLANGES (CR-MO)
0064XXX	FLANGES (FOR COPPER PIPE)
0065XXX	FLANGES (FOR COPPER ALLOY PIPE)
0066XXX	FLANGES (FOR PLASTIC PIPE)
0067XXX	FLANGES (FOR HYDRAULIC PIPE)
0069XXX	FLANGES (OTHERS)
0070XXX	PIPE PENETRATION PIECES
0071XXX	ELBOW, TEE, BACKING RING (BUTT TYPE)

IS-SO NO.	NAME
0072XXX	REDUCING TEE, REDUCER (BUTT TYPE)
0073XXX	SOCKET, ELBOW, TEE, ETC. FOR STEEL PIPE
0074XXX	ELBOW, TEE, SOCKET, ETC. (NON-FERROUS)
0075XXX	UNION JOINTS
0076XXX	ELBOW, TEE, REDUCER FOR POLIVINYL PIPE
0077XXX	FLANGE TYPE BEND PIECE, TEE, REDUCER
0078XXX	BOSS, PLUG, NIPPLE
0079XXX	OTHER PIPE PIECES
0080XXX	EXPANSION JOINTS
0081XXX	DRAIN TRAPS
0082XXX	STRAINERS AND FILTERS
0083XXX	MISC. PIPE FITTINGS (GROUP-1)
0084XXX	GASKETS
0085XXX	OTHER PACKINGS
0086XXX	MISC. PIPE FITTINGS (GROUP-2)
0087XXX	PIPE BANDS
0088XXX	U-BOLTS, PIPE SUPPORT FITTINGS
009XXXX	BOLT, NUT AND WASHER
00051XX	HINGES, BUTTERFLY NUT
00052XX	EYE, RING PLATE, CLEATS
00053XX	WIRE SOCKET, CLIP
00054XX	SHACKLE, THIMBLE
00055XX	TURNBUCKLE, RIGGING SCREW
00056XX	MACHINE SCREW, SET SCREW
00057XX	WOOD SCREW, TAPPING SCREW, NAILS
00058XX	SPIRIT PIN, TAPER PIN, TOGGLE PIN

IS-SO NO.	NAME
00059XX	MISCELLANEOUS WIRE FITTINGS
0006XXX	EXTENSION GEARS FOR VALVE REMOTE HAND
0007XXX	WIRE CLOTH, STEEL WIRE, ETC.
0008XXX	INSULATION MATERIAL
0009XXX	WIRE AND OTHER PARTS
00001XX	LADDER
00002XX	VERTICAL LADDER
00003XX	STEP, HANDLE
00004XX	STEEL DOOR
00005XX	ACCESSORY OF STEEL DOOR
00006XX	VENTILATION
00007XX	MANHOLE AND MANHOLE COVER

LIST OF IS-SO

HULL PART

(TYPE - D CODE)

IS-SO NO.	NAME
214XXXX	WOODEN CONSTRUCTION PARTS, OTHERS
221XXXX	FLOORING
224XXXX	MISC. MATERIAL
232XXXX	ANODE FOR CATHODIC PROTECTION
242XXXX	STEERING GEAR
243XXXX	NAVIGATION OUTFITS
244XXXX	INTERNAL COMMUNICATION
245XXXX	INSTRUMENT OF NAVIGATION
246XXXX	INSTRUMENT OF SIGNAL
252XXXX	ANCHOR, CHAIN CABLE
253XXXX	ANCHORING
254XXXX	MOORING OUTFITS
262XXXX	MAST, POST
263XXXX	BOOM
264XXXX	BLOCK
265XXXX	CARGO GEAR
266XXXX	SPECIAL CARGO GEAR
268XXXX	HATCH COVER
272XXXX	LIFE SAVING APPLIANCE
273XXXX	TRAFFIC OUTFITTING
274XXXX	HATCH COVER, MANHOLE AND DOOR
275XXXX	MISC. DAVIT
276XXXX	AWNING, HANDRAIL
277XXXX	MISC. FITTINGS
282XXXX	LIGHTING
283XXXX	VENTILATION AND AIR-CONDITIONING

IS-SO NO.	NAME
284XXXX	VENTILATION FOR CARGO HOLD AND C.O. TANK
285XXXX	VENTILATION FOR PUMP ROOM AND OTHER
293XXXX	MISC. FITTINGS FOR HULL PIPING
294XXXX	PUMPING
295XXXX	DRINKING, SANITARY, AND SCUPPER
296XXXX	STEM AND EXHAUST PIPING
297XXXX	HYDRAULIC PIPE
298XXXX	FIRE FIGHTING SYSTEM
313XXXX	CARGO OIL AND BALLAST HANDLING
314XXXX	DISTANCE PIECE FOR CARGO OIL HANDLING
315XXXX	FITTING FOR CARGO AND BALLAST PIPING
321XXXX	MATERIAL OF REMOTE CONTROL FOR C/O, BALLAST
322XXXX	FITTING OF REMOTE CONTROL FOR C/O, BALLAST
331XXXX	REF. PROV. CHAMBER, MATERIAL
332XXXX	PROV. CHAMBER
333XXXX	REF. CARGO HOLD, MATERIAL
334XXXX	JOINER WORK, MATERIAL
342XXXX	JOINER WORK, FITTING
3521XXX	BED, WARDROBE, CHEST, DESK
3522XXX	TABLE
3523XXX	CASE, RACK, LOCKER
3524XXX	CHART TABLE
3525XXX	SHELF
3526XXX	CHAIR
3527XXX	SOFA
3529XXX	OTHER

IS-SO NO.	NAME
353XXXX	COMMISSARY OUTFITS
3541XXX	BATH, CLOSET, BASIN
3542XXX	MIRROR, LOCKER, TOILET CABINET
3544XXX	IRONING TABLE, RINSING TUB
3545XXX	CONSULTATION SEAT, STERILIZER TABLE
3546XXX	WATER CLOSET UNIT, BASIN PANEL
3549XXX	OTHER
3551XXX	MATTRESS, PILLOW, CURTAIN
3552XXX	TABLE CLOTH, CARPET
3553XXX	SPECIAL EQUIPMENT
35541XX	LOCK
35542XX	LATCH
35543XX	FITTINGS FOR DOOR
35544XX	HARDWARE FOR FURNITURE
35545XX	FURNISHING
35546XX	HARDWARE FOR SANITARY EQUIPMENT
35547XX	NAME PLATE, LABELING
35549XX	OTHER
3561XXX	WEATHER DOOR
3562XXX	JOINER DOOR
3563XXX	STAIR WAY
3564XXX	SHELVES FOR STORE
3569XXX	OTHERS
372XXXX	MISCELLANEOUS
3731XXX	BOSUN'S AND CARPENTER STORE INVENTORY
3732XXX	FRAMES, BOX

IS-SO NO.	NAME
3733XXX	JACOB LADDER
3735XXX	WINDSCOOP, INSECT SCREEN

LIST OF IS-SO

MACHINERY PART

(TYPE - D CODE)

IS-SO NO.	NAME
41XXXXX	MAIN ENGINE AND ACCESSORY
42XXXXX	BOILER
43XXXXX	SHAFTING AND PROPELLER
431XXXX	SHAFT, PROPELLER
432XXXX	BEARINGS
433XXXX	STERN BEARINGS
434XXXX	OTHERS (SHAFTING)
44XXXXX	AUXILIARY MACHINERIES
45XXXXX	FUNNEL, UPTAKE AND DRAFT TRUNK
451XXXX	FUNNEL, UPTAKE AND DRAFT TRUNK COMMON
452XXXX	FUNNEL
453XXXX	UPTAKE
454XXXX	M/E EXHAUST GAS PIPING
455XXXX	DRAFT TRUNK
46XXXXX	PIPE FITTINGS
462XXXX	MATERIALS FOR PIPING
463XXXX	PIPE FITTINGS, SUPPORT, ETC.
467XXXX	PIPE FITTINGS, STERILIZER, ETC.
468XXXX	PIPE FITTINGS, EQUIPMENT
469XXXX	PIPE FITTINGS, MISCELLANEOUS
47XXXXX	INSTRUMENTATION
471XXXX	GAUGES, GROUP-1
472XXXX	GAUGES, GROUP-2
473XXXX	CONTROL ROOM
48XXXXX	MISCELLANEOUS EQUIPMENT
481XXXX	TANKS

IS-SO NO.	NAME
4819XXX	TANK FITTINGS
482XXXY	VENTILATION TRUNK
483XXXA	FLOOR, GRATING, LADDER
484XXXX	GENERAL TOOLS AND OUTFITS
485XXXX	INSULATION
486XXXX	STORE AND WORK SHOP
489XXXX	MISCELLANEOUS OUTFITS
491XXXX	MATERIAL FOR FITTING WORK

LIST OF IS-SO

ELECTRICAL PART

(TYPE - D CODE)

IS-SO NO.	NAME
531XXXX	INCANDESCENT LIGHT
532XXXX	FLUORESCENT LIGHT
533XXXX	PROJECTOR, CARGO LIGHT
536XXXX	SIGNAL LIGHT
537XXXX	EXPLOSION PROOF LIGHT
548XXXX	MOTOR SIREN, BELL, PRESSURE SWITCH, ETC.
552XXXX	POWER DISTRIBUTION AND ELECT. APPLIANCE
5721XXX	CABLE INSTALLATION MATERIAL
5722XXX	CABLE RACK
5723XXX	CABLE COAMING
5724XXX	CABLE GLAND
5726XXX	CABLE BAND
5727XXX	CABLE CONDUIT
5728XXX	MOUNTING BASE
5732XXX	NAME PLATE
5733XXX	APPLIANCE COVER
5736XXX	PROTECTION BOX FOR ELECTRIC APPLIANCE
5739XXX	OTHER ELECTRIC MATERIAL

LIST OF IS-SOT APPLICATION STANDARD OF MATERIALS

IS-SOT NO.	NAME
001XXXX	PIPE
003XXXX	VALVE
006XXXX	FLANGE
007XXXX	PIPE PIECES
008XXXX	PIPE FITTINGS
009XXXX	BOLT,NUT AND WASHER
0001XXX	STEEL FITTING
0005XXX	BASIC FITTING GEARS
0006XXX	TRANSMISSION GEARS FOR REMOTE HANDLING
00004XX	STEEL DOOR
00006XX	VENTILATOR
00007XX	MANHOLE COVER
24XXXXX	NAVIGATION, INTERNAL COMMUNICATION
25XXXXX	MOORING
26XXXXX	MAST, CARGO HANDLING, HATCH COVER
27XXXXX	OTHER OUT FITTING
28XXXXX	LIGHTING, VENTILATION
29XXXXX	PIPE FITTING
31XXXXX	CARGO OIL AND BALLAST PIPE
32XXXXX	CARGO OIL AND BALLAST PIPE, REMOTE CONT.
36XXXXX	DECK MACHINERY
37XXXXX	MISC. (HULL PARTS FITTING)
43XXXXX	SHAFTING AND PROPELLER
45XXXXX	FUNNEL, UPTAKE AND DRAFT TRUNK
46XXXXX	PIPE FITTINGS
47XXXXX	INSTRUMENTATION
48XXXXX	MISCELLANEOUS EQUIPMENT (ENGINE)

LIST OF IS-SOT-A

DESIGN STANDARD

GENERAL FACILITY AND WORK PLAN

IS-SOT NO.	NAME
A11XXXX	DESIGN GENERAL SYMBOL, CODE ETC.
A13XXXX	DESIGN GENERAL TEST PROCEDURE
A15XXXX	DESIGN GENERAL DRAWING PRACTICE
A16XXXX	DESIGN GENERAL BASIC ITEMS
A17XXXX	DESIGN GENERAL PROGRAM APPLICATION
A18XXXX	DESIGN GENERAL ENGINEERING ADMINIST.
A19XXXX	DESIGN GENERAL OTHERS
A21XXXX	BASIC DESIGN
A220XXX	HULL STRUCTURAL DESIGN (GENERAL)
A221XXX	HULL STRUCTURE MATERIAL APPLICATION
A222XXX	HULL STRUCTURE COMMON ITEMS
A223XXX	HULL STRUCTURE HOLD CONST.
A224XXX	HULL STRUCTURE E/R. P/R CONST.
A225XXX	HULL STRUCTURE BOW CONST.
A226XXX	HULL STRUCTURE STERN CONST.
A227XXX	HULL STRUCTURE SUPERSTRUCTURE
A228XXX	HULL STRUCTURE REDDER & STERN FRAME
A229XXX	HULL STRUCTURE OTHERS
A231XXX	HULL FITTING DESIGN, GENERAL
A232XXX	HULL FITTING DESIGN, OUTFIT.
A2320XX	HULL OUTFITTING GENERAL
A2321XX	HULL OUTFITTING STEERING & NAVIGATION SYSTEM
A2322XX	HULL OUTFITTING MOORING
A2323XX	HULL OUTFITTING CARGO HANDLING
A2324XX	HULL OUTFITTING HATCH COVER
A2325XX	HULL OUTFITTING TRAFFIC ARRANGEMENT & OPENING
A2326XX	HULL OUTFITTING LIFE SAVING
A2327XX	HULL OUTFIT. MISC. FITTING

IS-SOT No.	NAME
A2328XX	HULL OUTFITTING LIGHTING & VENTILATION
A2329XX	HULL OUTFITTING OTHERS
A2330XX	HULL FITTING DESIGN, PIPING GENERAL
A2331XX	HULL PIPING PUMPING
A2332XX	HULL PIPING FEEDWATER & SCUPPER PIPING
A2333XX	HULL PIPING STEAM & EXHAUST PIPING
A2334XX	HULL PIPING HYDROPIPE, REMOCON PIPE
A2335XX	HULL PIPING FIRE FIGHTING
A2336XX	HULL PIPING VENTILATION
A2337XX	HULL PIPING CARGO OIL PIPE, BALLAST PIPE
A2338XX	HULL PIPING VENT PIPE & INERT GAS SYSTEM
A2340XX	HULL FITTING JOINER WORK GENERAL
A2341XX	JOINER WORK ACCOMMODATION ARRANGMENT
A2342XX	JOINER WORK FURNITURE
A2343XX	JOINER WORK CABIN CONSTRUCTION
A2344XX	JOINER WORK LIGHTING
A2345XX	JOINER WORK EQUIPMENT & NAME PLATE
A2346XX	JOINER WORK NOISE & VIBRATION
A2347XX	JOINER WORK PROUISION STORE & REF.
A2348XX	JOINER WORK DOOR & STAIR WAT.
A2349XX	JOINER WORK WOODEN CONST.
A2356XX	DECK MACHINERIES REF. SYSTEM
A236XXX	INVENTORY OUTFITTING & SPARE PARTS
A2370XX	HULL FITTING CABIN CONSTRUCTION GENERAL
A2371XX	CABIN CONSTRUCTION CORRIDOR WALL
A2372XX	CABIN CONSTRUCTION WALL/CABIN TO CABIN
A2373XX	CABIN CONSTRUCTION CORRIDOR LINING WALL

IS-SOT No.	NAME
A2374XX	CABIN CONSTRUCTION CABIN LINING WALL
A2375XX	CABIN CONSTRUCTION CEILING LINING WALL
A2376XX	CABIN CONSTRUCTION FLOORING, INSULATION
A2377XX	CABIN CONSTRUCTION REF. PROVCHAMBER
A2378XX	CABIN CONSTRUCTION DOOR, STAIRWAY
A2379XX	CABIN CONSTRUCTION CARGO HOLD WOOD. WORK
A241XXX	MACHINE FITTING DESIGN GENERAL
A242XXX	MACHINE FITTING MAIN ENGINE
A243XXX	MACHINE FITTING BOILER
A244XXX	MACHINE FITTING SHAFT PROPELLER
A245XXX	MACHINE FITTING AUX. MACHINERIES
A246XXX	MACHINE FITTING FUNNEL, UPTAKE DRAFT TRUNK
A247XXX	MACHINE FITTING PIPING
A248XXX	MACHINE FITTING MISC. FITTING
A249XXX	MACHINE FITTING OTHERS
A251XXX	ELECT. FITTING DESIGN, COMMON ITEMS
A252XXX	ELECT. FITTING DESIGN, POWER SOURCE
A253XXX	ELECT. FITTING DESIGN, LIGHTING
A254XXX	ELECT. FITTING DESIGN, INTERIOR COMMUNI./NAV.
A255XXX	ELECT. FITTING DESIGN, RADIO
A256XXX	ELECT. FITTING DESIGN, AUTOMATIC/REMOCON SYSTEM
A257XXX	ELECT. FITTING DESIGN, FITTING WORK
A259XXX	ELECT. FITTING DISIGN, OTHERS
A261XXX	AUTO/REMOCON DESIGN
A280XXX	WELD. SURFACE TREATMENT, PAINT, (WELD)

IS-SOT No.	NAME
A281XXX	WELD. SURFACE TREATMENT, PAINT (S'TREAT)
A282XXX	WELD. SURFACE TREATMENT, PAINT (PAINT)
A283XXX	WELD. SURFACE TREATMENT PAINT (CATHODIC PRO.)
A29XXXX	MISC. DESIGN
A311XXX	HULL PRODUC. ENG. DESIGN, GENERAL
A312XXX	HULL PRODUC. ENG. DESIGN, STRENGTH DESIGN
A313XXX	HULL PRODUC. ENG. DESIGN, DETAIL DESIGN
A314XXX	HULL PRODUC. ENG. DESIGN, PRODUCTION ENG.
A315XXX	HULL PRODUC. ENG. DESIGN, HULLPART PLAN
A316XXX	HULL PRODUC. ENG. DESIGN, STAGE PLAN
A321XXX	HULL FITTING PRODUC. DESIGN, COMMON ITEMS
A322XXX	HULL FITTING PRODUC. DESIGN, OUTFITTING
A323XXX	HULL FITTING PRODUC. DESIGN, PIPING
A324XXX	HULL FITTING PRODUC. DESIGN, WOODEN WORK
A325XXX	HULL FITTING PRODUC. DESIGN, VENT. AIR-CON
A326XXX	HULL FITTING PRODUC. DESIGN, DECK MACHINERIES
A327XXX	HULL FITTING DESIGN, WELD. OTHERS
A33XXXX	MACHINERY PRODUCTION DESIGN
A347XXX	ELECT. FITTING PRODUC. DESIGN, FITTING WORK
A360XXX	PRODUC. DESIGN, GENERAL
A361XXX	PRODUC. DESIGN, PIPE FITTING PIECE

IS-SOT NO.	NAME
A362XXX	PROD. DESIGN, PIPE FABRICATION
A39XXXX	MISC. PRODUCTION DESIGN

APPENDIX D

EXAMPLES OF IHI STANDARDS - SOT A221XXX

HULL STRUCTURE MATERIAL APPLICATION

NOTE: The standards contained in this section are included for instructional purposes only. Some are more recent versions of the ones listed on the following page, which is from the detailed index. No attempt, however, has been made to obtain the most recent revision of any standard.

HULL STRUCTURE MATERIAL APPLICATION SOT-A221XXX

IS-NO	TITLE	QTY	RMKS
A221001A	Rolled Steel for Hull Structure & It's Application	14	
A221002A	Application Of Steel Flat Bars For Fore & Aft Const.	2	
A221003A	Application of Slab Longitudinal for Fore & Aft Structure	2	
A221004B	Standard Rolled Steel Angles for Hull Structure	3	
A221005	Application of Built UP Sections for Fore & Aft Const.	9	
A221006A	Standard Types of Pillar for Fore & Aft Hull Construction	3	
A221007A	Application of Rolled Steel for Superstructure Const.	3	
A221008	Standard F. B Size Used for Cargo Parts	3	
A221011	Size of Steel Plate for Hull Const.	7	

FOR FORE AND AFT STRUCTURE

上段：断面係数 CM³
中段：断面積 CM²
下段：単位長重量 KG/M

表－1

厚＼巾	50	65	75	90	100	125	150	180	200	230	250	300	350	400	450	500
6	7 3.0 2.35	10 3.9 3.06	13 4.5 3.53	← Section Modulus (CM³) ← Sectional Area (CM²) ← WEIGHT PER UNIT (KG/M)												
9			19 6.75 5.30	27 8.1 6.36	32 9.0 7.06	49 11.25 8.83	69 13.5 10.60	97 16.2 12.72								
10					36 10.0 7.85	54 12.5 9.81	76 15.0 11.78	107 18.0 14.13								
11					39 11.0 8.63	59 13.75 10.79	83 16.5 12.95	117 19.8 15.54	142 22.0 17.27							
12					43 12.0 9.42	64 15.0 11.77	90 18.0 14.13	127 21.6 16.96	154 24.0 18.84	200 27.6 21.67						
12.5					44 12.5 9.81	67 15.62 12.27	94 18.75 14.72	132 22.5 17.66	160 25.0 19.62	208 28.75 22.57	242 31.25 24.53					
14						74 17.5 13.74	104 21.0 16.49	146 25.2 19.78	178 28.0 21.98	230 32.2 25.28	269 35.0 27.48					
16						90 20.0 15.70	125 24.0 18.84	175 28.8 22.61	213 32.0 25.12	275 36.8 28.89	321 40.0 31.40	451 48.0 37.68	600 56.0 43.96			
19							147 28.5 22.37	205 34.2 26.85	249 38.0 29.83	322 43.7 34.30	376 47.5 37.29	526 57.0 44.74	699 66.5 52.20			
22							168 33.0 25.90		285 44.0 34.54		429 55.0 43.17	599 66.0 51.81	795 77.0 60.44	1016 88.0 69.08		
25							189 37.5 29.44	264 45.0 35.32	319 50.0 39.25	412 57.5 45.11	480 62.5 49.06	671 75.0 58.87	889 87.5 68.69	1131 100.0 78.50	1105 112.5 88.31	1702 125.0 98.12
28											531 70.0 54.95	740 84.0 65.94				
30												785 90.0 70.65		1324 120.0 94.20	1639 135.0 105.97	1984 150.0 117.75
35															1864 157.5 123.61	2255 175.0 137.37

注：断面係数はＦ・Ｂの板厚が１４mmまでは６１０×１０，１６mm以上は６１０×１５の付板を含む値である。

部長

課長

改正回数	0	1	2	3	4	5

IS | 前後部構造用 SLAB LONGL 適用基準 | SOT-A221003A | 1/2 1

APPLICATION OF SLAB LONGITUDINAL FOR FORE AND AFT STRUCTURE

1. 適用範囲　この基準は一般商船の前後部構造に使用する SLAB DECK LONGL について規定する.

2. 標準寸法　下表の寸法を標準とする.

STANDARD SIZE

SIZE 寸法	SECTIONAL AREA A cm²	WITH PLATE = 610 × 15 I cm⁴	Z cm³	Zp cm³	WEIGHT 重量 kg/m
200 × 16	32.0	3,823	213	375	25.12
19	38.0	4,386	249	444	29.83
22	44.0	4,917	285	515	34.54
250 × 19	47.5	7,980	376	664	37.29
22	55.0	8,912	428	770	43.17
25	62.5	9,791	480	878	49.06
300 × 22	66.0	14,478	599	1,079	51.81
25	75.0	15,866	670	1,230	58.87
28	84.0	17,181	740	1,383	65.94
350 × 25	87.5	23,846	888	1,644	68.69
28	98.0	25,781	979	1,780	76.93
30	105.0	27,020	1,039	1,891	82.42
400 × 28	112.0	36,633	1,249	2,271	87.92
30	120.0	38,369	1,324	2,401	84.20
32	128.0	40,057	1,398	2,525	100.48
35	140.0	42,508	1,507	2,701	109.90
450 × 32	144.0	54,561	1,730	3,093	113.04
35	157.5	57,881	1,864	3,301	123.64
38	171.0	61,094	1,996	3,500	134.23
500 × 35	175.0	76,315	2,255	3,946	137.37
× 38	190.0	80,550	2,413	4,180	149.15
520 × 35 ※	182.0	84,580	2,420	4,216	142.87
38	197.6	89,277	2,590	4,466	155.12
40 ※	208.0	92,340	2,702	4,628	163.28
540 × 38	205.2	98,594	2,773	4,759	161.08
40	216.0	101,982	2,893	4,932	169.56

※ MARKS SHOWN SPECIAL CASE　D-3 ※印は特に必要な時のみ使用する.

Z_P = 塑性断面係数

STANDARD SIZE OF ROLLED SECTIONS FOR HULL STRUCTURE

1. 適用

本基準は一般商船の船体構造に使用する形鋼の標準寸法について規定する。

2. 基準

(1) 下表の右端"基準欄"に○印を付した形鋼を標準とする。

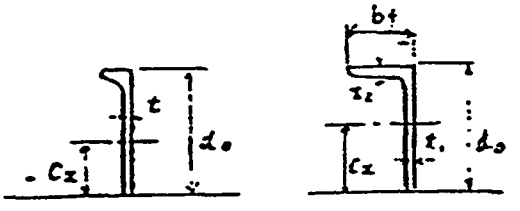
(2) "基準欄"に△印を付した山形鋼はその部度ヒールタップと損失の比較検討を行い採否は設計主管部長決裁による。(解説5参照)

(3) 等辺山形鋼は使用しないのを原則とする。

(4) 船体各所は下表に各材料を使用する。但し原則として縦強部材には使用しない。(解説2参照)

NAME OF STILL MILL

		SIZE $d_o \times b_f \times t/t_1$	A_o (cm²)	Z (cm³) WITH 610×15	I (cm⁴) WITH 610×15	SELF I (cm⁴)	Cx (cm)	W (kg/m)	基準欄 日本	英国	米国
EQUAL THICKNESS ANGLE	不等辺山形鋼	100 × 75 × 7	11.87	22.5 (610×10)	67% (610×15)	112	6.94	9.3	○	○	○
		125 × 75 × 7	13.62	47.2 (")	110% (")	213	9.40	10.7	○	○	○
		125 × 75 × 10	19.00	150.0 (610×10)	164.0 (610×15)	293	5.27	14.9	○	○	○
		150 × 90 × 9	20.94	101	2490	484	10.04	16.4	○	○	○
		150 × 90 × 12	27.36	230	3060	619	9.93	21.5	○	○	○
UNEQUAL THICKNESS ANGLE	不等辺不等厚山形鋼	200 × 90 × 9/14	29.66	340	5870	1710	13.64	23.3	○	○	○
		250 × 90 × 10/15	37.47	494	10300	2440	16.39	29.4	○	○	○
		250 × 90 × 12/16	42.95	540	11000	2790	16.01	33.7	○	○	○
		300 × 90 × 11/16	46.22	681	16400	4470	19.00	36.3	○	○	○
		300 × 90 × 13/17	52.67	743	17610	4940	18.70	41.3	○	○	△
		350 × 100 × 12/17	57.74	956	25800	7440	22.00	45.3	○	○	△
		400 × 100 × 12/18	64.77	1190	35200	10900	24.90	50.8	○	○	△
		400 × 100 × 13/18	68.59	1230	36710	11500	24.60	53.8	○	○	△
BULB PLATE	球形鋼	180 × 9.5	21.06	171	2860	673	10.51	16.5	○	○	○
		200 × 10	25.23	230	4150	1000	11.85	19.8	○	○	○
		232 × 11	31.92	330	6610	1680	13.7	25.1	○	○	○
		255 × 12	38.13	424	8920	2370	14.90	29.9	○	○	○



1. 適用範囲　本基準は一般船の前後部構造の DECK LONG^{L}, SIDE LONG^{L}, L.B^{HD} & T.B^{HD} STIFF., BOTTOM LONG^{L} 等に使用する BUILT-UP SECTION について規定する。

2. 使用条件　"SOT-A221004B 船殻構造用標準形鋼" をOVERするSETCION MODULUSを必要とする場合に使用する。
THESE BUILT-UP SECTIONS WILL BE APPLIED IN CASE OF UNCOVER THE ROLLED SECTIONS.

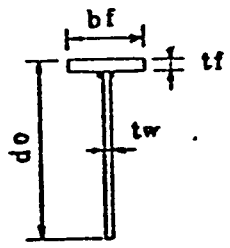
3. BUILT-UP SECTION のTYPE

BUILT-UP SECTION のTYPE はT型, L_2型の2種類とする。
BUILT-UP SECTIONS ARE CLASSIFIED BOTH T AND L2 TYPE.

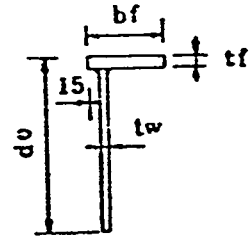
4. 寸法表示法　BUILT-UP SECTION の寸法は次の様に表示する。

do × bf × tw/tf　TYPE

T 型.



L_2型



〔例〕 400×150×11/16　T

450×150×11/19　L_2

5. 標準寸法　標準寸法表に示す寸法をBUILT-UP SECTIONの標準とする。

(注) WEBサイズ 650×14, 700×14はBOTTOM LONG^{L}に使用する。

標準寸法表

do×bf×tw/tf	A cm^2	I cm^4	Z cm^3	WEIGHT 重量 Kg/m	備考
400×150×11/16	66.24	39754	1355	52.0	
19	70.41	42844	1497	55.3	
22	74.58	45714	1635	58.5	WITH PL
450×150×11/16	71.74	51787	1588	56.3	
19	75.91	55600	1748	59.6	610×15
22	80.08	59203	1905	62.9	
25	84.25	62565	2058	66.1	
500×150×11/16	77.24	65590	1833	60.6	
19	81.41	70301	2011	63.9	
22	85.58	74709	2186	67.2	
25	89.75	78836	2357	70.5	
550×150×11/16	82.74	81398	2091	65.0	
19	86.91	87027	2287	68.2	
22	91.08	92310	2479	71.5	
25	95.25	97272	2668	74.8	
28	99.42	101934	2854	78.0	
30	102.20	104885	2976	80.2	
32	104.98	107717	3096	82.4	
600×150×11/19	92.41	105860	2574	72.5	
22	96.58	112087	2784	75.8	
25	100.75	117950	2991	79.1	
28	104.92	123474	3194	82.4	
30	107.70	126979	3328	84.5	
32	110.48	130349	3460	86.7	
35	114.65	135163	3655	90.0	
650×150×11/22	102.08	134117	3101	80.1	
25	106.25	140948	3325	83.4	
28	110.42	147398	3546	86.7	
30	113.20	151500	3691	88.9	
32	115.98	155449	3835	91.0	
35	120.15	161103	4047	94.3	
38	124.32	166449	4256	97.6	
650×180×11/28	118.82	160419	4014	93.3	
30	122.20	164990	4189	95.9	
32	125.58	169369	4363	98.6	
35	130.65	175602	4620	102.6	
38	135.72	181453	4872	106.5	
650×200×11/30	128.20	173369	4521	100.6	
32	131.98	177986	4715	103.6	
35	137.65	184530	5001	108.1	
38	143.32	190647	5282	112.5	
650×230 11/32	141.58	190024	5240	111.1	
35	148.15	196945	5570	116.3	
38	154.72	203375	5893	121.5	次頁に続く

部長 | 課長

IS	前後部構造用 PILLAR 標準材 STANDABD .TYPES OF PILLAR FOR FORE&AFT HULL CONSTRUCTION	SOT-A221006 B	1/2枚

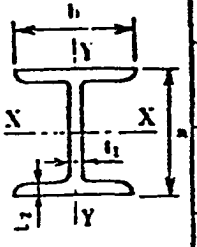
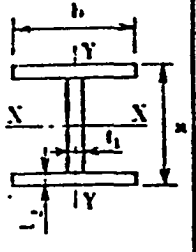
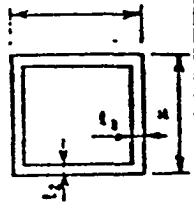
1. 適 用 範 囲

この基準は一般船の船殻前後部構造に使用するPILLARの標準材について規定する。

2. 標 準 寸 法

次表に示す寸法を標準とする。

2－1. H形，□形の断面形状

TYPE	CODE NUMBER 呼 称	SIZE a	b	t_1	t_2	SEC.AREA 断面積 A (cm²)	WEIGHT 重 量 W (kg/m)	MOMENT OF INERTIA Ix (cm⁴)	MOMENT OF INERTIA Iy (cm⁴)	THE LEAST R OF GYRATION k (cm)
 (H - BAR)	H 1 5	150	150	7	10	40.14	31.5	1.640	563	3.75
	H 2 0	200	200	8	12	6353	49.9	4.720	1.600	502
	H 2 5	250	250	9	14	92.18	72.4	10.800	3.560	629
	H 3 0	300	300	10	15	119.8	94.0	20.400	6.750	7.51
	H 3 5	350	350	12	19	173.9	137.	40.300	13600	684
	H 4 0	400	400	13	21	218.7	172.	66.600	22.400	101
 (BUILT-UP)	H 5 0	500	500	14	25	313.0	246.	150.200	52.100	129
	H 6 0	600	600	16	28	423.0	332.	296.500	101.000	15.5
	H 7 0	700	700	19	30	5415	425.	513200	173000	17.9
	H 8 0	800	800	22	35	720.6	566.	891.000	298.700	20.4
 (BUILT-UP)	S 3 5	350	350	14	14	188.2	148.	35.450	35.450	13.7
	S 4 0	400	400	14	14	2162	170	53750	53.750	158
	S 5 0	500	500	14	14	280.0	220	110.000	110.000	198
	S 6 0	600	600	16	16	3700	290.	215.000	215.000	239
	S 7 0	700	700	16	16	437.7	344.	341.700	341.700	27.9
	S 8 0	800	800	16	16	5018	394	514.000	514.000	320

IS	前後部構造用 PILLAR 標準材	SOT - A221006 B	2/3-2

2 － 2　丸形の断面形状

TYPE	呼　称	SIZE OUT DIA m/m	SIZE THICKNSS m/m	断面積 A(cm²)	重　量 W(kg·m)	MOMENT OF INERTIA I (cm⁴)	RADIUS OF GYRATION k (cm)
溶　接	R 100	114.3	8.6	28.6	22.4	401	3.75
	R 125	139.8	9.5	38.9	305	829	4.62
	R 150	165.2	11.	53.25	41.8	1587	547
	R 200	216.3	12.7	8129	63.8	4.225	7.21
	R 250	267.4	15.1	1197	93.9	9557	894
	R 300	318.0	17.4	164.3	129	18620	10.8
	R 350	355.6	19.	2009	158	28.090	11.9
内　作	R 419	400	19.	227.8	179	41.370	13.5
	R 422		22.	2612	205	46.830	134
	R 519	500	19.	287.1	225	83.200	170
	R 522		22.	335.1	263	95.540	16.9
	R 619	600	19.	346.8	272	146.500	206
	R 622		22.	399.5	314	167.000	20.4

部長
課長

1. 適用範囲

上部構造に使用する一般材料の種類およびその寸法について規定する。

2. 基　　準

2－1　使用材料は各CLASSに適合したものであること。

2－2　型鋼および平鋼寸法表

注 ※印の材料は一般には使用しない。

	寸法 (mm)	Wt (kg/m)	I (cm⁴)	Z (cm³)		寸法 (mm)	Wt (kg/m)	I (cm⁴)	Z (cm³)
等辺山形 EQUAL THICKNESS ANGEL	※ 75× 75× 6	6.9	91	31.9	平鋼 FLAT BAR	65× 6	3.1		9.6
	100× 75× 7	9.3	674	725		75× 9	5.3		18.1
	125× 75× 7	10.7	1,110	972		90× 9	6.4		25.3
	150× 90× 9	16.4	2,490	1810		100×12	9.4		40.1
不等辺不等山形 UNEQUAL THICKNESS ANGLE	200× 90× 9/14	23.5	5870	3400		100×16	12.6		
	250× 90× 10/15	29.4	10500	4940		150×12	14.1		
	300× 90× 11/16	36.3	16,400	6810		150×16	18.8		
	350×100×12/17	45.3	25800	9560		200×16	25.1		
	400×100×12/18	50.1	35,200	11900		200×19	29.8		
I型鋼 I SECTION	200×200× 8/13	33.0	8596	6190	球平型鋼 BULB PLATE				
	250×200 10/16	44.8	15,057	9000		230×10	19.5	4,165	231.0
	300×200×11/17	52.8	23,022	11,920					
					丸棒鋼 ROUND BAR	22φ×5500	3.6		
U型鋼 U SECTION	60×6	6.6		20.8					
	75×6	8.0		30.1	鋼管 PIPE	76.3φ×7	12.0	106	k(cm) 2.57
	100×6	10.4		49.3		89.1φ×7.6	15.5	155	3.02
						114.3φ×8.6	22.4	450	3.89

I.Zに算入する板の寸法

平鋼 ---------- 420× 8

U型スチフナー ------- 420× 8

型鋼(WEB DEPTH≦ 125) --- 610×10

型鋼(WEB DEPTH> 150)---610×15

その他 ---------- 610×15

表 — 1

THICKNESS t (mm) \ BREADTH b (mm)	100 (1250)	125 (1550)	150 (1900)	180 2250	200 (2500)	230 (2900)	250 (3100)	280 3500	300 (3750)
	← SEC. AREA (CM²)								
	← MOMENT OF INERTIA WITH PLATE (CM⁴)								
	← b/t								
9	9.0	11.25	13.5						
	3125	579.6	960.7						
	11.1	13.9	16.7						
10	10.0	12.5	15.0	18.0					
	343.3	635.4	1051.8	1740.6					
	10.0	12.5	15.0	18.0					
10.5	10.5	13.125	15.75	18.9					
	358.6	663.4	1096.6	1813.0					
	9.5	11.9	14.5	17.1					
11	11.0	13.75	16.5	19.8	22.0				
	373.8	690.4	1140.9	1885.7	2783.2				
	9.1	11.4	13.6	16.4	18.2				
11.5	11.5	14.375	17.25	20.7	23.0				
	388.7	717.5	1184.3	1953.8	2891.5				
	8.7	10.9	13.0	15.7	17.4				
12	12.0	15.0	18.0	21.6	24.0				
	403.6	744.2	1227.1	2023.3	2997.4				
	8.3	10.4	12.5	15.0	16.7				
12.5			18.75	22.5	25.0	28.75			
			1269.5	20910	31026	45504			
			12.0	14.4	16.0	18.4			
13.5				24.3	27.0	31.05	33.75		
				22245	33099	48490	60372		
				13.3	14.8	17.0	18.5		
16						36.8	40.0	44.8	
						55610	69704	94713	
						14.4	15.6	17.5	
19							47.5	53.2	57.0
							79634	107947	129880
							13.2	14.7	15.8
22									66.0
									144614
									13.6

注 (1) ( )内数値は該当 FLAT BAR の使用寸法を MAX・Z とする（b. Z＝0.08）

(2) 表中数値は 上段 FLAT BAR の断面積 CM²

中段 〃 取付部の 2次モーメント CM⁴

下段 〃 b/t 〃 b：F・Bの巾 t：F・Bの厚さ

(3) 取付部の2次モーメントは F・Bの巾が 150 mm までは 610×19、200以上は 610×15 の鋼板を含むものとする。

(4) [ ] の寸法はなるべく使用しない。

D=10

0	1	2	3	4	5

1. Application

This standard regulates the sizes (width and length) for purchase of all steel plates to be employed to hull construction of general merchant ship except superstructure, and is applied to repair ship as much as possible.

2. Size Classification

2.1 Sketch Size

Size required is to be the one purchased, rounding size in consideration of size for extra cost only, provided that the size is generally within the range of Table 1.

2.2 Standard Size per ship

Size required is to be deemed to the standard size stipulated in 2.3 because of considerable numbers used for each ship owing to addition of:

- More than 10 pieces per size of the sketch-sized plates used around flat mid part, and
- A few pieces per size of the various-sized plates used for any parts to be made the same size as the above sizes, provided that the size is generally within the range of Table 1.

Weight (ton)	Width (meter)	Length (meter)
less than 15	1,400 to 1,500	6,000 to 16,000

Table 1 Size Table of Sketch Size and Standard Size per Ship

Approval	
Check	

Alteration	0	1	2	3	4	5
Date						
Bibliography		D-11				

2.3 General Standard Size

Standard sizes are regulated as shown in Table 2 in order to standardize a few pieces of purchase plates per size and to obtain the merits through the standardization, provided that the following may be accepted:

- Mild steel plates, thicker than 19.5mm or thinner than 5,5
- High grade mild steel plates, higher than B grade and inclusive
- Special steel plates such as high tensile steel plate, etc.

T (mm)	W (mm)	L (mm)
6 to 19	2,200	12,000
	2,800	

Table 2 General Standard Size of Steel Plate for Hull Structure

3. Applicable Range of Size Classification

Table 3 shows the applicable range of steel plates for each Size Classification.

O ..... Applicable , X ..... Unapplicable

Range \ Size Classification	Sketch	Standard per ship	General Standard
- Skin, deck and double bottom - More than 19.5mm in thickness - Higher than B grade inclusive - Special steel such as high tensile	O*	O	O
- More than 10 pcs. used for main and internal structure	X	O*	O
- Main and internal structure except the above	X**	O	O*

Table 3 Applicable Range of Size Classification of Steel Plates

Note: * this is a main of standard of the applicable range.

** The sketch size may be applied only for the special case after agreement made between Hull Construction Work Shop and Design Department

Approval

Check

LIST OF IS-SOT-B

WORK STANDARD

IS-SOT No.	NAME
B01XXXX	WORKING STANDARD FOR HULL CONSTRUCTION
B1XXXXX	WORKING STANDARD FOR HULL OUTFITTING
B2XXXXX	WORKING STANDARD FOR JOINER WORK
B3XXXXX	WORKING STANDARD FOR MACHINERY FITTING
B4XXXXX	WORKING STANDARD FOR ELECTRIC FITTING
B5XXXXX	WORKING STANDARD FOR PIPING
B6XXXXX	WORKING STANDARD FOR PAINTING
B61XXXX	WORKING STANDARD FOR PAINTING (GENERAL)
B62XXXX	WORKING STANDARD FOR PAINTING (SURFACE CLEAN)
B63XXXX	WORKING STANDARD FOR PAINTING (PAINTING)
B69XXXX	WORKING STANDARD FOR PAINTING (OTHER)
B7XXXXX	WORKING STANDARD FOR REPAIR
B9XXXXX	WORKING STANDARD FOR OTHER

APPENDIX E

EXAMPLES OF IHI STANDARDS - SOT B5XXXXX

1. Extract from the detailed index for Group B5XXXXX - Working Standard for Piping

2. Example standard SOT B552001 - Standard Procedure for Inside Finishing of Pipe

NOTE: The material in this index is presented for instructional purposes only.

WORKING STANDARD FOR PIPING SOT-B5XXXXX

IS-NO	TITLE	QTY	PMKS
B511001	Quality Control Standard For Cutting Length Of Steel Pipe	3	
B511002	Quality Control Standard For Cutting Surface Of Steel Pipe	2	
B511003	Quality Control Standard For Cutting Angle Of Steel Pipe	3	
B511004	Quality Control Standard For Cutting Groove Of Steel Pipe	3	
B512001	Standard Of Marking And Cutting Procedure For Pipe	7	
B512002	Standard Procedure For Pipe Coaster	11	
B520001	Allowance For Fitting Of Dresser Joint	3	
B521001	Quality Control Standard For Ellipticity Of Cold Bending Pipe	2	
B521002	Quality Control Standard For Thickness Decrease-Rate Of Cold Bending Pipe	2	
B521003	Quality Control Standard For Elongation Of Steel Pipe By Cold Bending	3	
B521004	Quality Control Standard For Wrinkle Of Steel Pipe By Cold Bending	3	
B521005	Quality Control Standard For Swell Of Steel Pipe By Cold Bending	2	
B521006	Quality Control Standard For Scratch Of Steel Pipe By Cold Bending	2	
B521007	Quality Control Standard For Bending Angle Of Steel Pipe By Cold Bending	2	

WORKING STANDARD FOR PIPING SDT-B5XXXXX

IS-NO	T I T L E	QTY	RMKS
B522001	Standard Of Bending Procedure For Pipe	5	
B531001	Quality Control Standard For Tolerance Of Butt Welded Joint	3	
B531002	Quality Control Standard For Gap Of Butt Welded Joint	3	
B531004A	Quality Control Standard For Angle Of Pipes Flange Assembly	3	
B531005	Quality Control Standard For Alignment Of Flange Bolt Hole	2	
B531006	Quality Control Standard For Assembly Length	3	
B531007	Quality Control Standard For Assembly Of Branch-Pipe	4	
B531008	Quality Control Standard For Clearance Between Pipe And Sleeve	6	
B532001	Standard Of Assembly Procedure For Butt Welded Joint	4	
B532002	Standard Procedure For Steel Flange Joint Assembly	6	
B532003	Standard Procedure For Steel Branch Pipe Assembly	6	
B532004	Standard Of Assembly Procedure For High-Pressure Pipe	6	
B532005	Standard Of Assembly Procedure For Pvc Pipe	2	
B532006	Standard Of Assembly Procedure For Model Pipe	3	
B532007	Standard Procedure For Construction Of Model Pipe	5	

WORKING STANDARD FOR PIPING SOT-B5XXXXX

IS-NO	TITLE	QTY	RMKS
B541001	Quality Control Standard For Under-cut Of Welded Part	2	
B541002	Quality Control Standard For Fish-scale Of Welded Bead	2	
B541003	Quality Control Standard For Thickness Reinforcement Of Welded Bead	3	
B542001	Standard Of Butt Welding Procedure For High-Pressure Pipe	6	
B542002	Standard Procedure For Arc Welding Of Steel Pipe	10	
B542011	Standard Of Brazing Procedure For Copper Pipe & Brass Casting Flange	7	
B542012	Standard Of Brazing Procedure For Al-brass Pipe & Bronze Casting Flange	7	
B542013	Standard Of Brazing Procedure For Cu-ni Pipe & Bronze Casting Flange	7	
B542014	Standard Procedure For Assembly And Soldering Of Non-ferrous Pipe	8	
B542021	Standard Of Tig-welding Procedure For Copper Pipe & Brass Casting Flange	4	
B542022	Standard Of Tig-welding Procedure For Copper Pipe & Steel Flange	4	
B542023	Standard Of Tig-welding Procedure For Al-brass Pipe & Steel Flange	4	
B542024	Standard Of Tig-welding Procedure For Cu-ni Pipe & Steel Flange	4	

WORKING STANDARD FOR PIPING SOT-B5XXXXX

IS-NO	T I T L E	QTY	RMKS
B542025	Standard Procedure For Tig Welding Of Non-ferrous Pipe	6	
B542026	Standard Of Tig Welding Procedure For Steel Pipe	9	
B542031	Standard Procedure For Co2 Arc Welding Of Steel Pipe	9	
B542091	Quality Control Standard For Preheat Of Steel Pipe	2	
B551002	Quality Control Standard For Warp Of Flange Surface	3	
B551003	Quality Control Standard For Warp Of Pipe After Branch Pipe Welding	3	
B552001	Standard Procedure For Inside Finishishing Of Pipe	5	
B552002	Standard Procedure For Face Finishing Of Flange	3	
B561003	Quality Control Standard For Galvanizing Pipe	3	
B562002	Standard Of Pipe Surface Preparation Before Painting	10	
B572001	Standard Of Hydrotesting Procedure For Group-1 Pipe	3	
B592001	Maintenance And Inspection Standard For Pipebnder	4	
B592002	Standard Procedure For Pallet Works	8	

[illegible] STANDARD FOR PIPING [illegible]-XXXXX

E-NO	TITLE	QTY PGS
[illegible]1001	Quality Control Standard [illegible] Of Steel Pipe	3
[illegible]	Quality Control Standard For Cutting Surface Of Steel Pipe	2
B511003	Quality Control Standard For Cutting Angle Of Steel Pipe	3
B511004	Quality Control Standard For Cutting Groove Of Steel Pipe	3
B512001	Standard Of Marking And Cutting Procedure For Pipe	7
B512002	Standard Procedure For Pipe Coaster	11
B520001	Allowance For Fitting Of Dresser Joint	3
B521001	Quality Control Standard For Ellipticity Of Cold Bending Pipe	2
B521002	Quality Control Standard For Thickness Decrease-Rate Of Cold Bending Pipe	2
B521003	Quality Control Standard For Elongation Of Steel Pipe By Cold Bending	3
B521004	Quality Control Standard For Wrinkle Of Steel Pipe By Cold Bending	3
B521005	Quality Control Standard For Swell Of Steel Pipe By Cold Bending	2
B521006	Quality Control Standard For Scratch Of Steel Pipe By Cold Bending	2
B521007	Quality Control Standard For Bending Angle Of Steel Pipe By Cold Bending	2

...BER	TITLE	QTY	REMARKS
B53...001	Standard Of Bending Procedure For Pipe	5	
...1004	Quality Control Standard ... Joint Welded Steel	3	
B53...002	Quality Control Standard For Gap Of Butt Welded Joint	3	
B5...1004A	Quality Control Standard For Angle Of Pipes Flange Assembly	3	
B531005	Quality Control Standard For Alignment Of Flange Bolt Hole	2	
B531006	Quality Control Standard For Assembly Length	3	
B531007	Quality Control Standard For Assembly Of Branch-Pipe	4	
B531008	Quality Control Standard For Clearance Between Pipe And Sleeve	6	
B532001	Standard Of Assembly Procedure For Butt Welded Joint	4	
B532002	Standard Procedure For Steel Flange Joint Assembly	6	
B532003	Standard Procedure For Steel Branch Pipe Assembly	6	
B532004	Standard Of Assembly Procedure For High-Pressure Pipe	6	
B532005	Standard Of Assembly Procedure For Pvc Pipe	2	
B5...2006	Standard Of Assembly Procedure For Model Pipe	3	
B532007	Standard Procedure For Construction Of Model Pipe	5	

WELDING STANDARD FOR PIPING SOT-B5XXXXX

S-NO	TITLE	QTY	RMKS
B541001	Quality Control Standard For Under-cut Of Welded Part	2	
B541002	Quality Control Standard For Fish-scale Of Welded Bead	2	
B541003	Quality Control Standard For Thickness Reinforcement Of Welded Bead	3	
B542001	Standard Of Butt Welding Procedure For High-Pressure Pipe	6	
B542002	Standard Procedure For Arc Welding Of Steel Pipe	10	
B542011	Standard Of Brazing Procedure For Copper Pipe & Brass Casting Flange	7	
B542012	Standard Of Brazing Procedure For Al-brass Pipe & Bronze Casting Flange	7	
B542013	Standard Of Brazing Procedure For Cu-ni Pipe & Bronze Casting Flange	7	
B542014	Standard Procedure For Assembly And Soldering Of Non-ferrous Pipe	8	
B542021	Standard Of Tig-welding Procedure For Copper Pipe & Brass Casting Flange	4	
B542022	Standard Of Tig-welding Procedure For Copper Pipe & Steel Flange	4	
B542023	Standard Of Tig-welding Procedure For Al-brass Pipe & Steel Flange	4	
B542024	Standard Of Tig-welding Procedure For Cu-ni Pipe & Steel Flange	4	

WORKING STANDARD FOR PIPING SOT-B5XXXXX

O	E	Q	S
B542025	Standard Procedure For Tig Welding Of Non-ferrous Pipe	6	
B542026	Standard Of Tig Welding Procedure For Steel Pipe	9	
B542031	Standard Procedure For Co2 Arc Welding Of Steel Pipe	9	
B542091	Quality Control Standard For Preheat Of Steel Pipe		
B551002	Quality Control Standard For Warp Of Flange Surface	3	
B551003	Quality Control Standard For Warp Of Pipe After Branch Pipe Welding	3	
B552001	Standard Procedure For Inside Finishishing Of Pipe	5	
B552002	Standard Procedure For Face Finishing Of Flange	3	
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B562002	Standard Of Pipe Surface Preparation Before Painting	10	
B572001	Standard Of Hydrotesting Procedure For Group-1 Pipe	3	
B592001	Maintenance And Inspection Standard For Pipebnder	4	
B592002	Standard Procedure For Pallet Works	8	

Is	Standard Procedure for Inside Finishing of Pipe	SOT-B552001

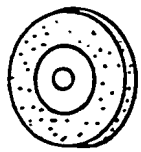
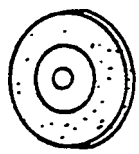
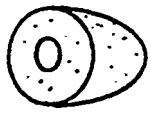
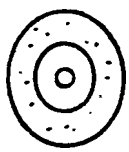
1. Application

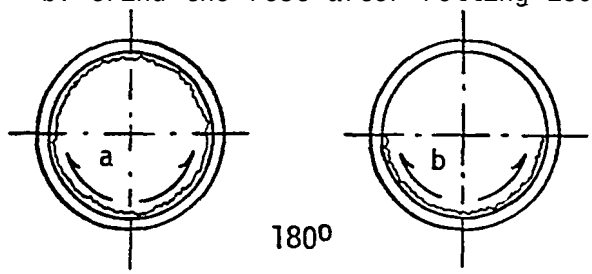
This standard prescribes about procedure and each process of inside pipe finishing.

NOTE: This is applied for non-ferrous pipes.

2. Work standard

Procedure	Work Detail	Notice
1. Preparation	(1) Tools and protectors to be used	Work table , round table, grinder, (angle & baby type), feeler gauge, under-cut gauge, air drilling machine, reamer, lights, pipe clamp, eye protectors, mask, gloves, intermediate shaft
	(2) Grinder safety check	1. Grease grinder before air hose connection. 2. Idle grinder for three minutes in the inspection box, in order to make sure that whetstone is strong enough.
	(3) Whetstone replacement	1. Bust be replaced when the whetstone wear up to the center label. 2. Replacement must be done by a qualified person. 3. After replacement, check to see if its security fastener is going back to (2) - 2.
	(4) Pipe fixing	1. Use vice for small pipes. 2. Work on the table for easy inspection of the inside. 3. Fix pipes applying clamps.
	(5) Reconfirmation of finishing grade	Reconfirm finishing grade by piece drawing prior to work start.

2. Finishing	(1) Tool selection	Application of Tools & Drills			
		Nom. Dia.	Tool	Drill	Application
		15ø (MM)	File		Flange inside bead & inside pipe (including saddle part)
			Baby Grinder	 U1tra Hardened	
			Air Drill-ing Machine	 Reamer	
		25ø ~ 50ø	File		Inside Pipe (includinq saddled part
			Air Drill-ing Machine	 Reamer	
			Baby Grinder	 	
		65ø	Baby Grinder		Inside Pipe (including saddled part
			Angle Grinder (over 250ø)	 	

	(2) Finishing process	Filing 1. Do not file without handle. 2. Clean the file before usage by wire brush. 3. Use rough surface file.
		Grinding 1. Work on the table. 2. Butt welded part. a. Grind lower half b. Grind the rest after rolling 180°  3. Use intermediate shaft in grinding at deep inside pipe. 4. Start rotation after insert into pipe. Do not approach with rotation.
		Reaming 1. Fix a pipe by vice. 2. Approach reamer slowly to avoid damage on reamer. 3. Check smoothness stopping occasionally. 4. Use round file for small pipes on which reaming is difficult.
	(3) Cleaning	After finishing process, do not forget to clean inside. Either blow air or stand a pipe and give a few inpacts.

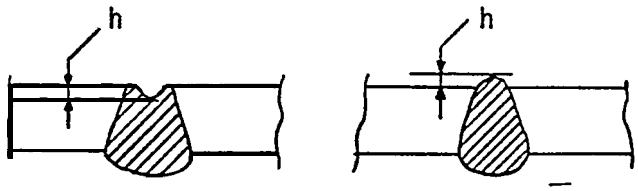
3. Confirmation

(1) Final check

1. According to "Standard of inside pipe finishing)

SOT-B551001

Grade	Standard	Allowance
A	--	h = 0~1.0
B	h = 0.5~2.5	--
C	Not specified	



2. Check using under-cut-gauge or feller gauge case by case.

APPENDIX F

EXAMPLE OF IHI STANDARDS IN USE

1. **Extract from the detailed index for**
   Group SOT A347XXX Electrical Fitting
   Production Design, Fitting Work

2. Design office drawing on "Practice
   for Electrical Installation"

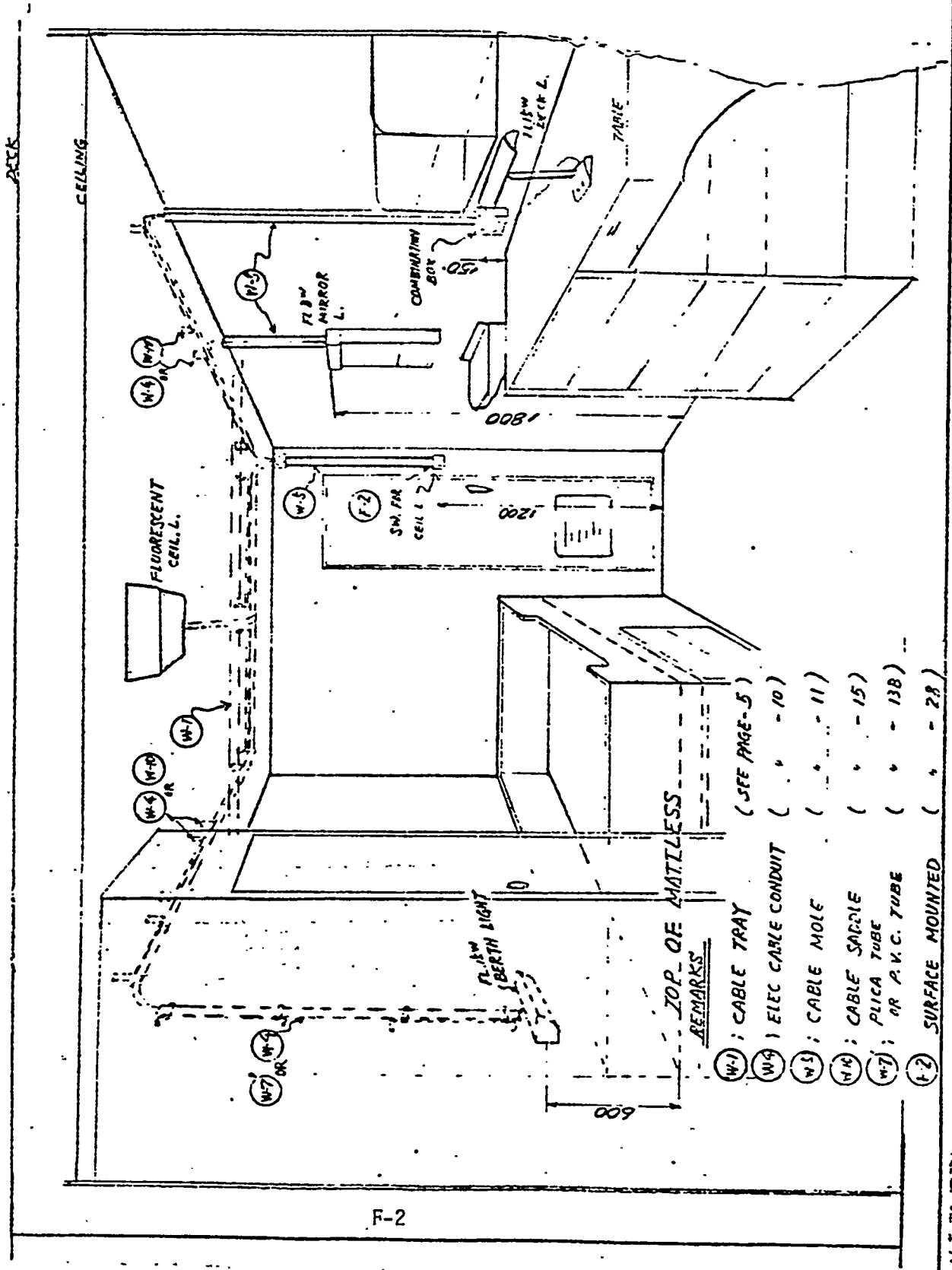
CONTENTS

MANAGER	SNO 2581, 2582	WORK NO. 241 - 2581
DEPUTY MANAGER		CLASSIFICATION: NK
CHIEF	PRACTICE FOR ELECTRICAL INSTALLATION	SCALE
CHECKED BY		DRAWING NO. K5700200
DRAWN BY		
DATE APR 24 '74		

Ishikawajima-Harima Heavy Industries Co., Ltd.
Ships Division Elec. Fitting Design Sec., Ships Design Dept., Aioi

ARRANGEMENT OF ELECTRIC EQUIPMENTS (GENERALLY)

APPLICATION IN CABIN

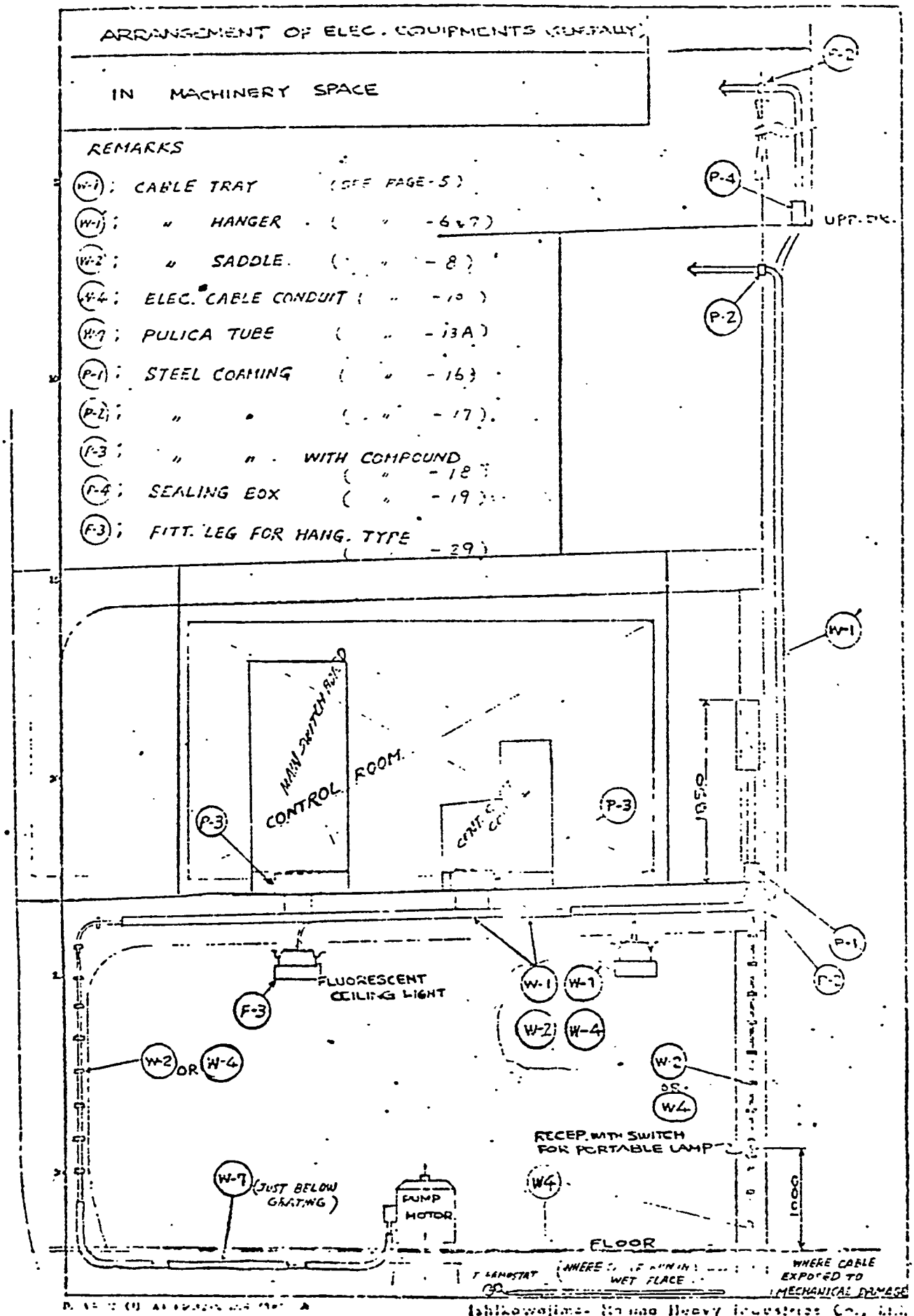


ARRANGEMENT OF ELEC. EQUIPMENTS (GENERALLY)

IN MACHINERY SPACE

REMARKS

(W-1) ; CABLE TRAY (SEE PAGE-5)
(W-1) ; " HANGER (" -6 & 7)
(W-2) ; " SADDLE (" -8)
(W-4) ; ELEC. CABLE CONDUIT (" -10)
(W-7) ; PULICA TUBE (" -13A)
(P-1) ; STEEL COAMING (" -16)
(P-2) ; " " (" -17).
(P-3) ; " " . WITH COMPOUND (" -18)
(P-4) ; SEALING BOX (" -19)
(F-3) ; FITT. LEG FOR HANG. TYPE (-29)



1. 適用範囲

この基準は船内の電線布設要領，電線貫通要領および配線，電路器具の[illegible]付要領について規定する。

(1) SCOPE

This standards are requlated to installation method of electri[c] cable way & support, penetration and fitting detail of wiring on board.

2. 備考

(1) 書船えの適用；第2原紙を利用して使用すること。

(2) 関連設計基準；(A) SOT－A347002 [illegible]

(B) SOT－A347003 電気機器えの[illegible]導入口の[illegible]

(C) SOT－A347004/5/6 電気品の非充電金属部の接地[illegible]

(D) SOT－A347007 防火区画[illegible]

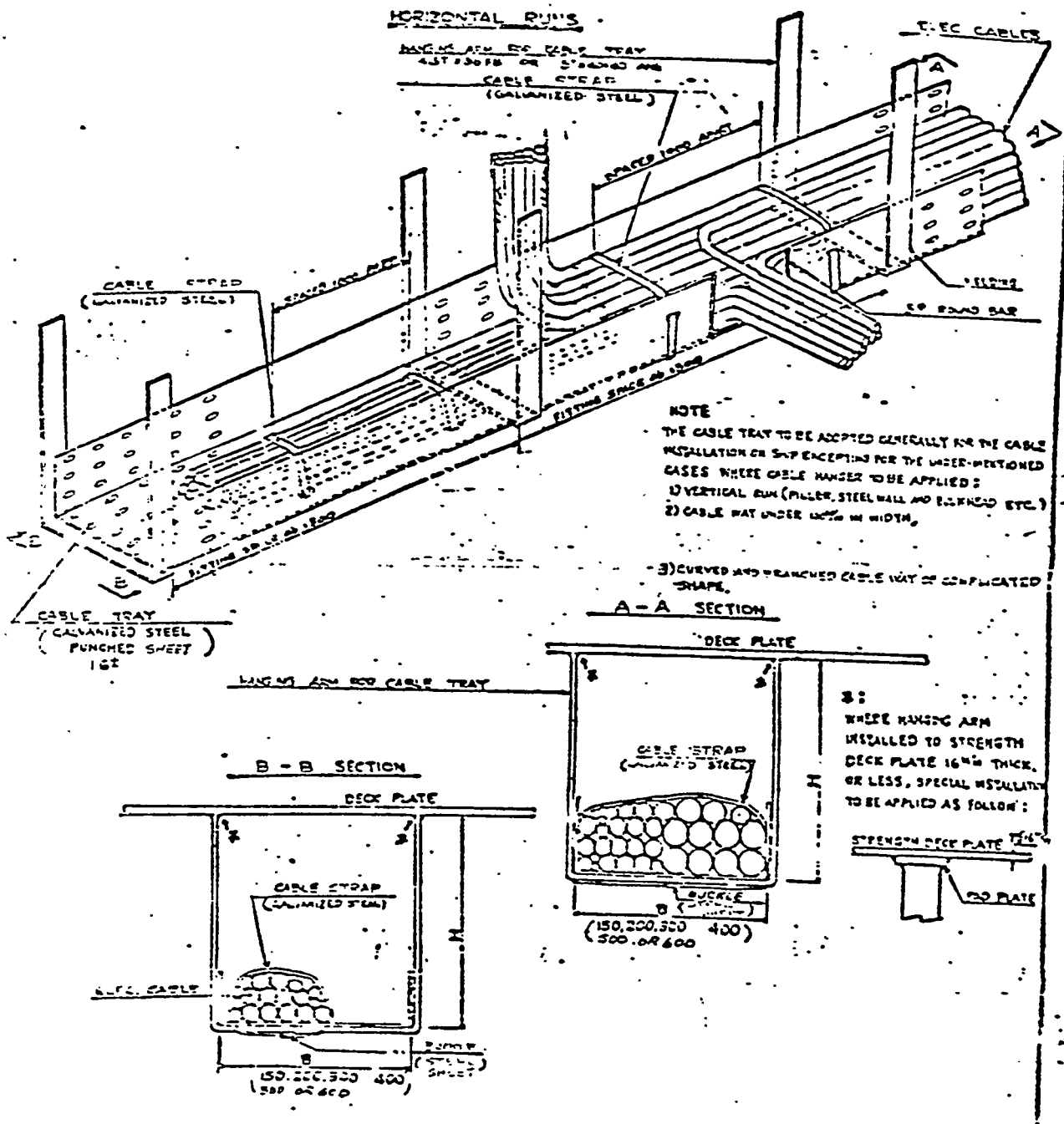
3. 目録

CONTENTS

改正記号	0	1	2	3	4	5
年月日	[illegible] 13					
条 記	[illegible]					

WIRING AND SUPPORTS - (1)

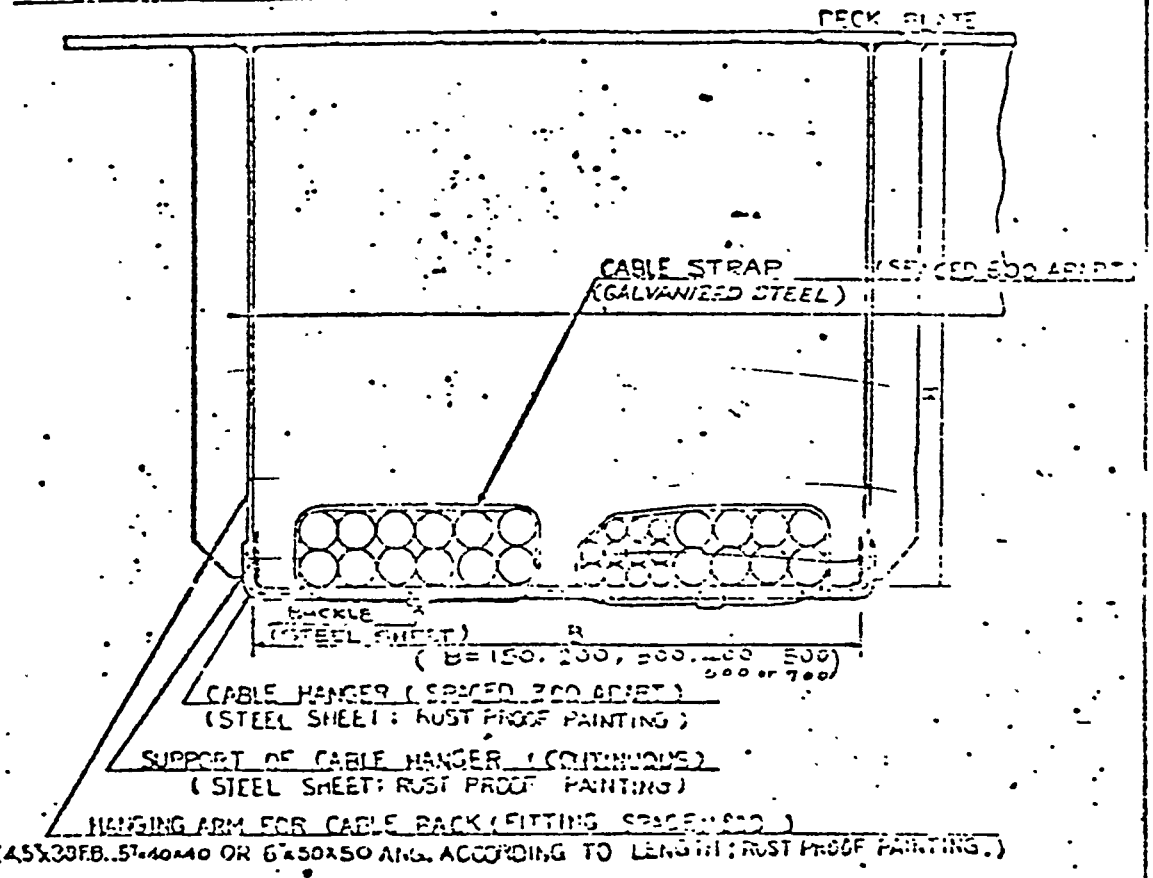
(M1)	EXPOSED AND CONCEALED	ALL INTERIOR INSTALLATION SUCH AS MACHINERY SPACE, STORE SPACE, ACCOMMODATION AND SIMILAR SPACES	MAIN WIRING

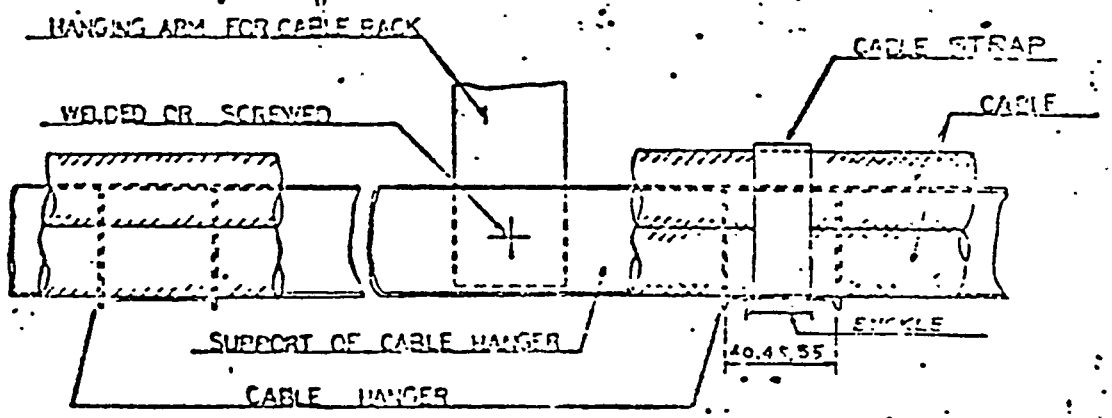


WIREWAY AND SUPPORTS -(2)

SYMBOL	WORKS	APPLICATION	REMARKS
W-1	EXPOSED AND CONCEALED	ALL INTERIOR WIREWAY SUCH AS MACHINERY SPACE, STORE SPACE AND ACCOMMODATION. (CURVED AND BRANCHED CABLE WAY OF COMPLICATED SHAPE)	MAIN WIREWAY (PARTIALLY)

HORIZONTAL RUNS



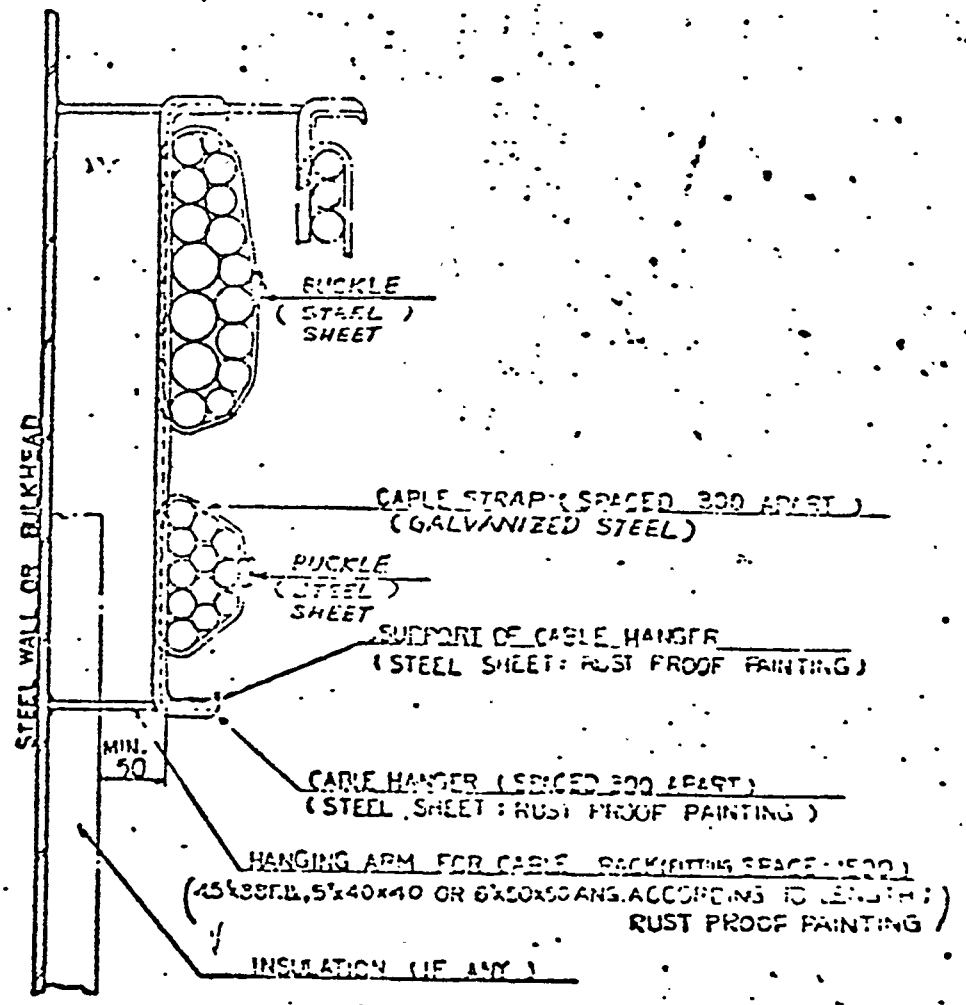


F

WIREWAY AND SUPPORTS -(2)

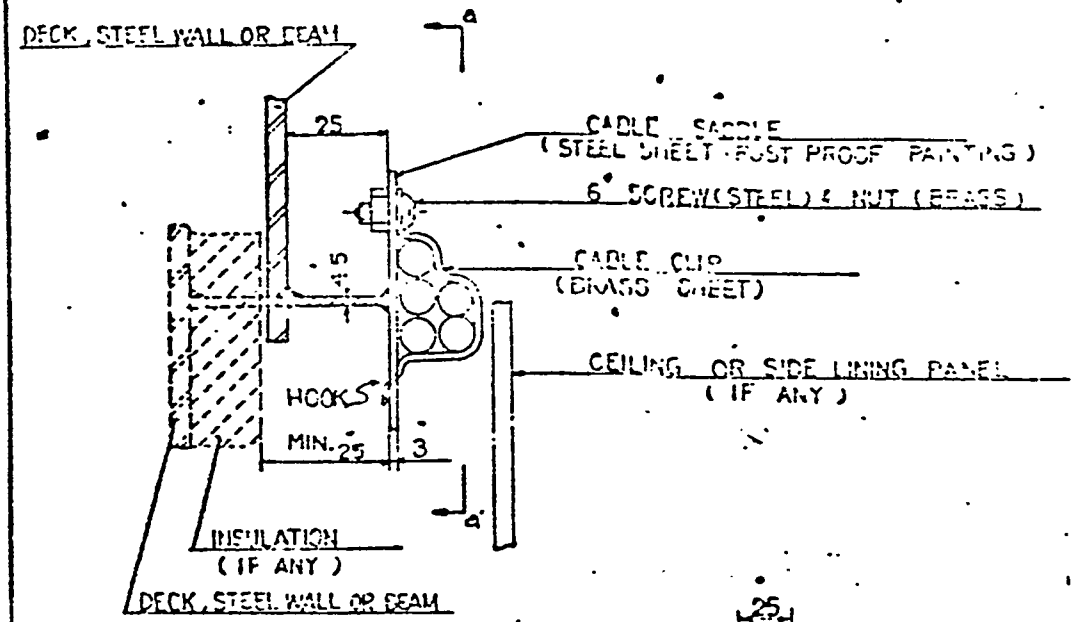
SYMBOL	WORKS	APPLICATION	REMARKS
W-1	EXPOSED AND CONCEALED	ALL INTERIOR WIREWAY SUCH AS MACHINERY SPACE, STORE SPACE AND ACCOMMODATION.	MAIN WIREWAY

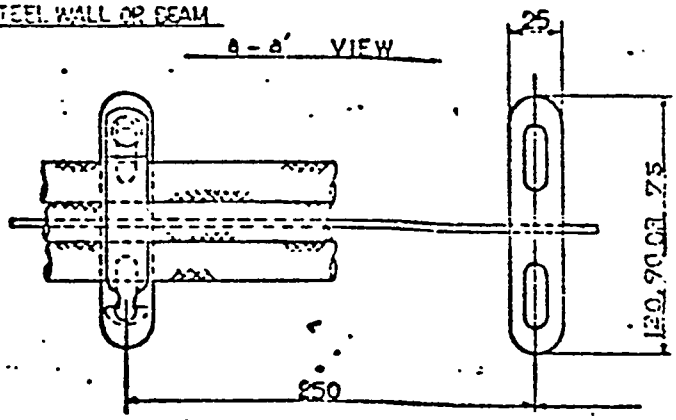
VERTICAL RUNS

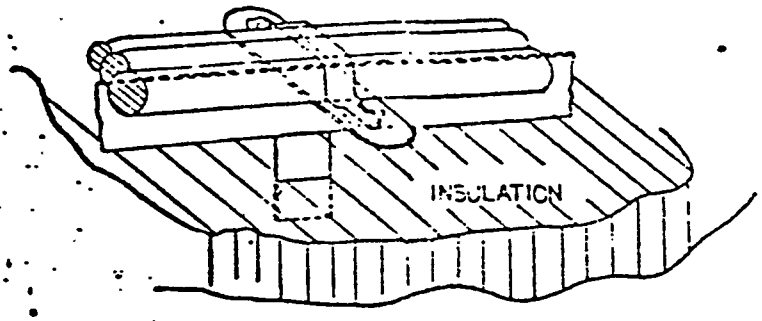


WIREWAY AND SUPPORTS - (3)

SYMBOL	WORKS	APPLICATION	REMARK
W-2	EXPOSED AND CONCEALED	ALL INTERIOR WIREWAY SUCH AS MACHINERY SPACE, STORE SPACE AND ACCOMMODATION.	SMALL WIREWAY

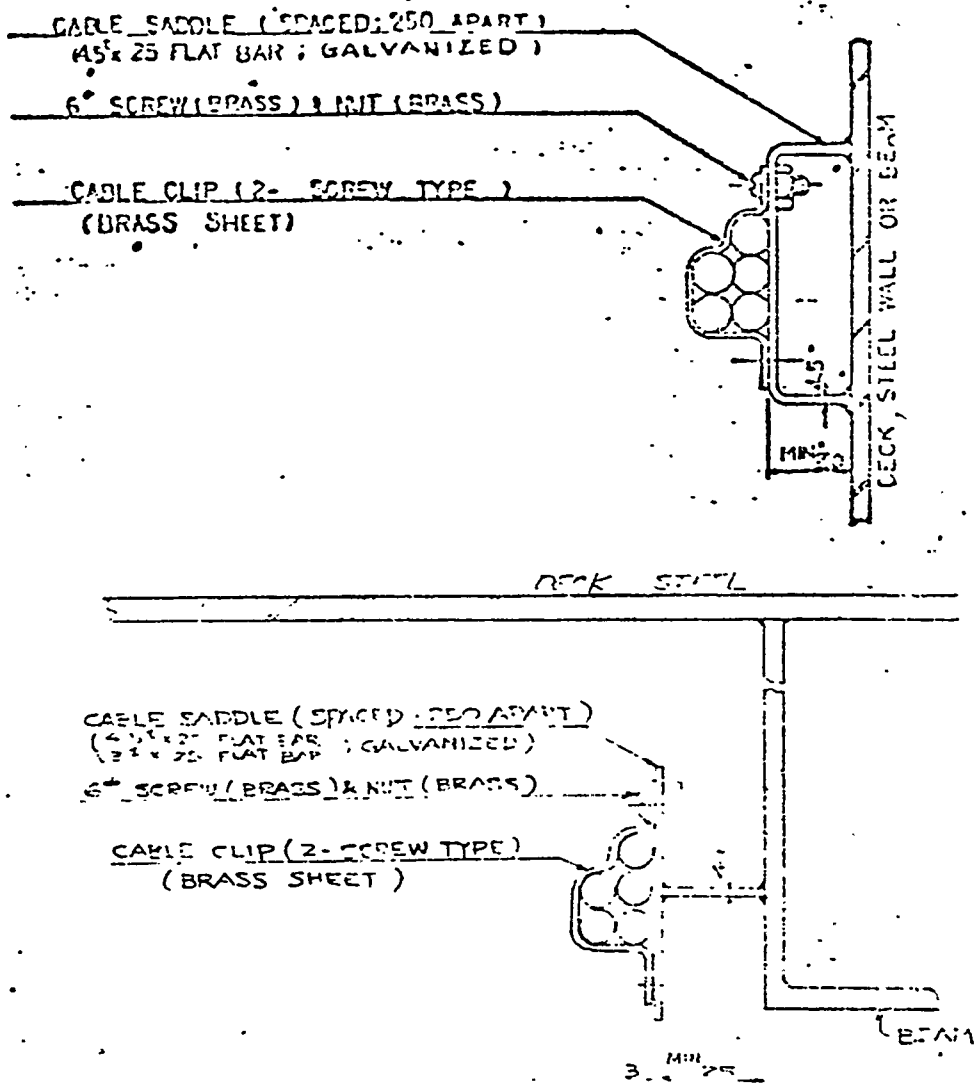






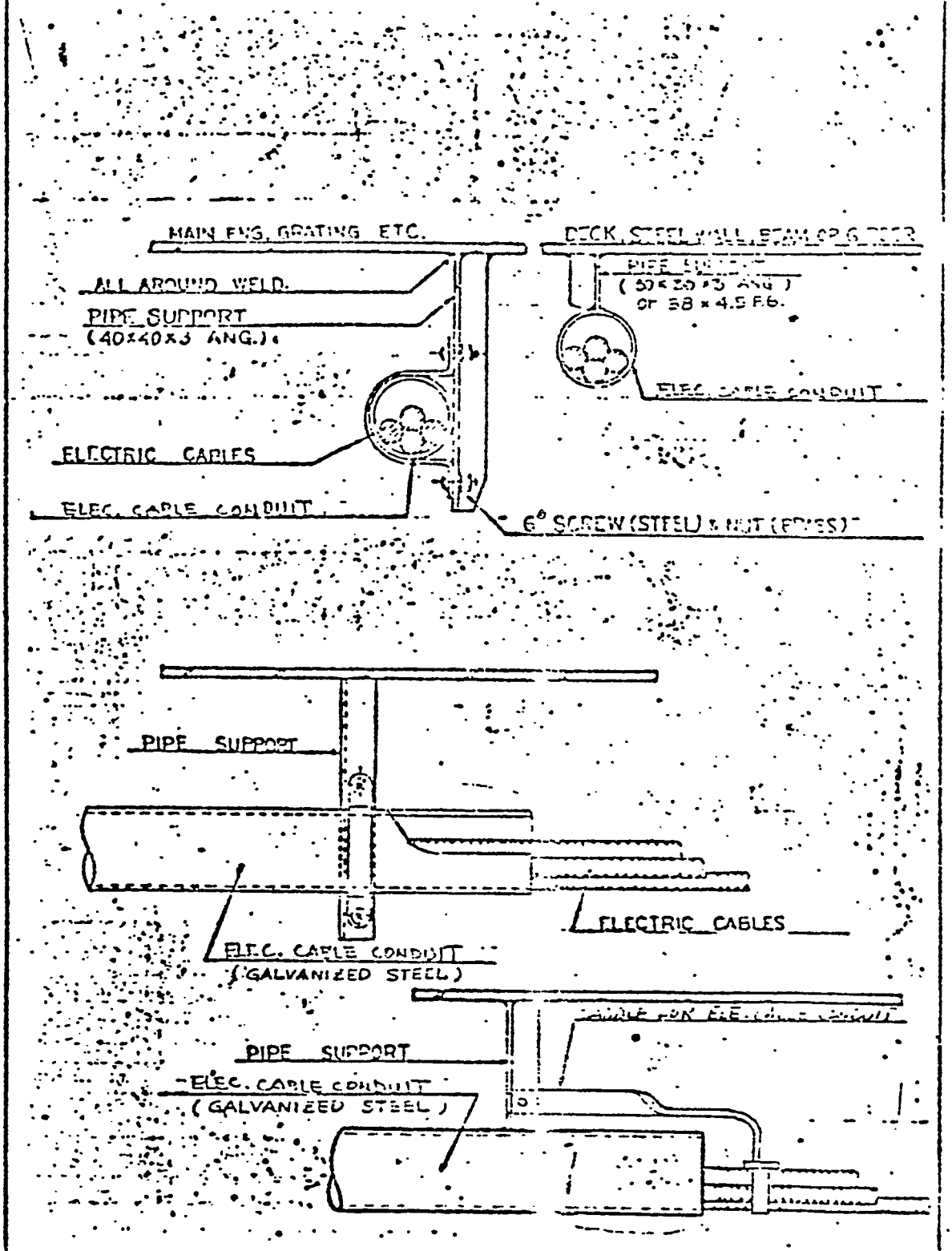
WIREWAY SUPPORTS - (4)

SYMBOL	WORKS	APPLICATION	REMARKS
W-3	EXPOSED	WHERE EXPOSED TO THE WEATHER	



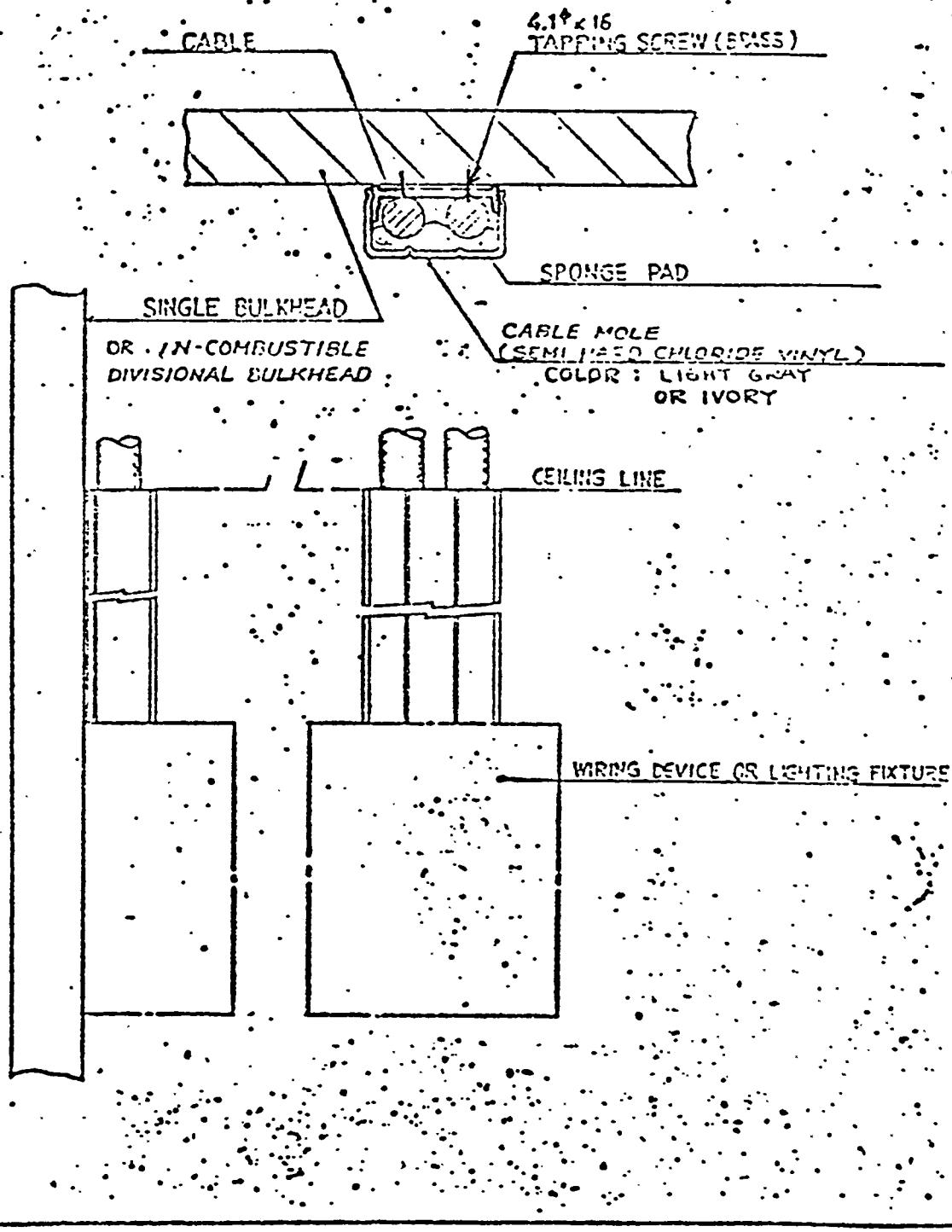
WIREWAY AND SUPPORTS - (S)

SYMBOL	WORKS	APPLICATION	REMARKS
W-4	CONDUIT WORK	ALL INTERIOR WIREWAY SUCH AS MACHINERY SPACE, STORE SPACE AND ACCOMMODATION.	SMALL WIREWAY



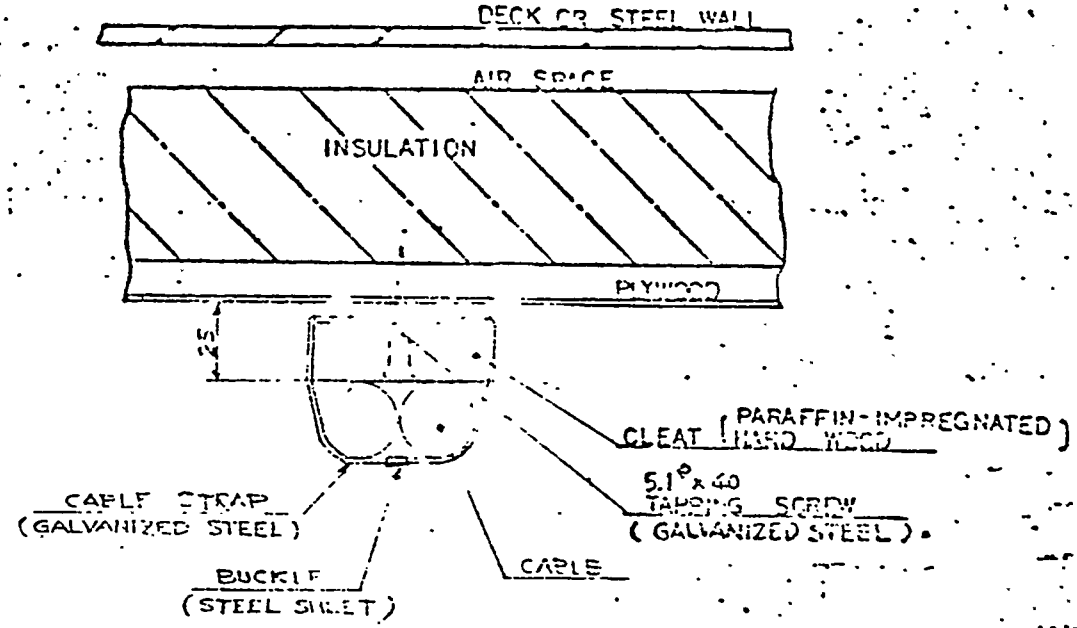
WIREWAY AND SUPPORTS - (6)

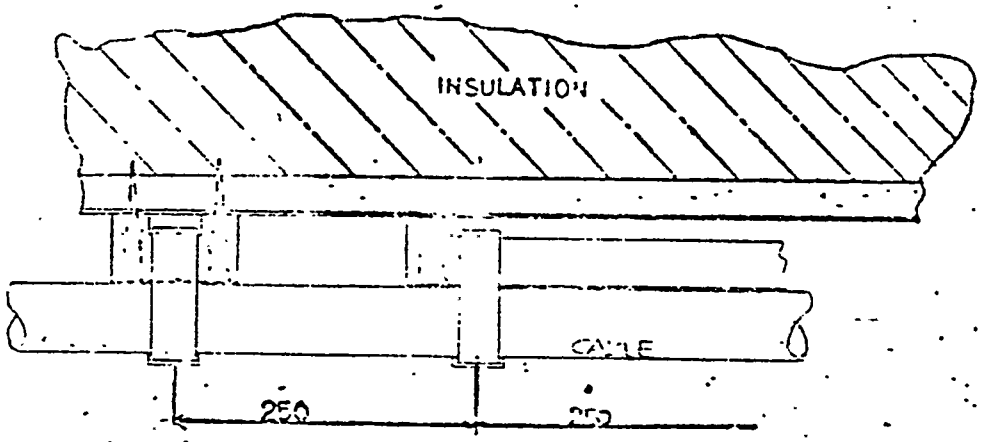
SYMBOL	WORKS	APPLICATION	REMARKS
W-5	SURFACE WIRING AND CAPPED	IN LIVING QUARTER WHERE CABLE CANNOT BE CONCEALED	



WIREWAY AND SUPPORTS - (7)

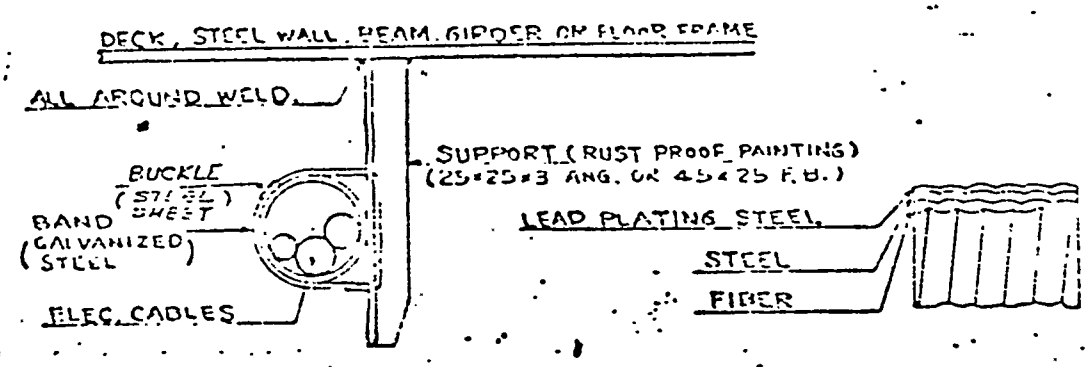
SYMBOL	WORDS	APPLICATION	REMARKS
W-6	EXPOSED	REFRIGERATED PROVISION CHAMBER	

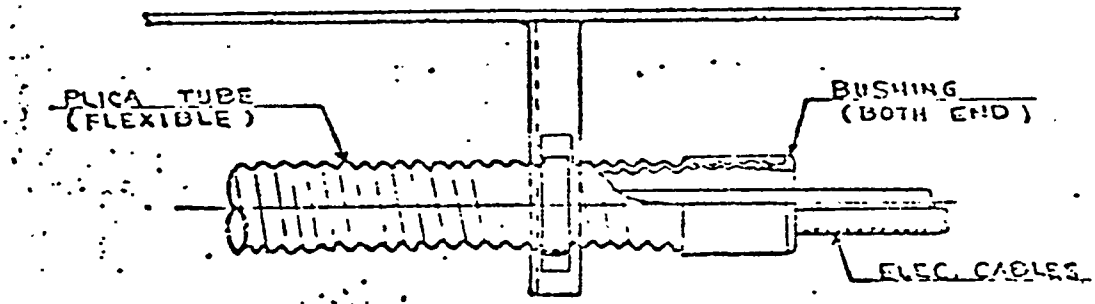


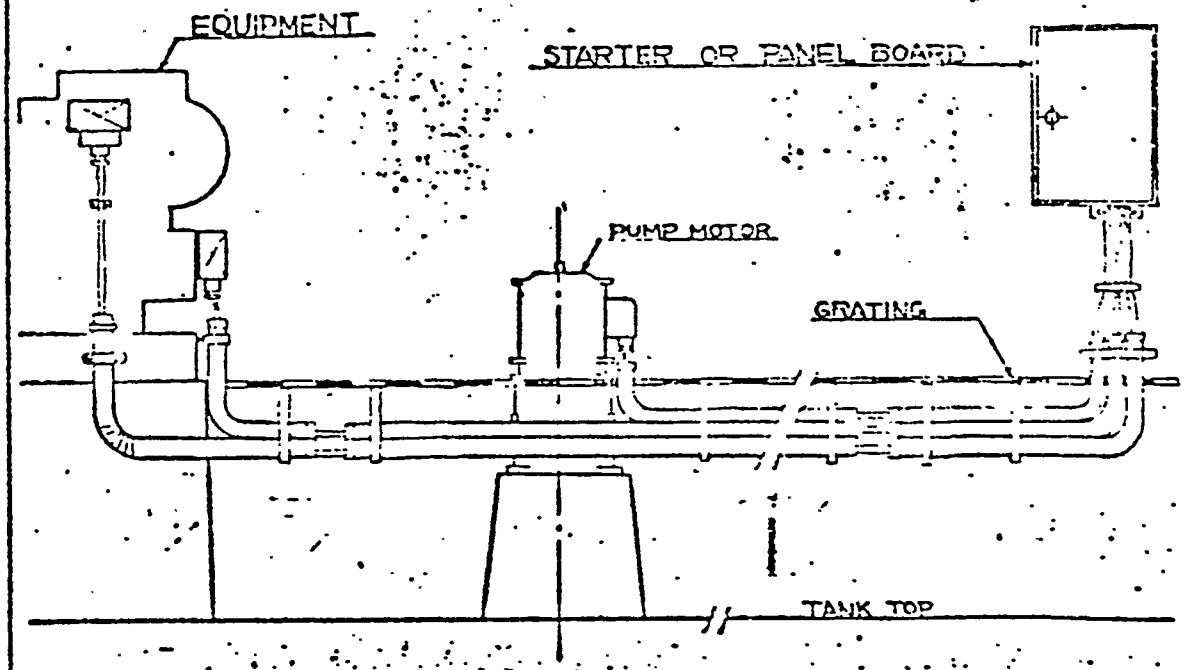


WIREWAY AND SUPPORTS - (8)

SYMBOL	WORKS	APPLICATION	REMARKS
W-7	FLEXIBLE CONDUIT (PLICA TUBE)	UNDER FLOOR WIRING AND ATTACHMENT WIRING ON EQUIPMENT	

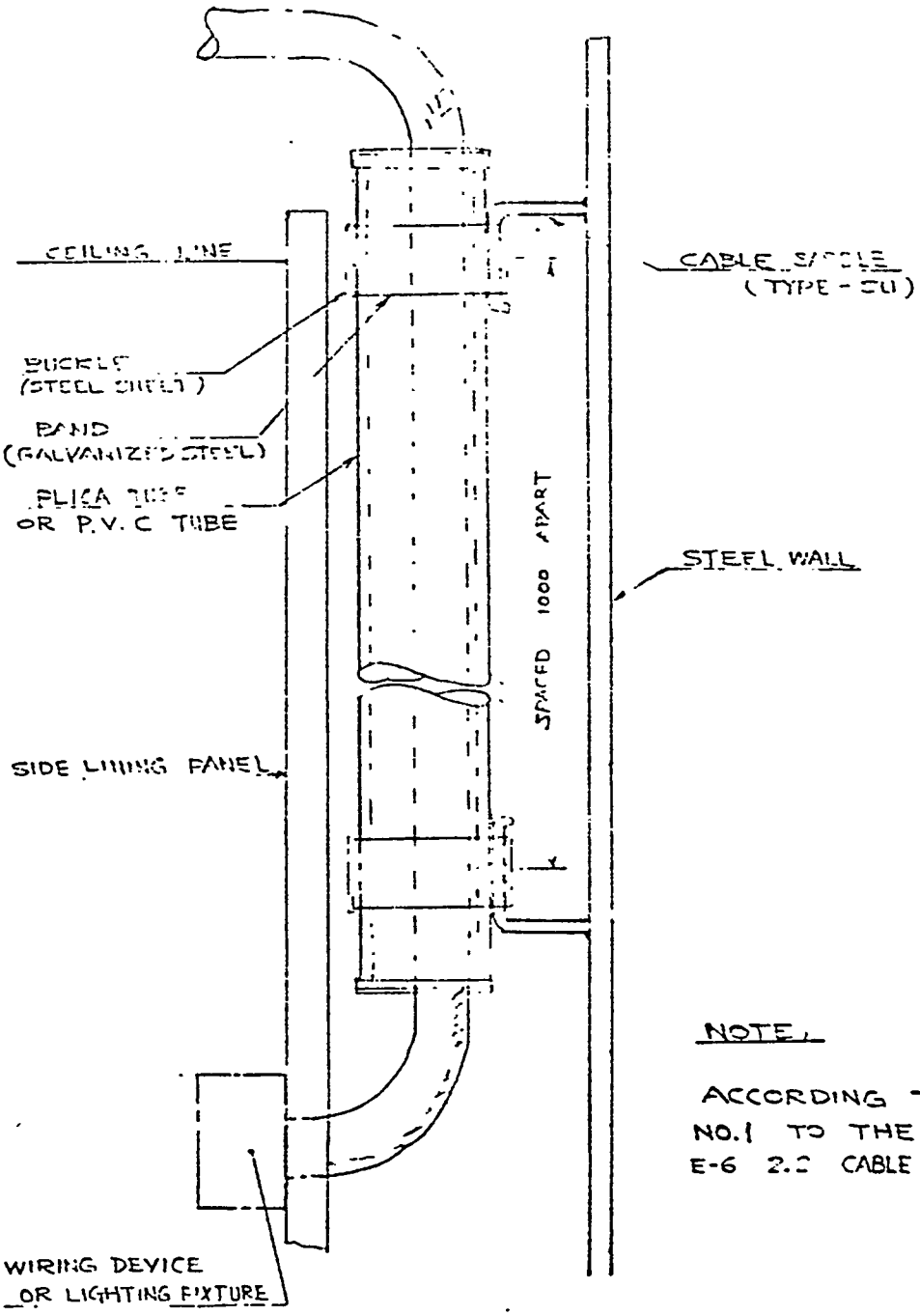






WIREWAY AND SUPPORTS -(S')

SYMBOL	WORKS	APPLICATION	REMARKS
W-7'	PLICA TUBE OR P.V.C. TUBE (CONCEALED)	WHERE CABLE LAID SPACE BETWEEN STEEL WALL AND SIDE LINING PANEL	

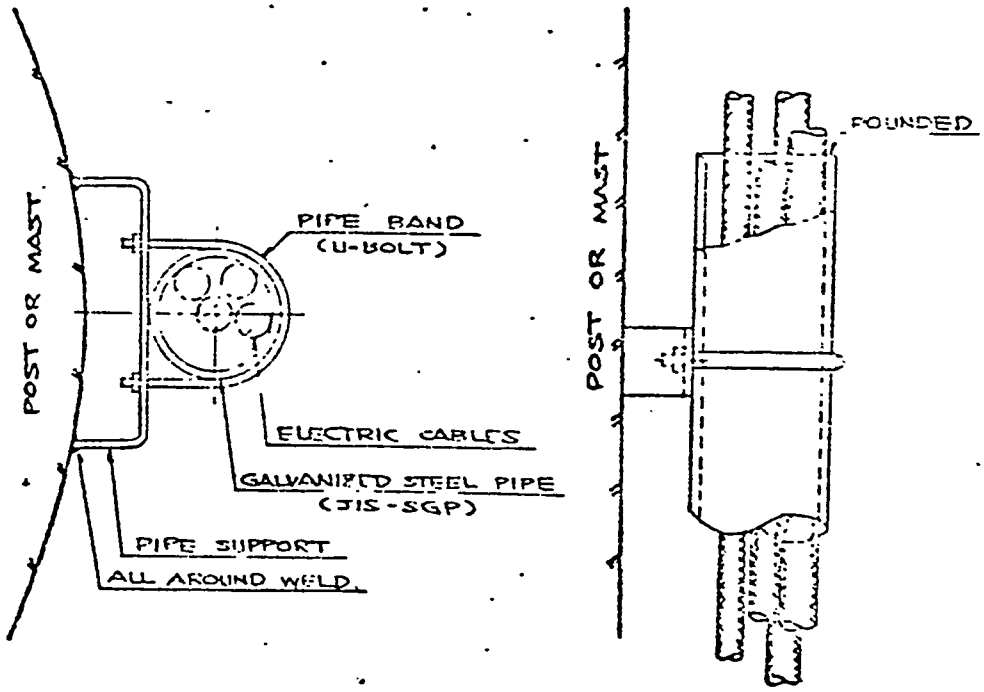


NOTE:

ACCORDING TO ADDENDUM NO.1 TO THE SPECIFICATIONS E-6 2.2 CABLE INSTALLATION

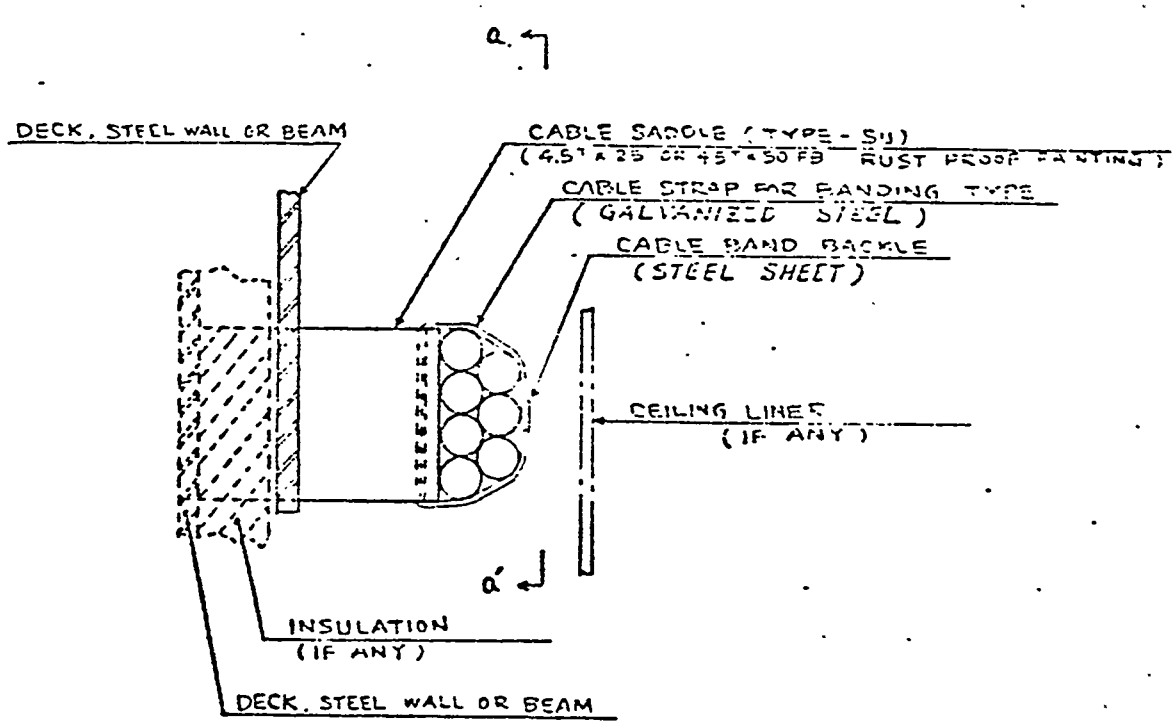
WIREWAY AND SUPPORTS - (9)

SYMBOL	WORKS	APPLICATION	REMARK
W-8	PIPE WORK	WHERE THE CABLE EXPOSED TO EXCEPTIONAL RISK OF MECHANICAL DAMAGE ON WEATHER DECK SUCH AS MAST. POST ETC.,	SMALL WIREWAY

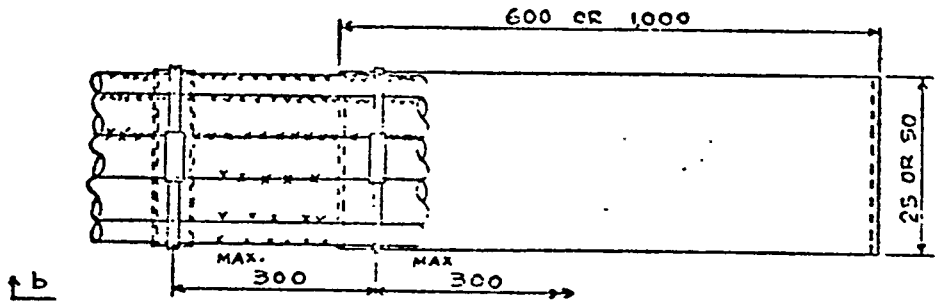


WIREWAY AND SUPPORTS - (10)

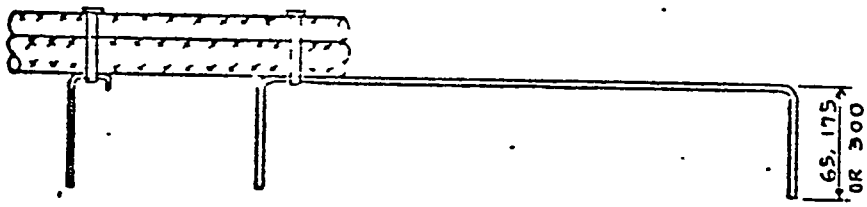
SYMBOL	WORKS	APPLICATION	REMARKS
W-10	EXPOSED AND CONCEALED	ALL INTERIOR WIREWAY SUCH AS STORE SPACE AND ACCOMMODATION EXCEPT SYMBOL MARK (W7)	SMALL WIREWAY



a - a' VIEW

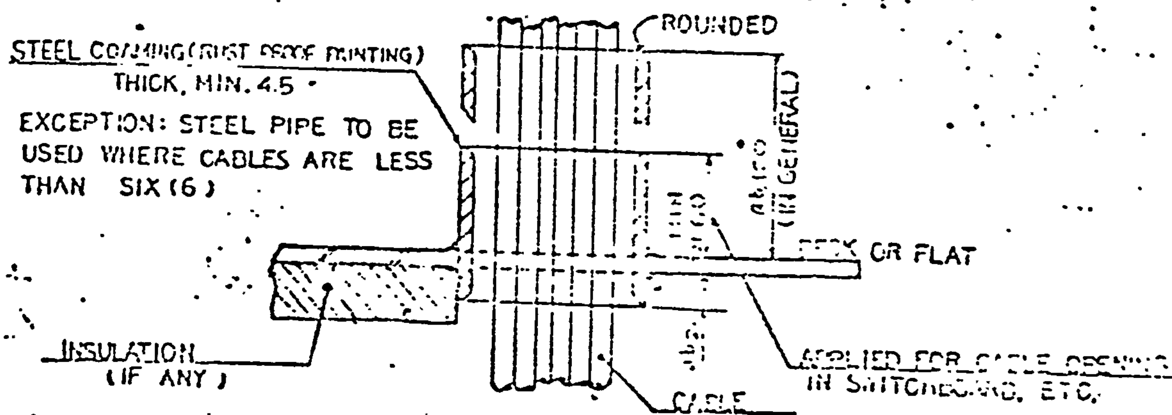


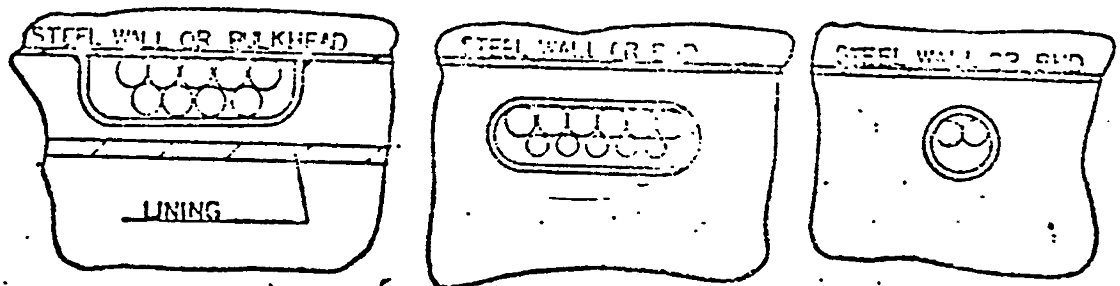
b - b' VIEW



PENETRATION - (1)

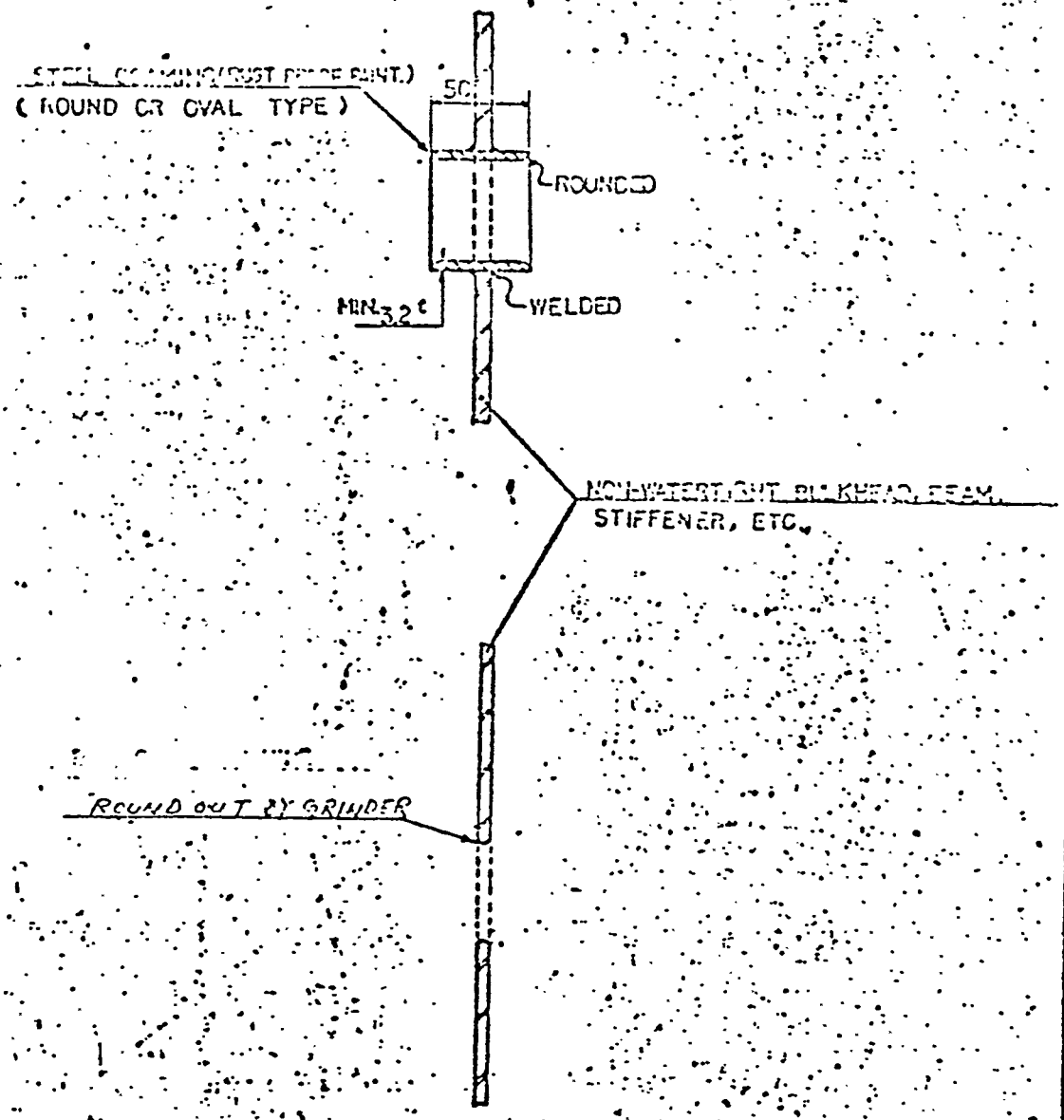
SYMBOL	WORKS	APPLICATION	REMARKS
(P-1)	STEEL COAMING •	WHERE CABLES PASS THROUGH NON-WATERTIGHT DECK OR FLAT. ETC.	





PENETRATION - (2)

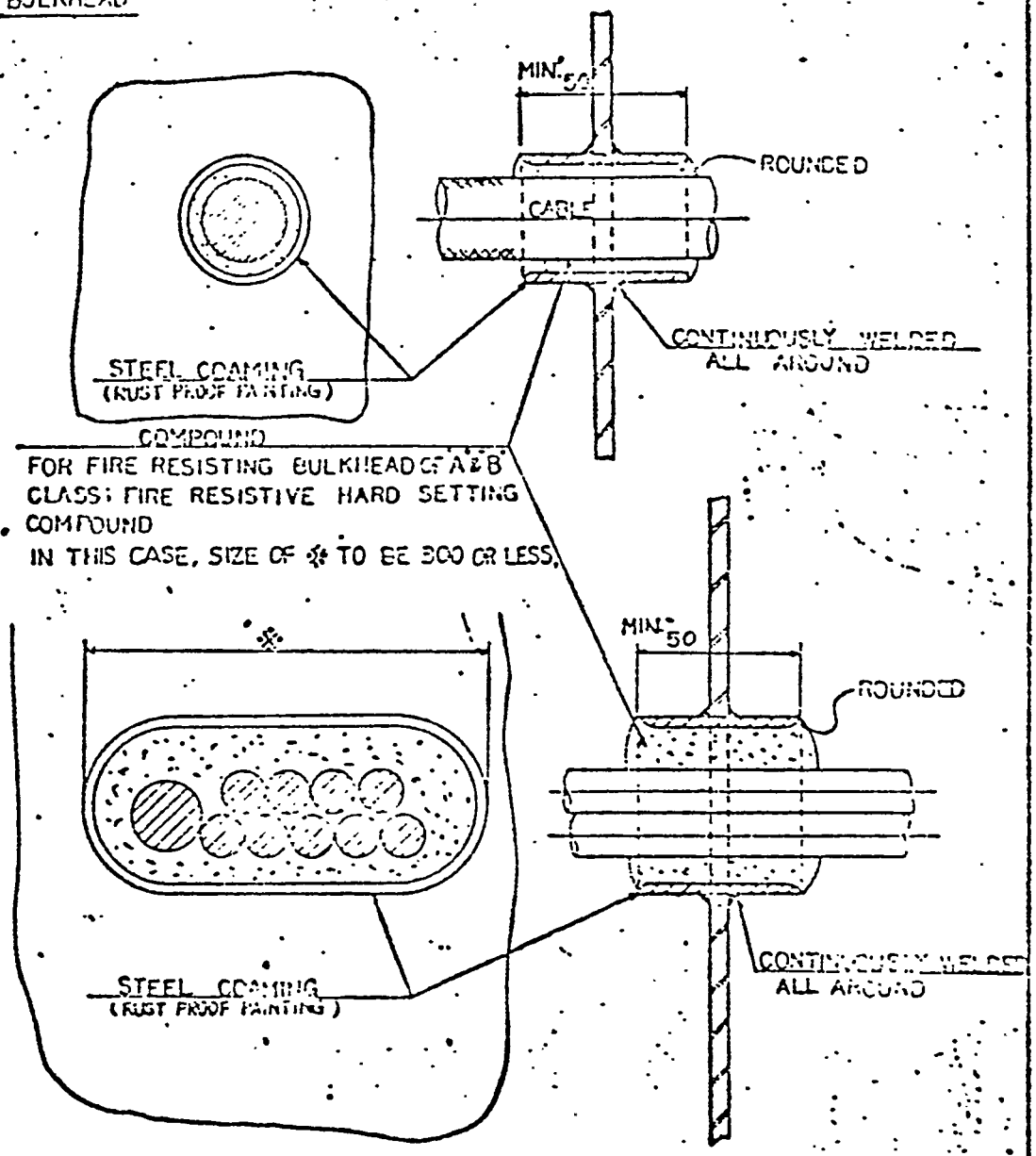
SYMBOL	WORKS	APPLICATION	REMARKS
P-2	STEEL COAMING	WHERE CABLES PASS THROUGH NON-WATERTIGHT WALL BULKHEAD, BEAM, STIFFENERS, ETC.	



PENETRATION - (3)

SYMBOL	WORKS	APPLICATION	REMARKS
P-3	COAMING WITH COMPOUND	WHERE CABLES PASS THROUGH BULKHEAD OR DECK PLATE EXCEPT EXPOSED TO WEATHER	

BULKHEAD



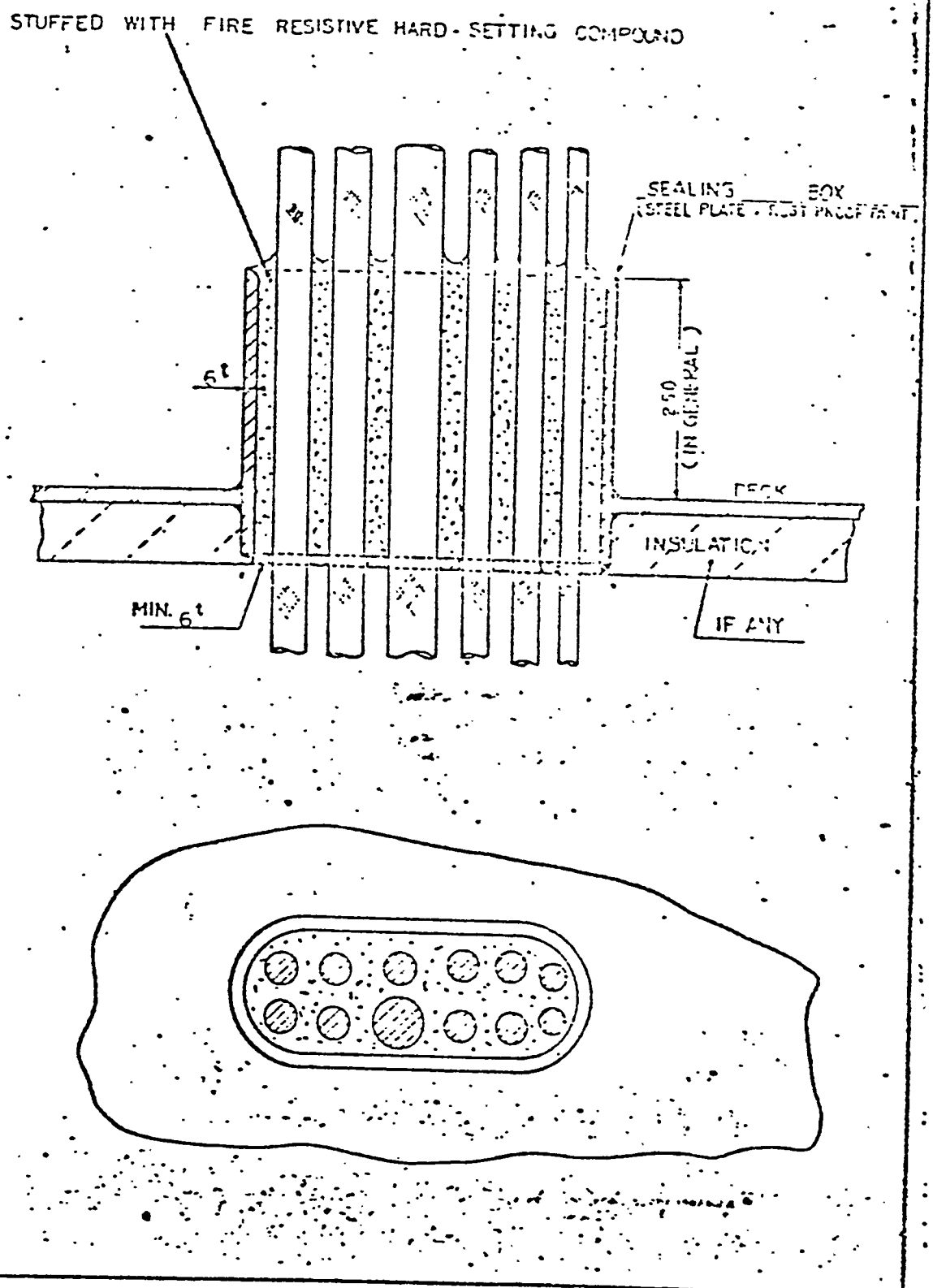
FOR FIRE RESISTING BULKHEAD OF A & B CLASS: FIRE RESISTIVE HARD SETTING COMPOUND

IN THIS CASE, SIZE OF ⊕ TO BE 300 OR LESS.

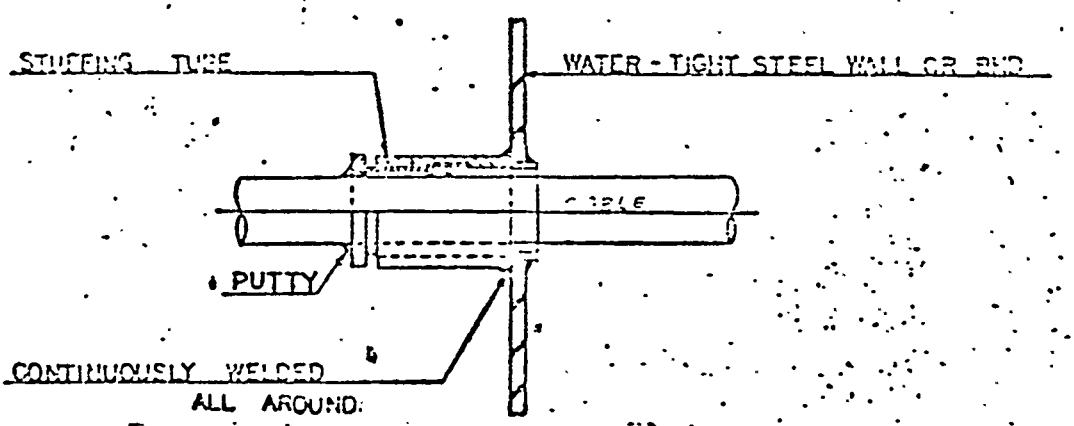
DECK

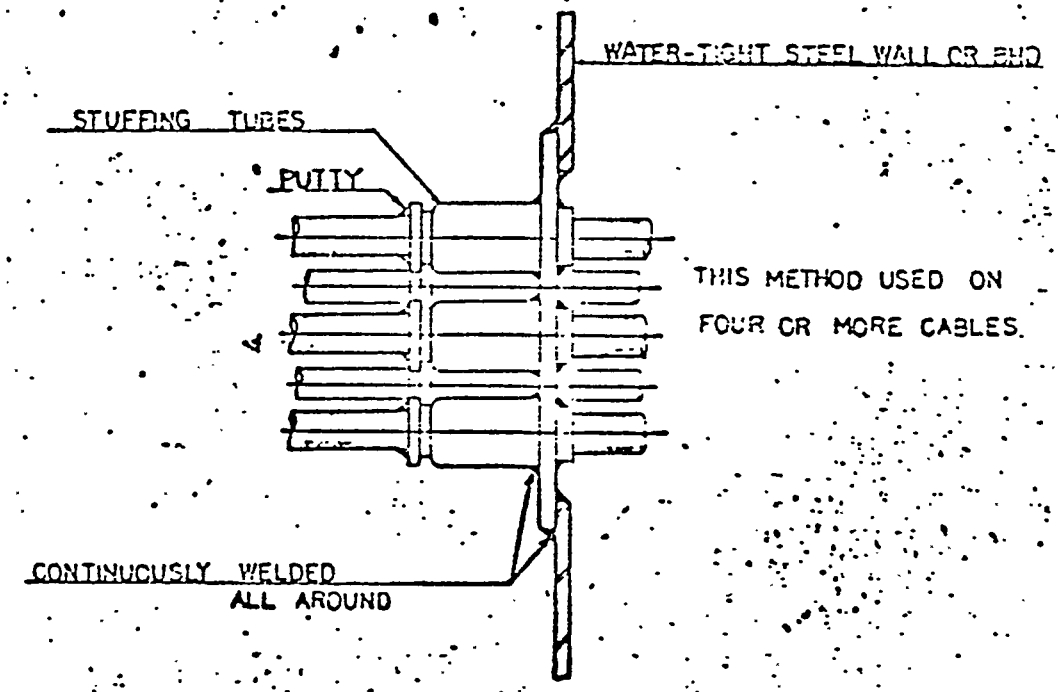
CONSTRUCTION OF COAMING SHALL CONFORM TO (P-1) AND STUFFED WITH SUITABLE COMPOUND.

SYMBOL	MARKS	APPLICATION	REMARKS
P-4	SEALING BOX	WHERE CABLES PASS THROUGH DECK IMMEDIATELY ABOVE ENGINE AND BOILER ROOM	

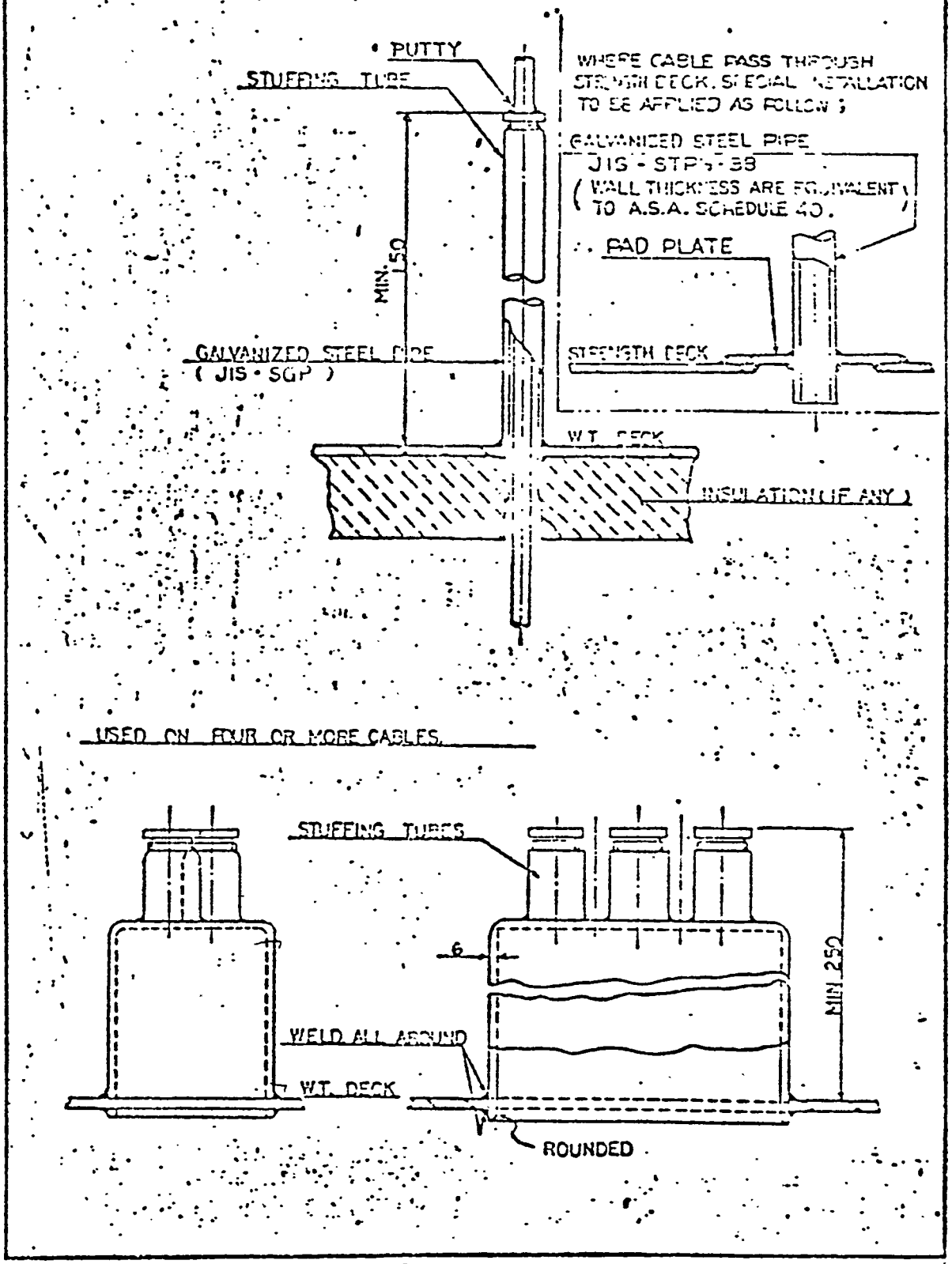


SYMBOL	WORKS	APPLICATION	REMARKS
P-5	WATERTIGHT STUFFING TUBE	WHERE CABLES PASS THROUGH WATERTIGHT BULKHEAD.	



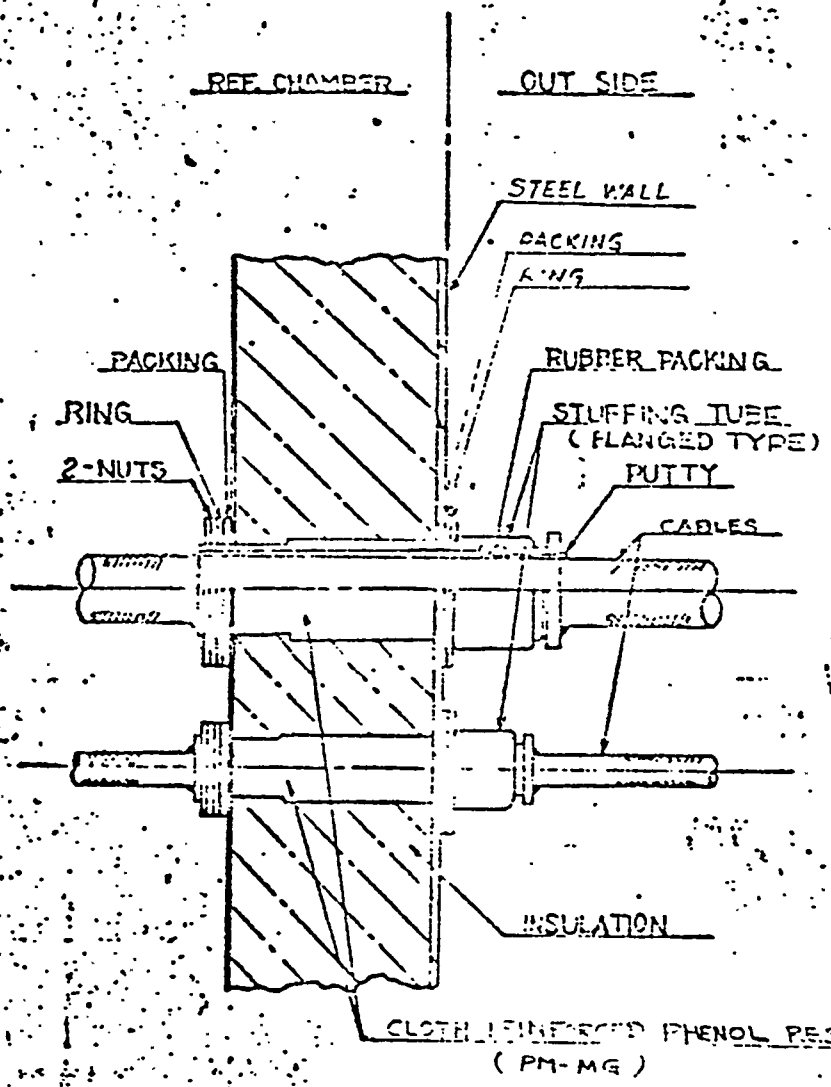


SYMBOL	NAMES	APPLICATION	REMARKS
(P-6)	WATERTIGHT STUFFING TUBE	WHERE CABLES PASS THROUGH WATERTIGHT DECK PLATE	



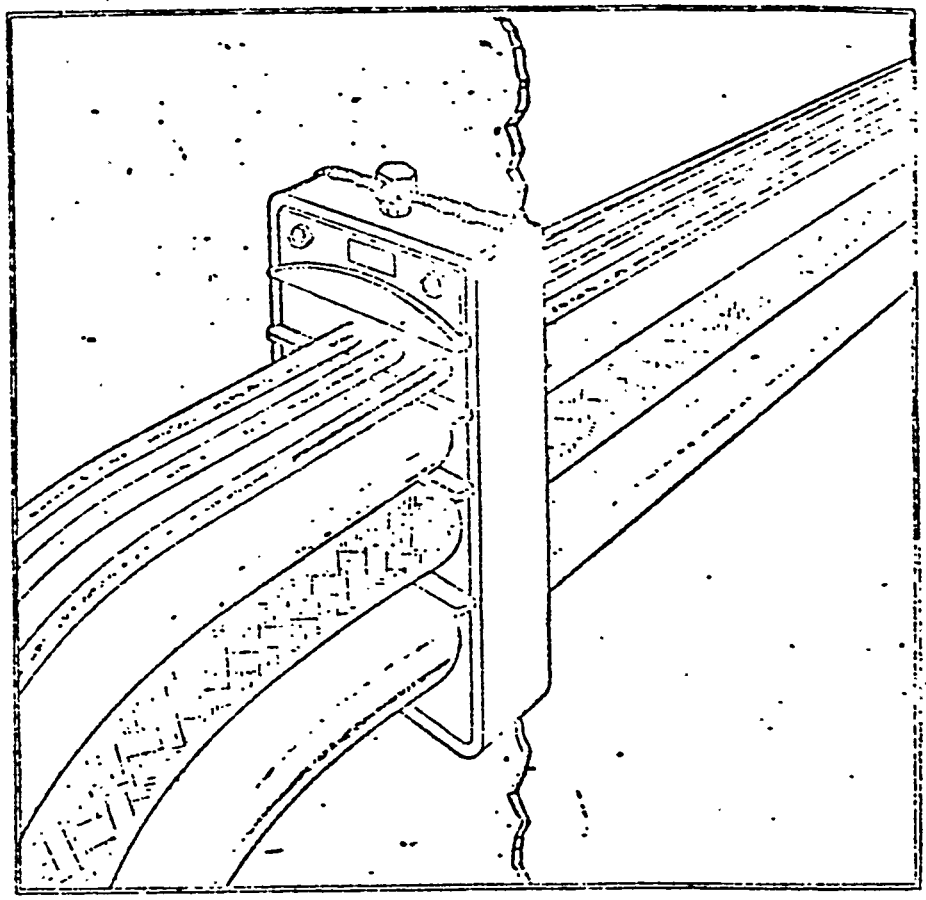
PENETRATION - (7)

SYMBOL	WORKS	APPLICATION	REMARKS
P-7	STUFFING TUBE WITH PIPE.	WHERE CABLE PASS THROUGH REFRIGERATED SPACE INSULATION	



PENETRATION - (8) 1/4

SYMBOL	WORKS	APPLICATION	REMARKS
MCT	MULTI-CABLE TRANSIT	WHERE CABLES PASS THROUGH WATER TIGHT BULKHEAL.	



Multi-Cable Transit Complies with Government Specifications

- U. S. Military Specifications MIL-P-15
  PERFORMANCE TEST (Thermocycling)
- U. S. Military Standard 167
  VIBRATION TEST
- U. S. Military Specification MIL-S-901C
  SHOCK TEST
- U. S. Military Standard MIL-STD-108D
  WATERTIGHT TEST
- International Convention for Safety of Life at Sea
  FIRE TEST (STANDARD)
- ASTM-E119-61
  FIRE TEST

NOTE: All Multi-Cable Transit test units contained an assortment of plain and armored marine cables.

PENETRATION -(8) 2/4"			
SYMBOL	WORKS	APPLICATION	REMARKS

What is Multi-Cable Transit

Tecrona Multi-Cable Transit is a proven fireproof, water and airtight method of passing electrical cables from one compartment to another.

PRINCIPAL FEATURES

- **Fire and Smoke Proof**
  Special elastomer blocks form an incombustible seal around burning cables, filling in all parts destroyed by fire and choking off any passage of fire or smoke.
- **Water and Airtight**
  Elastomer blocks provide a water and airtight seal.
- **Shock and Vibration Proof**
  A special "stay plate" (see page 5) prevents dislodgment of components.
- **Thermal Efficiency**
  Effective in temperatures between minus 320° and plus 1700° F.
- **Flexibility**
  Cables can be added, removed, or sizes changed in minutes.
- **Economy**
  Cable pulling time and cost is reduced drastically by inserting cables through wide open transit frames rather than stuffing tubes.
- **Space Saving**
  A large number of cables can be grouped in a small area.
- **Cable Protection**
  Large aperture and elastomer blocks prevent chafing and shredding of cables inherent in other devices.
- **Positive Visual Inspection**
  Danger of a poor sealing job is eliminated. All units may be visually inspected to assure proper seal against fire, water, air, and dust.
- **Durability**
  Inserts are unaffected by liquids, chemicals, oils, gases, etc.

Applications

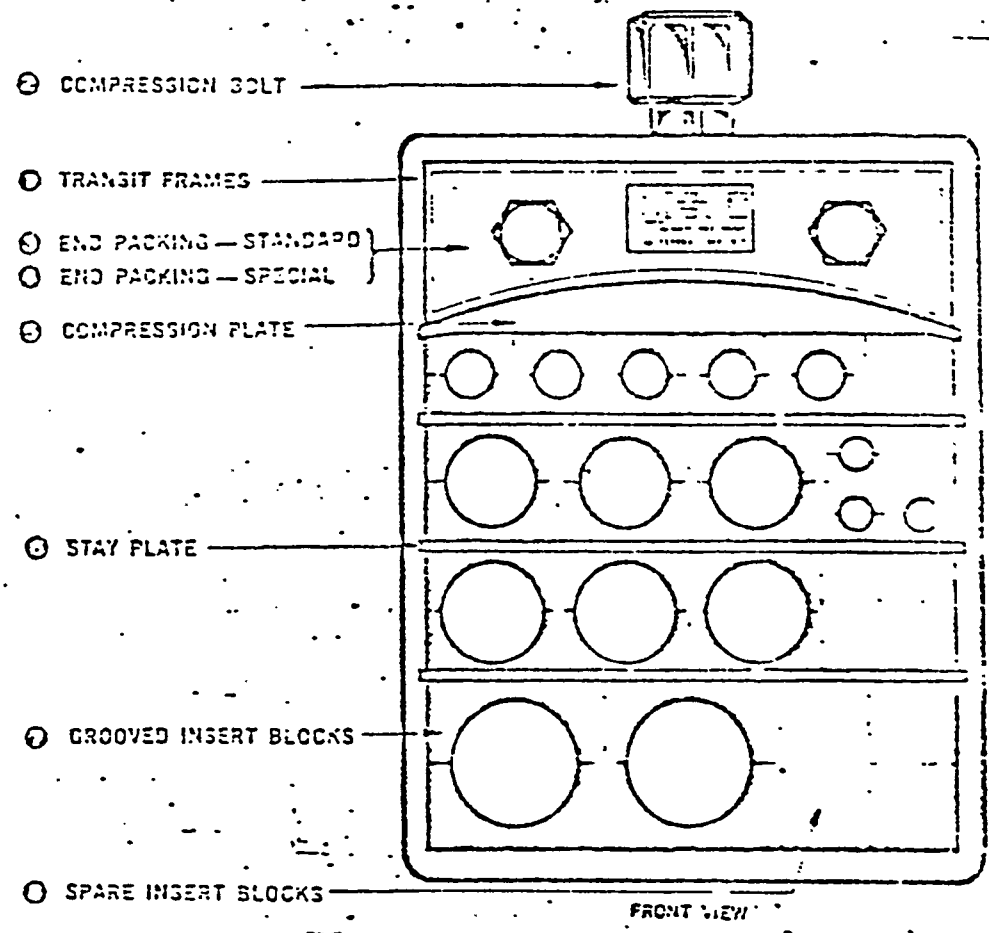
MARITIME

- Watertight, airtight, fireproof bulkhead penetrations.
- Weatherdeck penetrations.
- Fire and explosion-proof protection in critical areas.
- Electrical equipment penetrations.
- Thermal barrier for all type penetrations.
- Sound and vibration-free entries for cables and pipe.

PENETRATION - (8) 3/4

SYMBOL	WORKS	APPLICATION	REMARKS

Components of the Multi-Cable Transit



COMPONENT MATERIALS

Transit Frames are fabricated either of steel, aluminum, or steel alloys. Compression Plates are steel or aluminum castings. Compression Bolts are available in stainless steel or galvanized. Stay Plates are made of steel or aluminum. Insert Blocks and End Packings are made from a specially formulated fire-proof elastomer.

PENETRATION - (8) 4¼

SYMBOL	WORKS	APPLICATION	REMARKS

TRANSIT FRAMES

TYPES

There are a number of types of Multi-Cable Transit frames designed for the following uses: marine conventional construction and industrial equipment, whether original installation or where cables have already been pulled.

SIZES

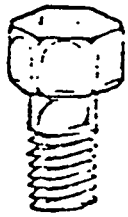
There are 3 basic sizes: small, the RG-2 series; medium, the RG-4 series; large, the RG-6 series.

FABRICATION

Frames are fabricated of steel, aluminum or steel alloys.

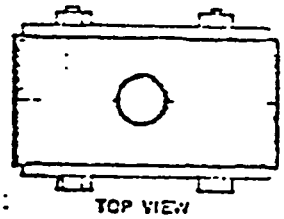
COMPRESSION BOLT

When tightened the bolt seats the compression plate and seals cables. (One size only, one required)



END PACKING — STANDARD

Compresses to seal off frame area above compression plate. (One size only, one required)

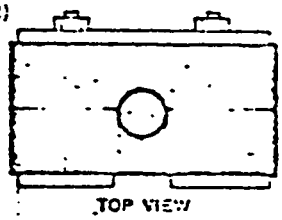


TOP VIEW

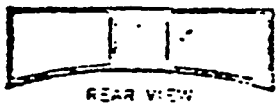
FRONT VIEW

END PACKING — SPECIAL

Used when a transit frame can be packed from one side only. (One size only, one required)



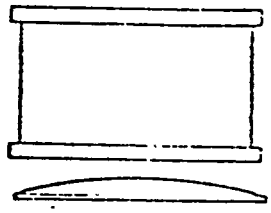
TOP VIEW



REAR VIEW

COMPRESSION PLATE

Seats and compresses the Insert Blocks so that the End Plate may be inserted in the transit frame. (One size only, one required)

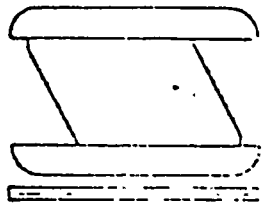


TOP VIEW

FRONT VIEW

STAY PLATE

Stay plates are normally placed between every row of Insert Blocks keeping them contained in the transit frame. (One size only)

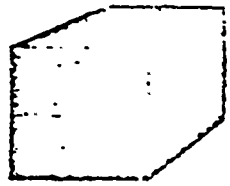


TOP VIEW

FRONT VIEW

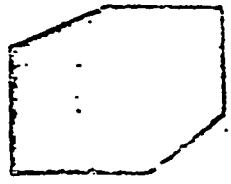
GROOVED INSERT BLOCKS

Twin half blocks of specially formulated elastomer with a centered semi-circular groove. When matched around a cable, these half blocks form a single block with a tight fit. Insert blocks are available in 7 basic middle sizes, each fitting an extensive range of cable sizes from .12" to 3-3/4" O.D.



SPARE INSERT BLOCKS

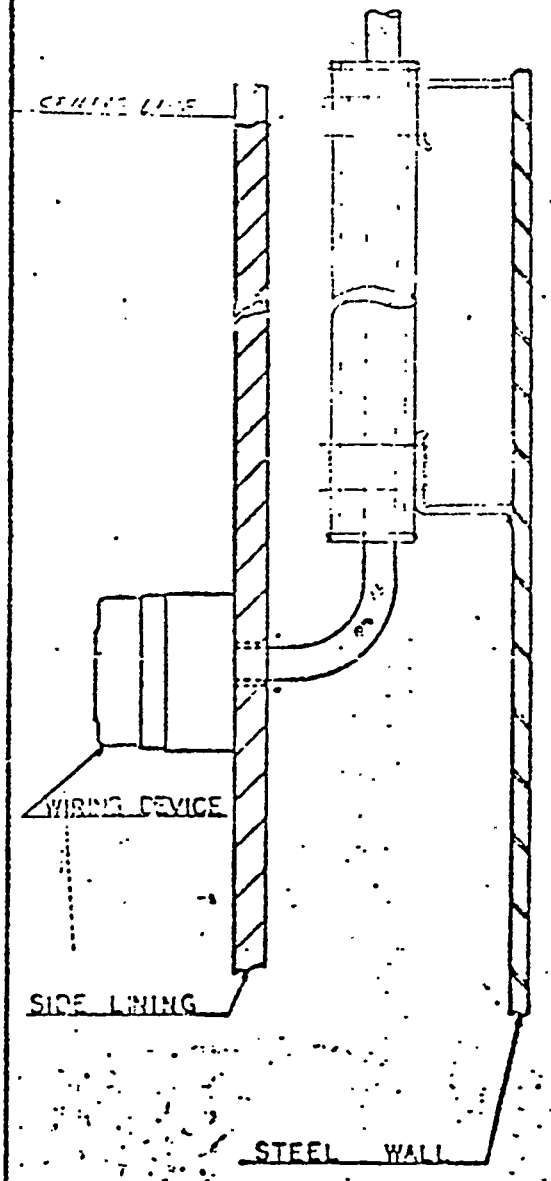
These solid blocks of elastomer are used to fill voids or to allow for the addition of cables at a future date. They are available in four sizes: 15 O, 20 O and 30 O. They may be used in any combination to match the seven Grooved Insert Block sizes.



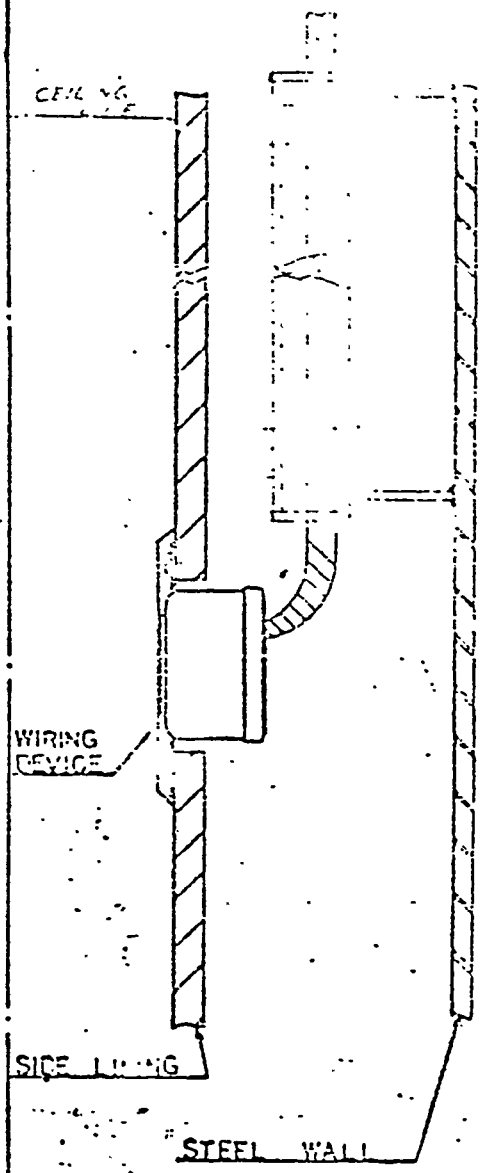
FITTING DETAIL OF WIRING DEVICE - (1)

SYMBOL	NAME	APPLICATION	REMARKS
F-1	SURFACE AND FLUSH MOUNTED	IN LIVING QUARTER	

CABIN ; JUNIOR OFFICER
PETTY OFFICER -
RATING



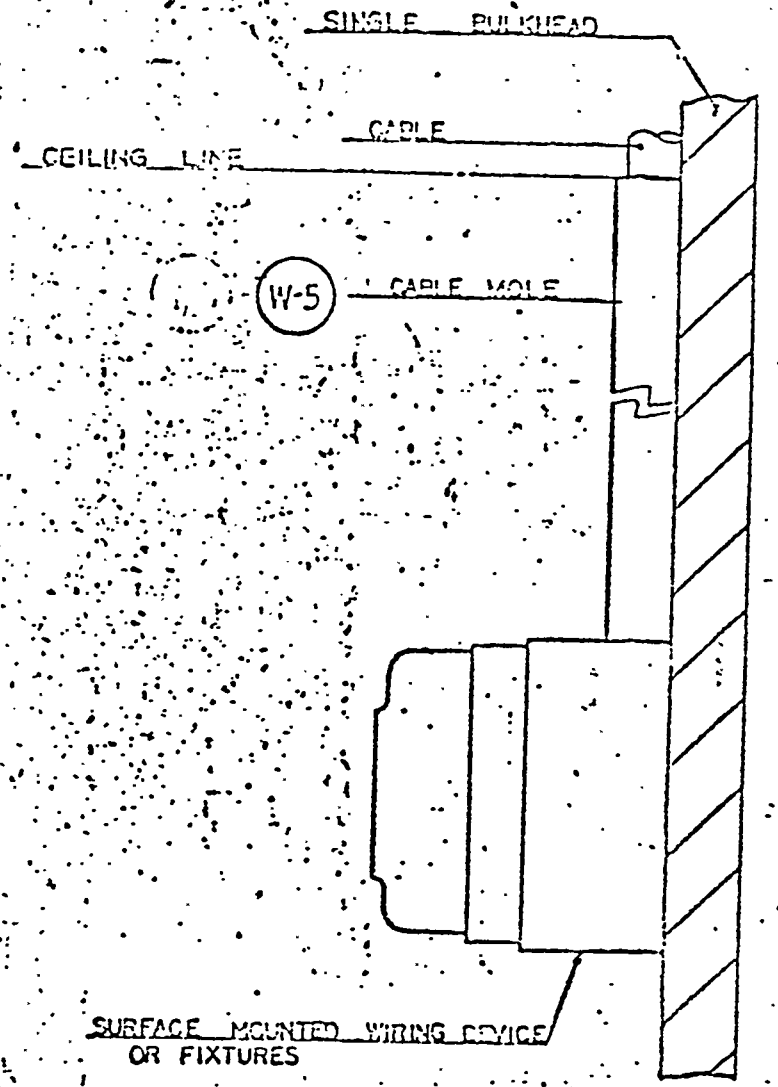
CABIN ;



SOT-A347001 (08)

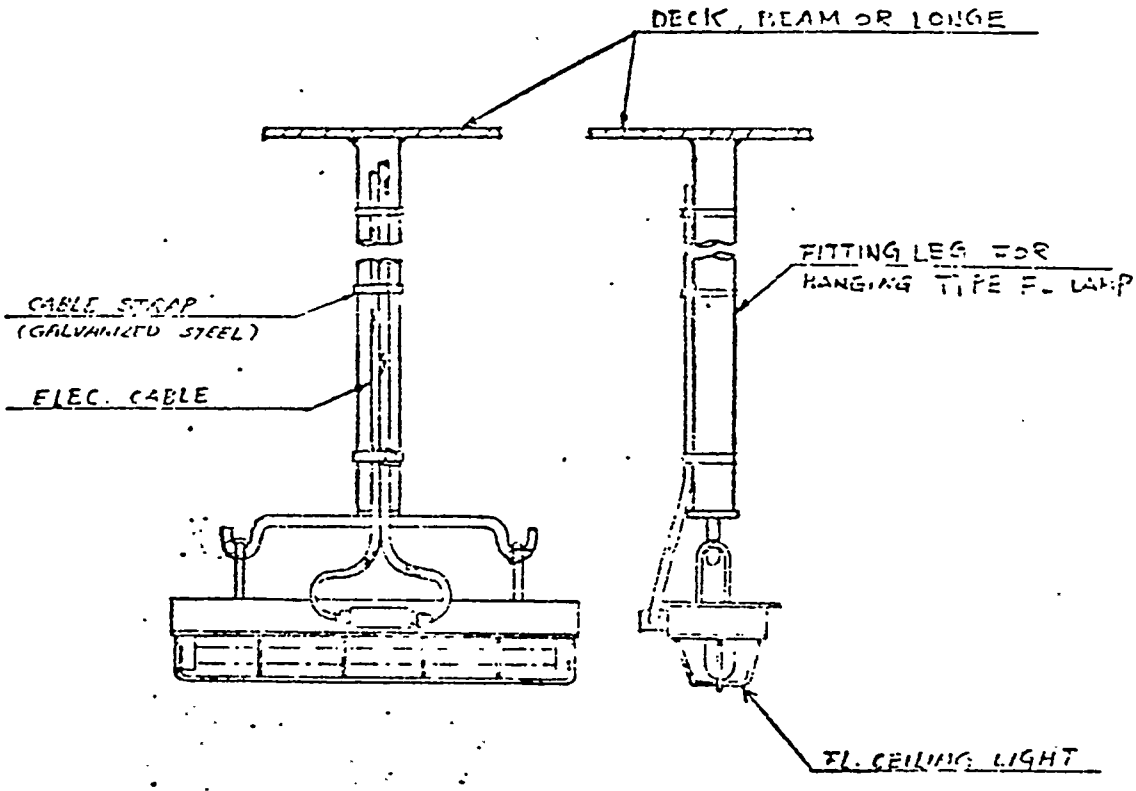
FITTING DETAIL OF WIRING DEVICE - (2)

SYMBOL	WORKS	APPLICATION	REMARKS
(F-2)	SURFACE MOUNTED	IN LIVING QUARTER, WHERE FIXTURES CANNOT BE FLUSHED	



FITTING DETAIL OF WIRING DEVICE - (3)

SYMBOL	WORKS	APPLICATION	
(F-3)	PENDANT	IN ENGINE ROOM & STEER. ENGINE ROOM	



1. 適用範囲

この基準は船体構造に電路を取り付ける場合の要領を示す。

(1) SCOPE

This standard shows the fitting method of electric cable way to hull structure.

2. 取付け方法

電路材の取付け方法は下表によること。

(2) FITTING METHOD

Fitting method of electric cable ways material is to be in accordance with following Table.

Marked "D" : Directly welded to steel plate.

Marked "P" : Welded with steel pad on steel plate.

TABLE

Type of Cable Way / Hull Structure	Cable Rack * (W-1)	Cable Saddle * (TYPE T) (W-2)	Cable Saddle * (TYPE U) (W-3)	Conduit Tube * (W-4)
Girder, beam & web frame	D	D	D	D
Engine room fore & aft. bulkhead and tank wall	P	D	-	D
Upper deck plate (except exceeding thick. of 16 mm) tank top plate of double bottom.	P	D	-	D
Engine casing, house wall, deck plate (except upper deck) & engine room flat.	D	D	-	D

* Remarks: Ref. Dwg. - IS SOT-A347001 INSTALLATION METHOD OF ELEC. CABLE AND FITTINGS.

	0	1	2	3	4	5

IS	SHAPE OF ELEC. CABLE ENTRY TO ELEC. EQUIPMENT	S O T - A 3 4 7 0 0 5	1/2

1. 適用範囲

この基準は各機器の装備区画による電気品の電線導入口の形式について規定する。

(1) SCOPE

This standard is applicable to shape of electric cable entry to electric equipment according to the compartments where the equipment is installed.

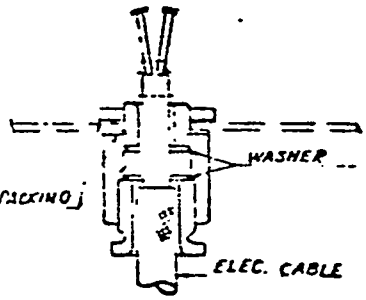
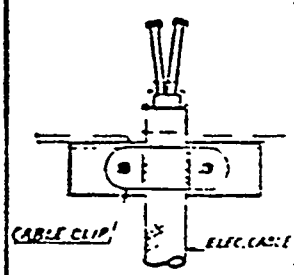
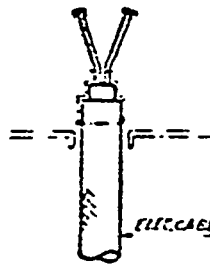
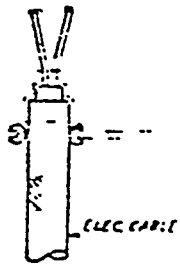
2. 形　　式

電線導入口の形式は図および表による。

(2) SHAPE

Shape of electric cable entry is to be in accoadance with Sketch and Table.

SKETCH

G	C			
				
GLAND TYPE CABLE ENTRY	JEM-R TYPE CABLE ENTRY	COAMING TYPE CABLE ENTRY	GUSHING TYPE CABLE ENTRY	

改正・改	0	1	2	3	4	5
年月日	44. 11. 15					
実施						

NOTE:
1) Marked (G) : Gland type
2) Marked (C) : Coaming type, Bushing type or Clamp type

TABLE

LOCATION / ELECTRIC EQUIPMENT	DRY ACCOMMODATION CABIN, OFFICE, GYRO ROOM, ETC.	WET SPACE GALLEY, RET., P.O. CHAMBER, LAVATORY, ETC.	MACHINERY SPACE ENGINE RM., STEER. ENG. RM., FAN RM., ETC.	EXPOSED TO WEATHER DECK
Generater	-	-	G	-
Exciter, CCP	-	-	C *	-
Motor	G	G	G	G
Starter, GCP	C	G	C *	-
Main Switchboard	-	-	C *	-
Panel Board	C	G	C *	-
Disiribution Panel	C	-	-	-
Radio Equipment & Electronic Apparatus	C	G	G	G
Engine Control & Measuring Equipment	C	-	G	-
Electric Nautical Instrument	C	-	-	-
Electric Communication Apparatus	C	G	G	G
Push Button Switch	C	G	G	G
Bell & Buzzer	C or G	G	G	G
Elec. Wiring Fittings	C	G	G or C *-1	G
Electric Lighting Fixtures	C	G	G	G

Remark: 1. Cable entry methods of imported apparatus are to be of maker's standerd.
2. Where cables lead in to equipment from upper part, * marked cable entry to be substituted by "G" for "C".
*-1 ; Applied to joint box

	0	1	2	3	4	5
	[illegible]					
	[illegible]					

LR

1. 適用範囲

この基準は電気設備の機器および電線の非充電金属部の接地について適用する。

(1) SCOPE

This standard is applicable to earthing method of non carring-parts of electric equipment & cable.

2. 規　　格

この基準は　ロイド　船級船に適用する。

(2) RULE

This standard is to be applied to *LLOYD'S REGISTER* class ship.

3. 接地要領

接地要領はスケッチならびに表による。

(3) EARTHING METHOD

Eathing method is to be in accordance with Sketch and Table.

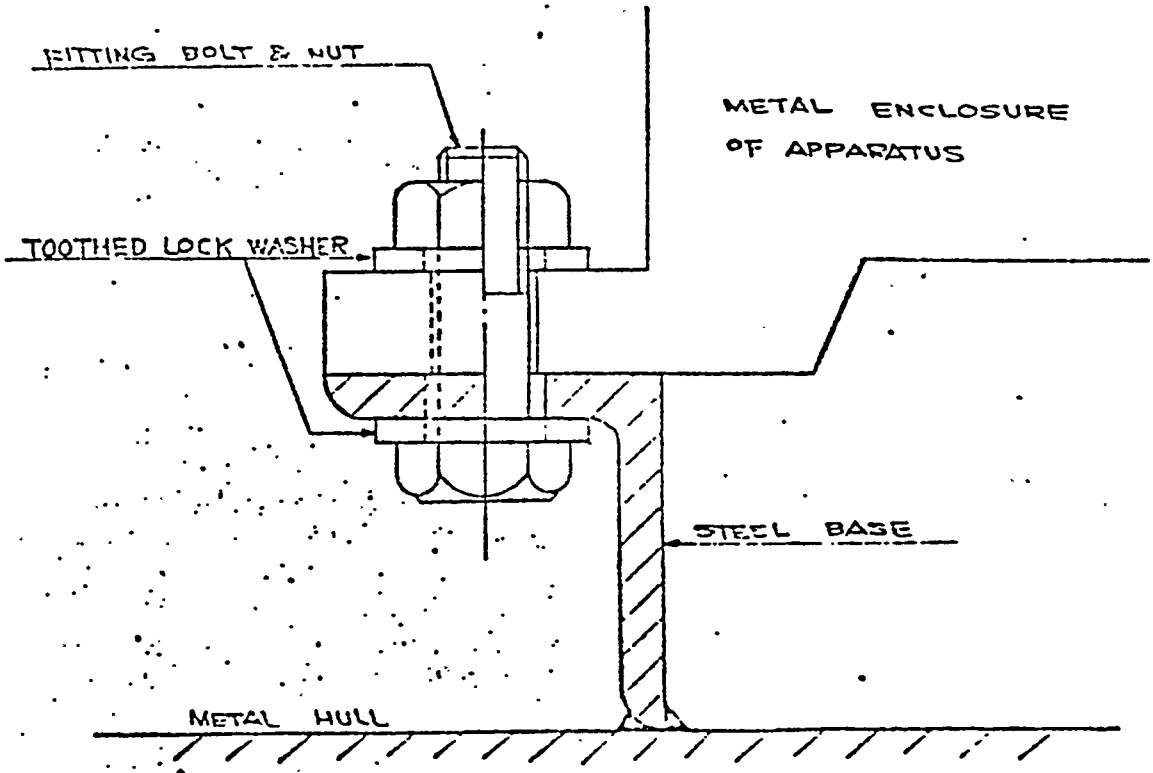
4. 目　　次

CONTENTS

1.5	EARTHING METHOD OF NON CURRENT-CARRYING PARTS 帯えるの非充電金属部の接地方式	SDT-A347005A	2/14

EARTHING OF METAL ENCLOSURES OF APPARATUS - (1)

SYMBOL	WORKING	APPLICATION	REMARKS
(E-1)	METALLIC CONTACT WITH METAL HULL	ELEC. APPARATUS ON STEEL STRUCTURES	



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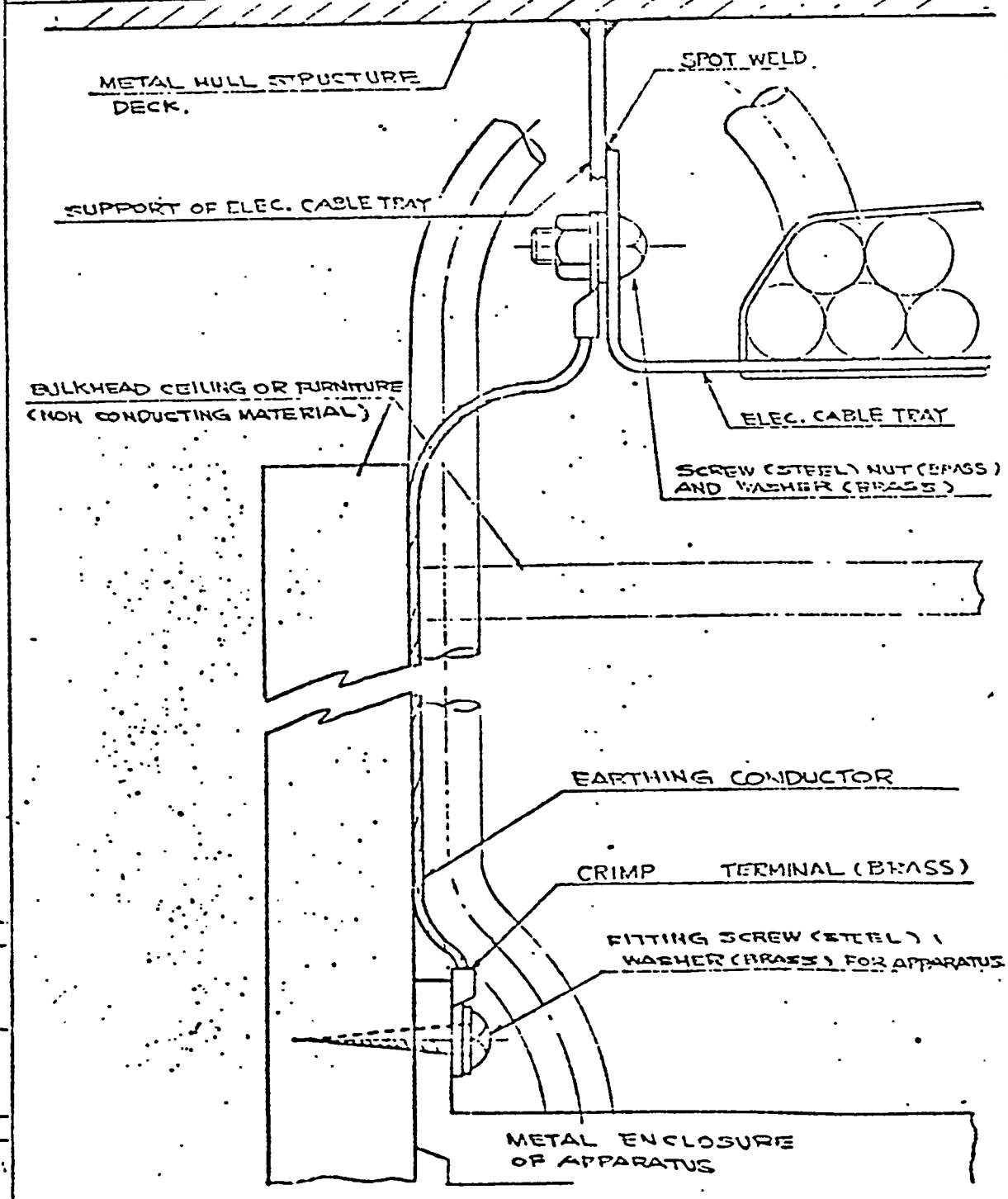
EARTHING OF METAL ENCLOSURES OF APPARATUS - (2)

SYMBOL	WORKING	APPLICATION	REMARKS
E-2	EARTHING CONDUCTOR TO BE USED	ELEC. APPARATUS ON NON-CONDUCTING MATERIAL	HORIZONTAL TYPE



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IS	CURRENT-CARRYING PARTS	SOC-AZ47005A

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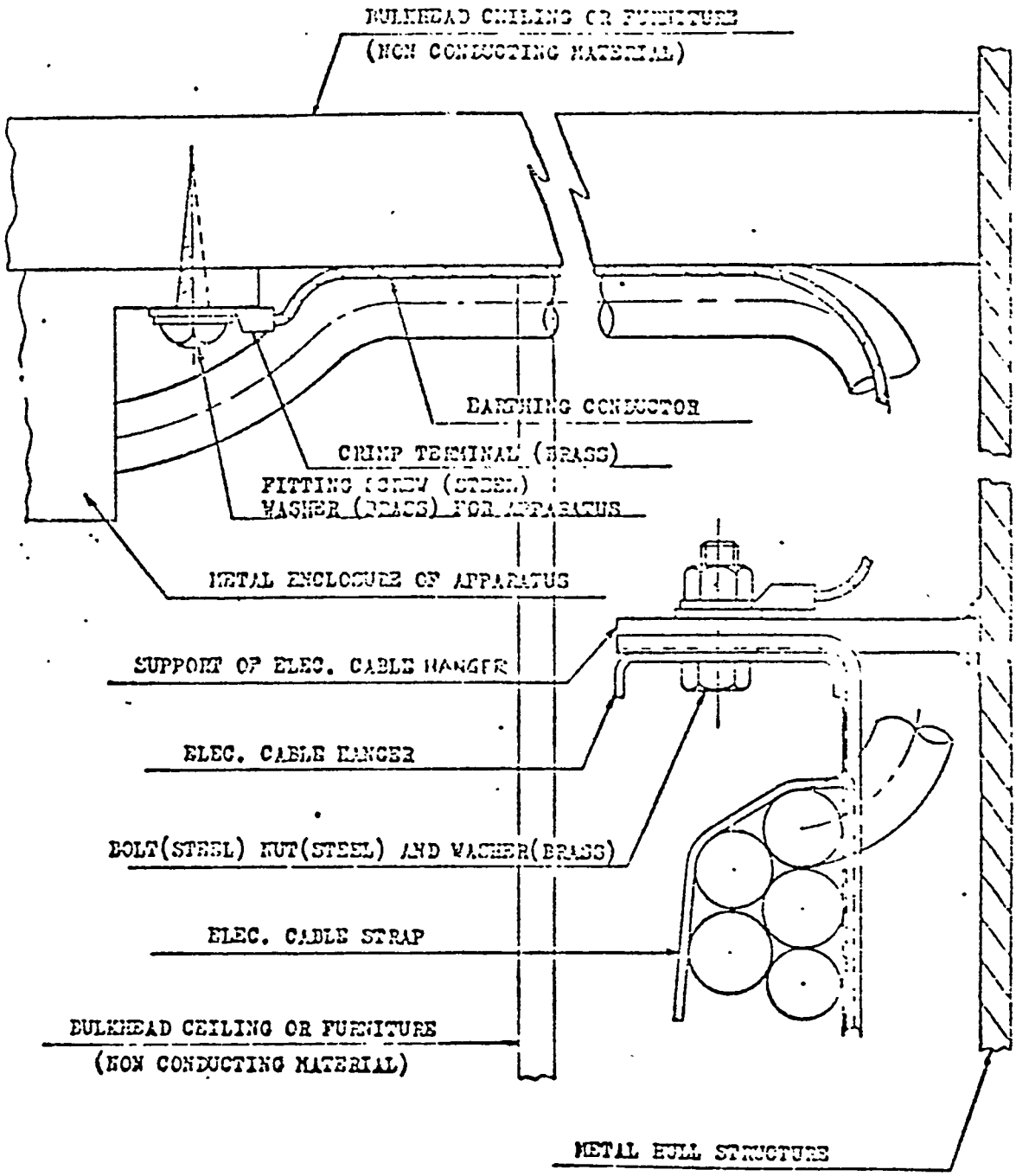
EARTHING OF METAL ENCLOSURES OF APPARATUS-(3)

SYMBOL	WORKING	APPLICATION	REMARKS
(E-3)	EARTHING CONDUCTOR TO BE USED	ELEC. APPARATUS ON NON-CONDUCTING MATERIAL	VERTICAL TYPE



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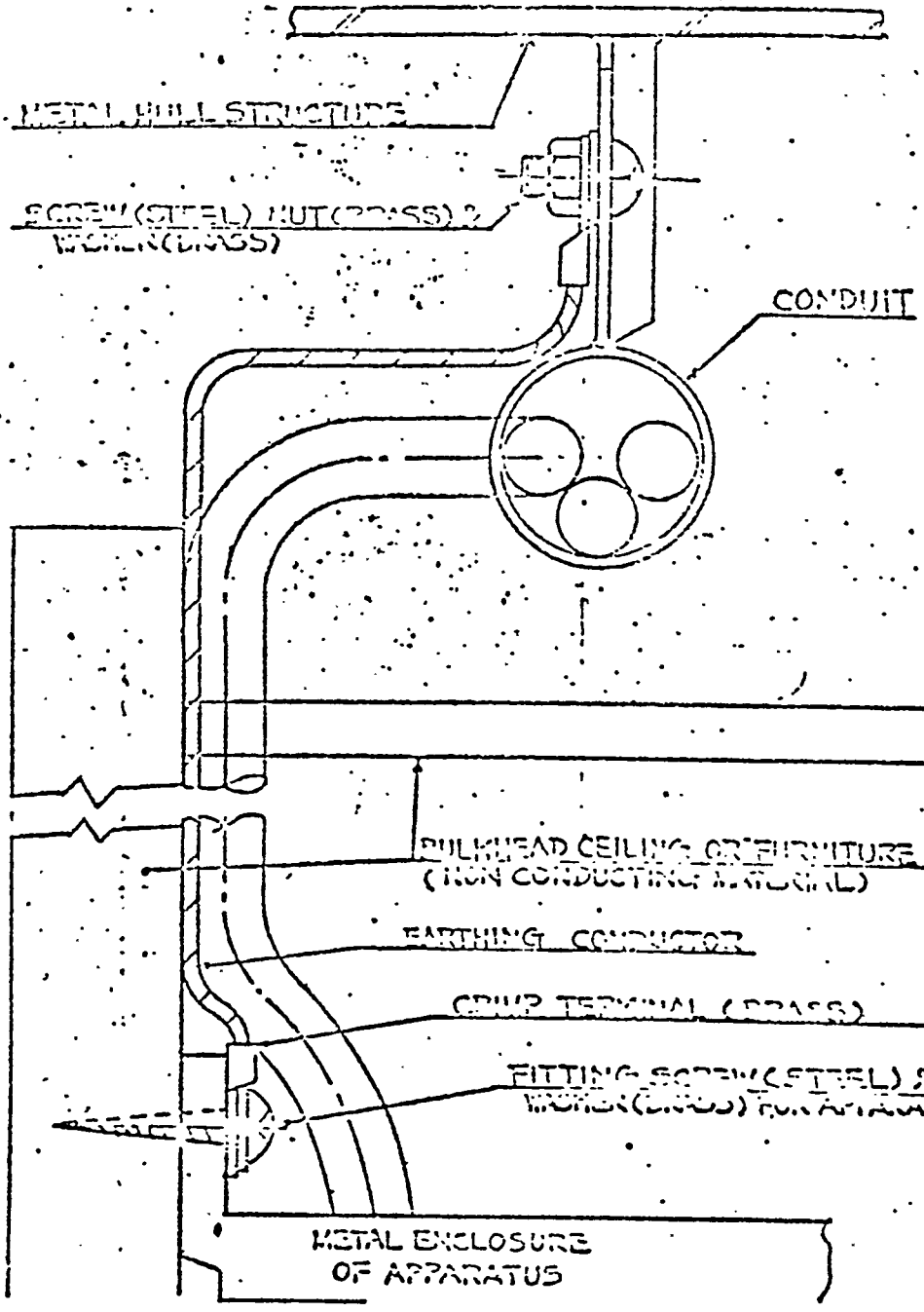
I S	EARTHING METHOD OF NON CURRENT-CARRYING PART	SDT-AB4703BA	5/

EARTHING OF METAL ENCLOSURES OF APPARATUS - (4)

SYMBOL	WORKING	APPLICATION
E4	EARTHING CONDUCTOR TO BE USED.	ELEC. APPARATUS ON NON CONDUCTING MATERIAL



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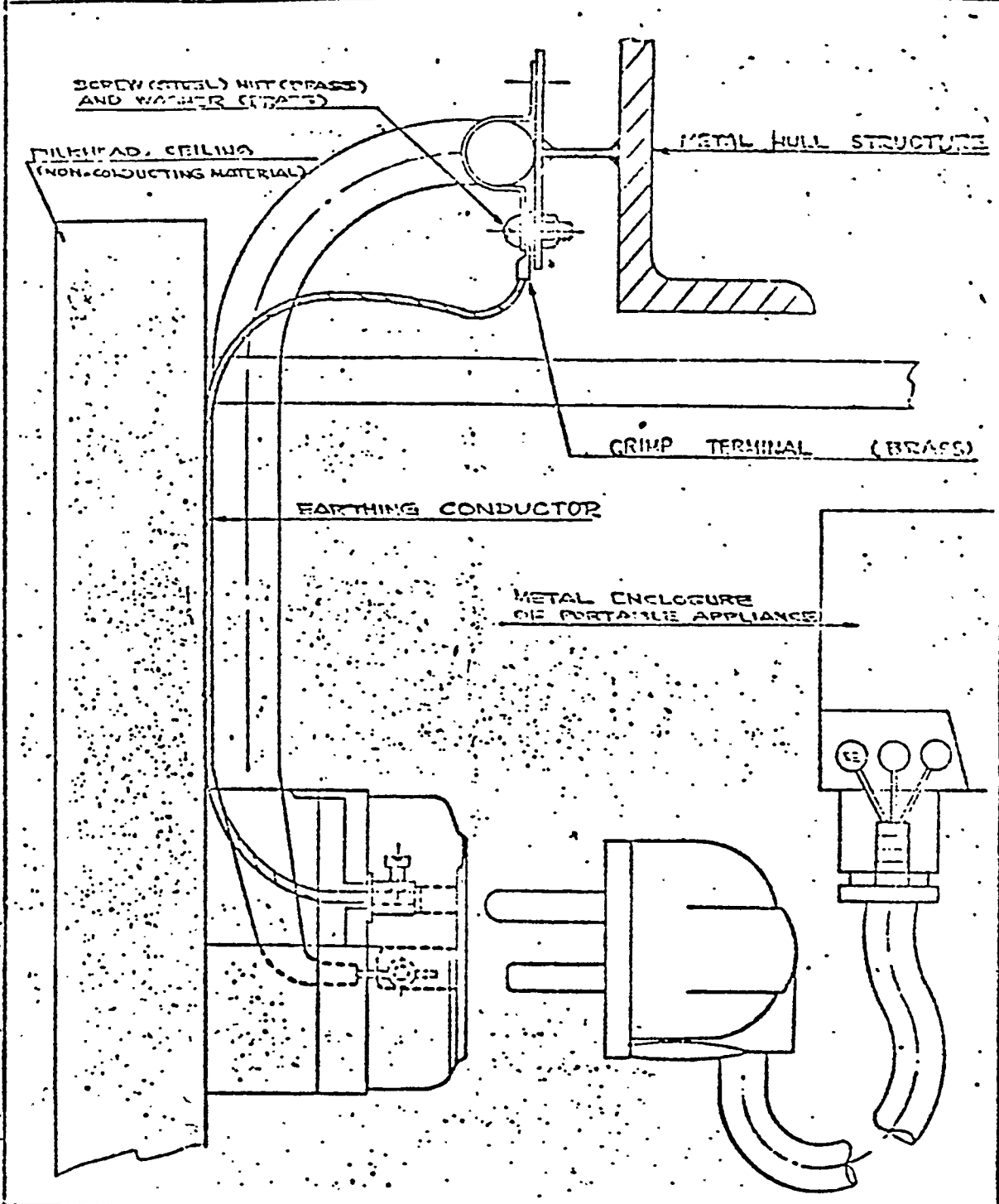
EARTHING OF METAL ENCLOSURES APPARATUS - (5)

SYMBOL	WORKING	APPLICATION	REMARKS
E-5	EARTHING CONDUCTOR TO BE USED	PORTABLE APPLIANCES	

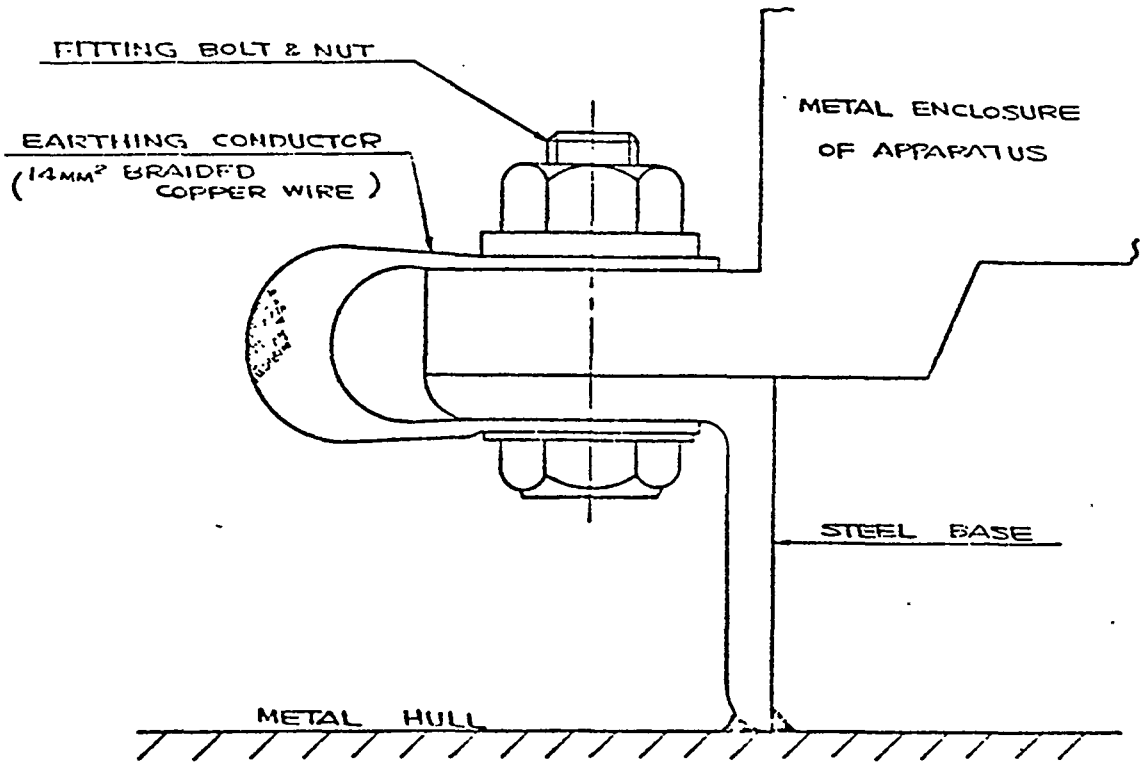


IS	EARTHING METHOD OF NON CURRENT-CARRYING PARTS 帯気品の非充電金属部の接地方法	SOT-AB17CCS	7/14

LR

EARTHING OF METAL ENCLOSURES OF APPARATUS – (4)

SYMBOL	WORKING	APPLICATION	REMARKS
E-5	EARTHING CONDUCTOR TO BE USED	ELEC RANGE OVEN, RICE BOILER, WASHIN MACHINE, DRYER ETC. IN GALLEY AND LAUNDRY RM.	



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IS	EARTHING METHOD OF NON CURRENT-CARRYING PARTS 電気品の非充電金属部の接地方法	SOT-A347005A	8/14

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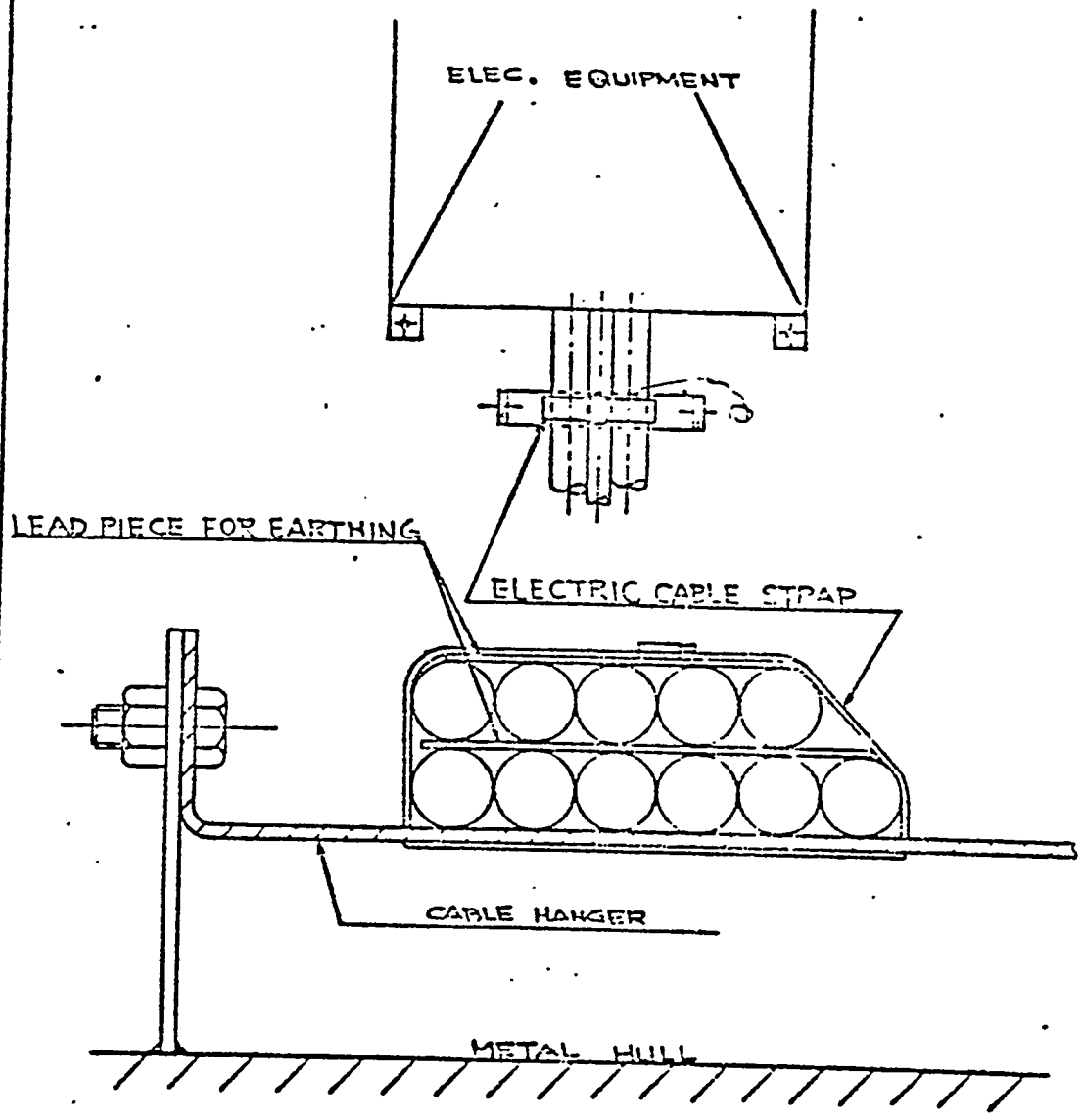
EARTHING OF METAL COVERING OF ELEC. CABLE -(1)

SYMBOL	WORKING	APPLICATION	REMARKS
e-1	METALLIC CONTACT WITH METAL HULL	END OF CABLE ON STEEL STRUCTURE	



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IS	EARTHING METHOD OF NON CURRENT-CARRYING PARTS 電気品の非充電金属部の接地要領	SOT-A347005A	9/14

EARTHING OF METAL COVERING OF ELEC. CABLE - (1)

SYMBOL	WORKING	APPLICATION	REMARKS
(e-2)	EARTHING LEAD PIECE TO BE USED	END OF CABLE ON STEEL STRUCTURE	

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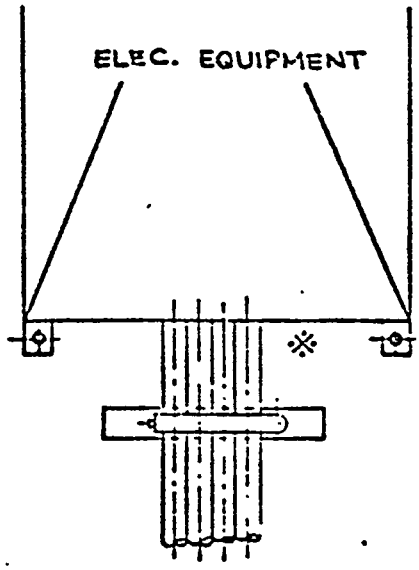
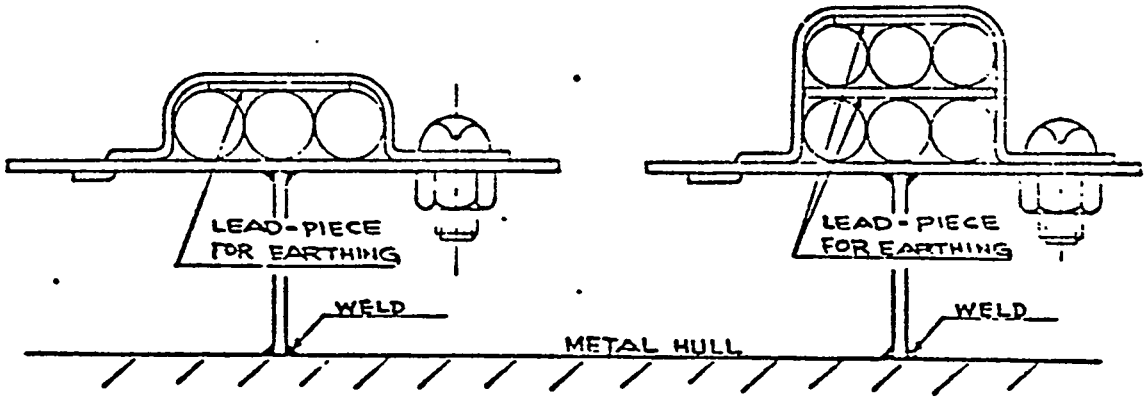


※ WHERE CABLE GLANDS ARE APPLIED TO THE EQUIPMENTS, THE METAL COVERING OF CABLE MAY BE EARTHED BY MEANS OF METALLIC PACKING IN THE GLANDS.

IN CASE OF SINGLE LAYER OF CABLE

IN CASE OF DOUBLE LAYERS OF CABLE



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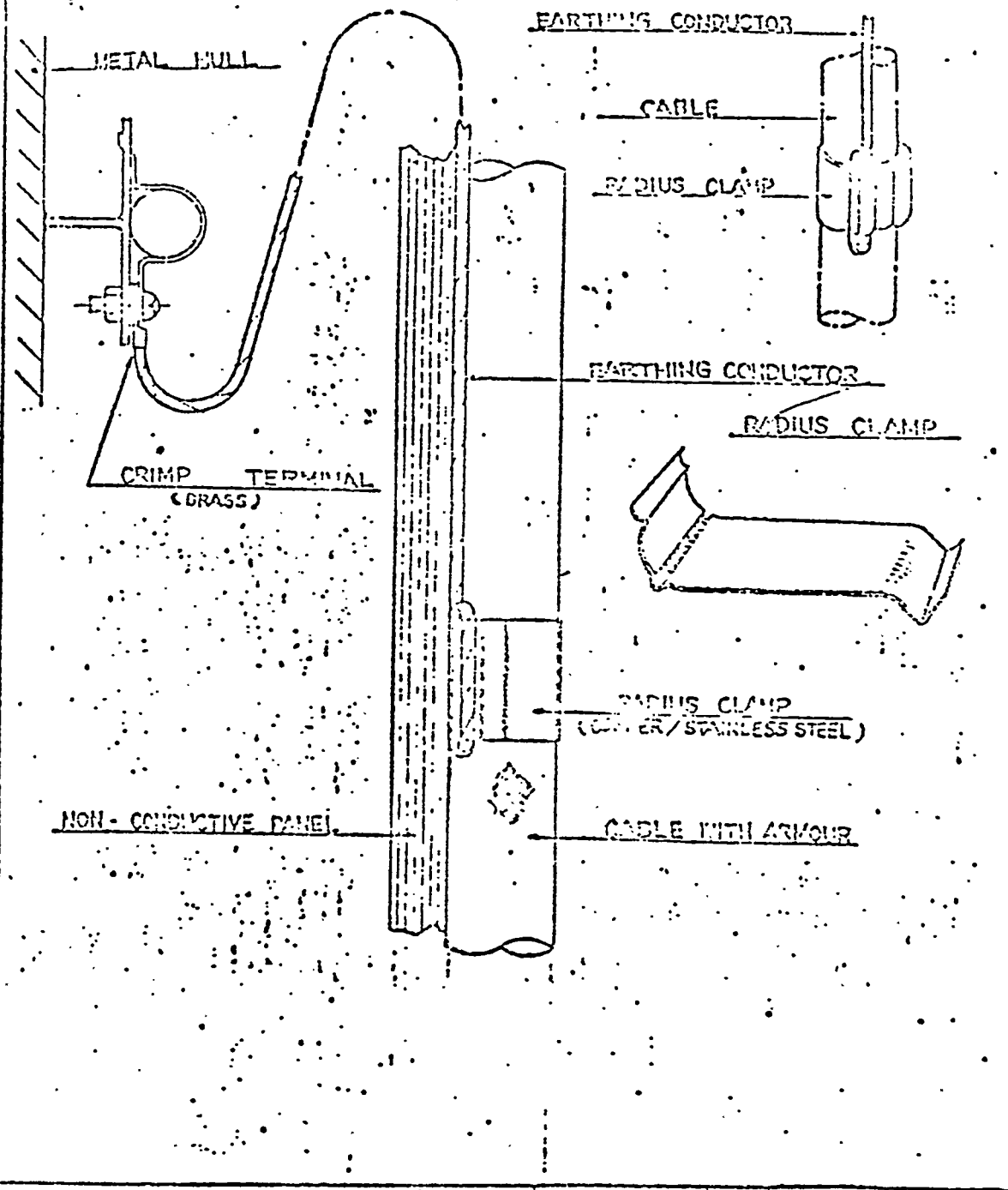
IS	EARTHING METHOD OF NON CURRENT CARRYING PARTS	SOT-A34700CA	10/14

EARTHING OF METAL COVERING OF ELEC. CABLE - (E)

SYMBOL	WORKING	APPLICATION	REMARKS
(E)	RADIUS CLAMP AND EARTHING CONDUCTOR TO BE USED	END OF CABLE ON NON CONDUCTIVE PANEL	



工C	EARTHING METHOD OF NON CURRENT CARRYING PARTS 電気設備非充電金属部の接地方法	SCT-AB470C 5	1/4

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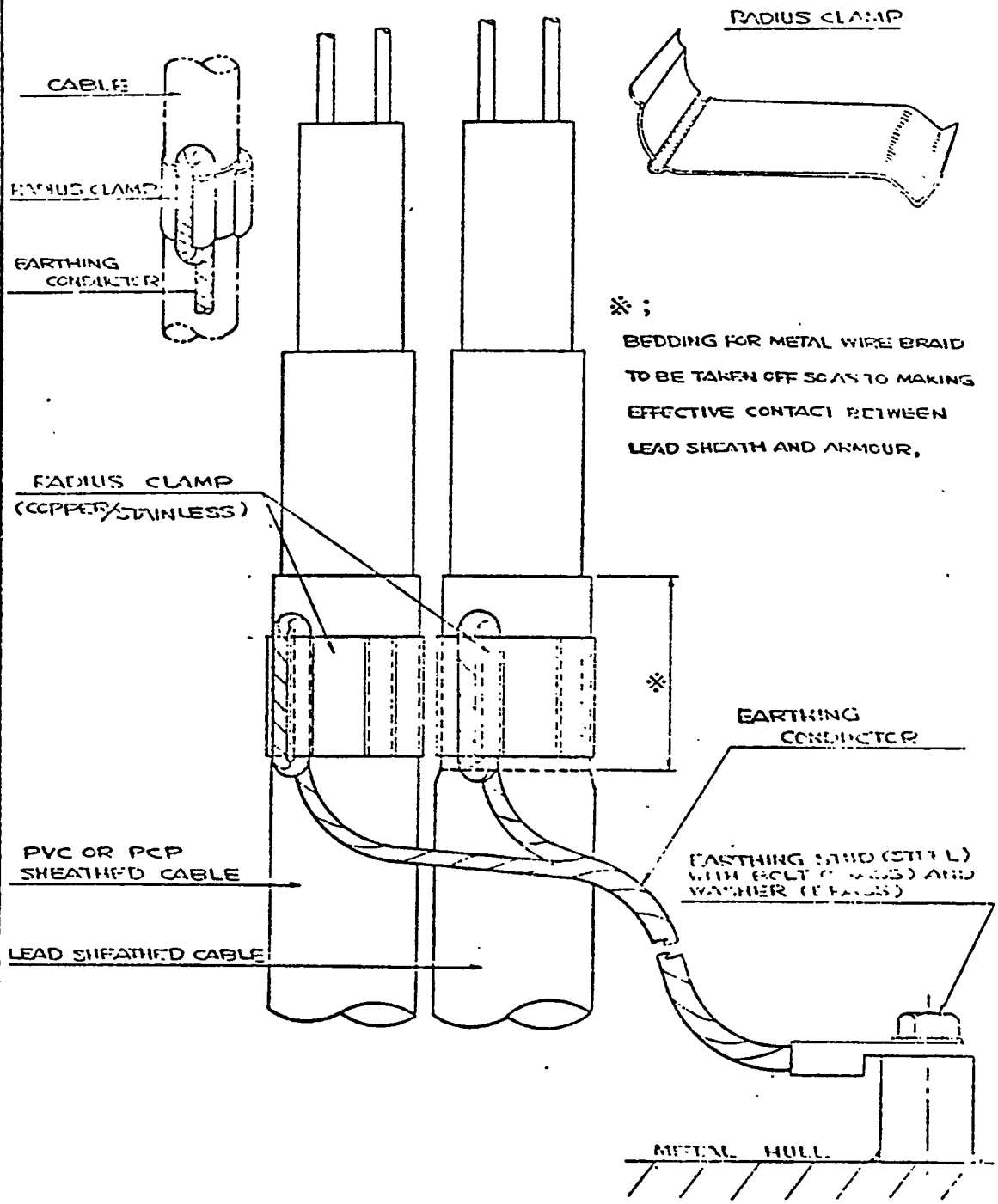
EARTHING OF METAL COVERING OF ELEC CABLE – (2)

SYMBOL	WORKING	APPLICATION	REMARKS
e-2	RADIUS CLAMP AND EARTHING CONDUCTOR TO BE USED	CABLE ENTRY OF SWITCHBOARD EXCITER	



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EARTHING CONDUCTOR FOR METAL ENCLOSURE OF APPARATUS ;

TYPE OF EARTHING CONDUCTOR		CROSS-SECT AREA OF ASSOCIATED CURRENT CARRYING CONDUCTOR	CROSS-SECTIONAL AREA OF COPPER EARTHING CONDUCTOR
ON THE NON CONDUCTIVE PANEL	SEPARATE FIXED EARTHING CONDUCTOR.	UP TO 16 mm^2	SAME AS CURRENT CARRYING CONDUCTOR, SUBJECT TO MINIMUM OF 2 mm^2
		EXCEEDING 16 mm^2	½ THE CROSS SECTIONAL AREA OF THE CURRENT CARRYING CONDUCTOR, SUBJECT TO MINIMUM OF 16 mm^2
ELEC. RANGE, OVEN, RICE BOILER WASHING MACHINE, DRYER ETC. IN GALLEY AND LAUNDRY ROOM		ANY	14 mm^2 BRAIDED WIRE
ANY WHERE	EARTH-CONTINUITY CONDUCTOR IN FLEXIBLE CABLE OR FLEXIBLE CORD.	ANY	SAME AS CURRENT CARRYING CONDUCTOR UP TO 16 mm^2 AND HALF ABOVE 16 mm^2

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EARTHING CONDUCTOR FOR
METAL COVERING OF CABLE ;

CIRCUITS	CROSS SECTIONAL AREA OF COPPER EARTHING CONDUCTOR
440V～100V POWER CIRCUIT	5.5mm² STRANDED WIRE
440V～250V I/C CIRCUIT R/T 〃	2.0mm² 〃
250V～100V I/C CIRCUIT R/T 〃 LTG. 〃	2.0mm² 〃
24V CIRCUIT	NOT TO BE EARTHED

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石川島播磨重工業株式会社

APPENDIX G

LIVINGSTON STANDARD OPERATING PROCEDURE

INITIATION, REVIEW,

AND

ISSUANCE OF LIVINGSTON STANDARDS

Levingston

STANDARD OPERATING PROCEDURE

DATE	PROCEDURE NUMBER
2/25/80	A-11

SUBJECT
Initiation, Review, and Issuance of Levingston Standards

REF. POLICY - PROCEDURES	CLASSIFICATION Inter-Directorate
All Levingston Standards	DIRECTORATES/ DEPTS. AFFECTED All

PURPOSE - This procedure establishes the origin, format, and approval requirements for the issuance of a Levingston Standard.

DEFINITION

Levingston Standard - a mutually agreed upon, formally published description of an item or procedure used within the company for the purpose of defining characteristics (e.g. dimensions, steps, quality, performance, costs, tolerances, etc.) of said item or procedure that must be the same (within specified limits) as other items or procedures conforming to the standard. A standard-may be issued in the form of a drawing, sketch, description, or specification (see Step 6 for formats).

Design Standard - a Livingston standard for a part, component, sub-assembly, assembly, fitting, product, or other item manufactured by Livingston for. use in an end product, manufacturing process or manufacturing procedure.

For example: structural details, panel sizes, an inner bottom unit, ladders, and pallets.

Tolerance Standard - a Livingston standard that describes the allowable range that a characteristic for a material, manufactured" item, or product may deviate from that specified by a design requirement. Material defects, errors in manufacturing, criteria for testing and trials, and design procedures to correct a deviation are described by tolerance standards.

For example: surface flaw, alignment, dimensional accuracy in cutting.

Material Standard - a Livingston standard for a raw material, part, component, fitting, or an item of machinery or equipment purchased by Livingston for use in an end product, manufacturing process or manufacturing procedure.

For example: grade and size of steel plates, watertight doors, portholes, and auxiliary pumps and motors.

APPROVALS S. Kopen for Directorates

Process Standard - a Levingston standard that describes the work content of a job by detailing the sequence of operations and specifications for performing the work. The specifications include the size, shape, and quality of material, the tools, jigs, fixtures, gauges, and the machine or piece of equipment used.

For example: all the steps required to cut a plate on the N/C burning machine from the time that a plate is picked up from the raw material stack until all pieces from that plate have been moved from the machine.

Cost Standard - a Levingston standard that associates with each process standard the cost in terms of manpower requirements (manhours, crew size, duration, craft and skill level). For each step of a process standard a normal completion time is determined. To it are added allowances for fatigue, delay, and personal time.

For example: the number of men required and the duration for each step in the process standard for cutting plates on the N/C burning machine together with all the allowances for delays.

Scheduling Standard - a Levingston standard for use by schedulers to determine elapsed time, manpower requirements, and facility requirements for certain operations or work stations.

For example: the number of men and the duration required to cut a particular plate on the N/C burning machine.

PROCEDURE

1. (All Directorates/Departments) Each Directorate/Department shall develop standards within their areas of responsibility. These standards shall conform to the requirements stated in Procedure 8-20-003. Table 1 lists the major areas of responsibility.

2. (All Directorates/Departments) Review Procedures.
   a. (Draft Originator) Subsequent to the development of an individual standard, the draft originator shall consult with Industrial Engineering to determine an appropriate distribution list of affected Directorates/Departments. If the standard, as decided by the originator and Industrial Engineering, does not affect any department except the originators', then review and approval by the Department Manager and the responsible Director shall fulfill all requirements of procedure steps 2c and 2d.

   b. (All affected Directorates/Departments) Upon receipt of a proposed standard a Directorate/Departmental representative shall be chosen. These representatives will act as the Review Committee with the originator of the proposed standard acting as chairman.

PROCEDURE (Continued)

c. (Review Committee) Each member shall have thirty (30) calendar days from the date of issue to return comments on the proposed standard to the chairman.

d. (Review Committee) The chairman shall review all comments and meet with the Review Committee to answer questions and resolve conflicts. The committee shall take appropriate action to revise and review succeeding drafts, obtain outside agency approvals if desired, and finally produce a final draft conforming to the requirements stated in Procedure A-11.

3. (Review Committee Chairman) Subsequent to the approval of the proposed standard, the chairman shall forward the master of the standard to the Manager, Systems & Procedures, for final distribution and inclusion in the master file of Livingston Standards. In the case where a standard is developed in the form of an engineering drawing (such as for structural details), the Engineering Department shall retain the original and shall insure that Systems & procedures is provided with a copy of the most recent revision.

4. (Systems & Procedures) The Systems & procedures group shall issue and control all Livingston Standards. A system of control shall be established including distribution of notebooks for Livingston Standards and subsequent issue/reissue of new and revised standards. Prior to issuance, each Livingston Standard shall be assigned a number as follows: S-10, S-20, S-30, etc. Related standards shall use the numbers between the increments of 10 (i.e., 11-19) as they are developed.

Department numbers shall be as established in the LSCO Accounting System.

Sequence numbers for Livingston Standards shall be sequentially numbered from 500 through and including 999.

Revision letters shall indicate revision/reissues of each Livingston Standard through the addition of a suffix letter (A. B. C . . .etc.) to the original Livingston Standards number. The original of each standard will not have any suffix letter. The first revision of a standard will carry the suffix "A" to indicate first revision.

5. (All Directorates/Departments) Revisions to any Levingston Standard will follow the same review procedure stated in Procedure A-Ii.

6. (All Directorates/Departments) Formats.

a. Each Livingston Standard shall have a cover sheet in the format shown in Figure 1. Prior to final approval and issuance, cover sheets shall be prominently marked as "preliminary" as shown in Figure 2.

b. Each Livingston Standard shall have an alteration list, when needed, in the format shown In Figure 3.

c. Each Livingston Standard shall have, when needed, a list of references in the format shown in Figure 4.

d. Each Livingston Standard shall have, when needed, a page for general notes in the format shown in Figure 5.

e. For pages of a Livingston standard that consist of typewritten matter, the format shown in Figure 6 shall be used.

f. Formats for other pages will vary according to the subject and content. Directorates/Departments shall develop the formats for those standards for which they have been assigned leadership responsibility (see Table 1). At a minimum, each of those formats shall include an appropriate border, the title or subject of the standard, the number of the standard, and the page number. The standard page size shall be 81/2″ x 11″. All other sizes shall be held to a minimum but in any case shall be folded to meet the 81/2″ x 11″ requirement.

7. (Review Committee Chairman) Reporting requirements. Each committee chairman shall report to the Systems & Procedures group at the end of each month on the status of their respective standards. A suggested method is by stating the status on the cover sheet as shown in Figure 2.

TABLE 1

Levingston Standards Development/Upkeep Responsibilities

Levingston Standard \ Directorate Responsibility	Production Control	Materiel	Ind. Rel.	Engineering	Program Management (QA)	Steelwork	Outfitting	I.E.
Design		S [1]		L [2]		S	S	S
Tolerance		S		L	S	S	S	S
Materiel		L		S		S	S	S
Process	S					S	S	L
Cost	S		S			S	S	L
Scheduling	L							S

1) S = Support Responsibility

2) L = Leadership Responsibility

CLASSIFICATION	STANDARDS NUMBER

SUBJECT

DISTRIBUTION and APPROVAL LIST

DEPT./DIRECTORATE	APPROVAL	DATE

Levingston

CLASSIFICATION

STANDARDS NUMBER

PRELIMINARY

SUBJECT

TOLERANCE STANDARDS

Status 2/18/80: Awaiting USCG/ABS approval (chairman's approval)

DISTRIBUTION and **APPROVAL LIST**

DE PT./ Directorate	APPROVAL	DATE

ALTERATION LIST

NO,	PAGE	DESCRIPTION

LIST OF REFERENCES

NO	DoCUMENT NUMBER	TITLE

STANDARD NO.	SUBJECT	PAGE
.	G-9	

FIGURE 4

GENERAL NOTES

NO	DESCRIPTION

STANDARD NO.	SUBJECT	PAGE
	G-10	

FIGURE 5

REMARKS	ALT.

STANDARD NO.	SUBJECT	PAGE
	G-11	