

**SHIP PRODUCTION COMMITTEE
FACILITIES AND ENVIRONMENTAL EFFECTS
SURFACE PREPARATION AND COATINGS
DESIGN/PRODUCTION INTEGRATION
HUMAN RESOURCE INNOVATION
MARINE INDUSTRY STANDARDS
WELDING
INDUSTRIAL ENGINEERING
EDUCATION AND TRAINING**

**September 1985
NSRP 0226**

THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

**1985 Ship Production Symposium
Volume I
Paper No. 9:
Zone Outfitting in a Canadian Great
Lakes Shipyard - The First Four Years**

**U.S. DEPARTMENT OF THE NAVY
CARDEROCK DIVISION,
NAVAL SURFACE WARFARE CENTER**

Report Documentation Page				Form Approved OMB No. 0704-0188	
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1. REPORT DATE SEP 1985		2. REPORT TYPE N/A		3. DATES COVERED -	
4. TITLE AND SUBTITLE The National Shipbuilding Research Program 1985 Ship Production Symposium Volume 1 Paper No. 9: Zone Outfitting in a Canadian Great Lakes Shipyard - The First Four Years				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Surface Warfare Center CD Code 2230-Design Integration Tools Building 192 Room 128 9500 MacArthur Bldg Bethesda, MD 20817-5700				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT SAR	18. NUMBER OF PAGES 39	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

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ZONE OUTFITTING
IN A CANADIAN GREAT LAKES SHIPYARD
 (The First Four Years)

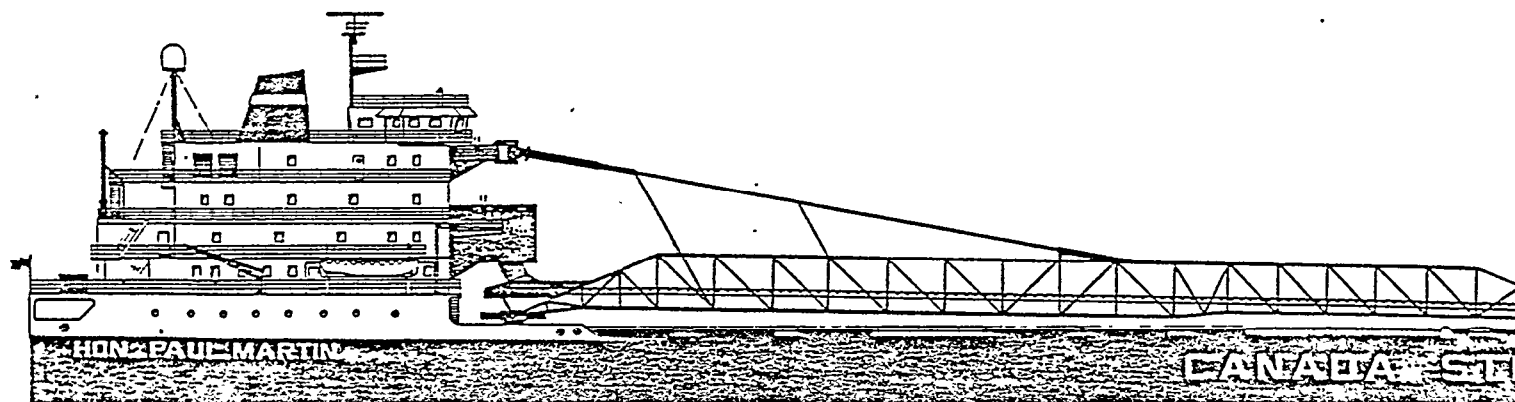
BY
 Alan J. Telfer
 Chief Planner

COLLINGMOOD SHIPYARDS

ONTARIO

FEBRUARY

1985



HULL 225 PRINCIPAL PARTICULARS

Length Overall	224.50 m -- 736'-6½"
Length B.P.	217.97 m -- 715'-1½"
Breadth (Moulded)	23.120 m -- 75'-10½"
Depth (Moulded)	15.250 m -- 50'-0"
Total Deadweight	39,000 t — 38,400 L.T.
Summer Draft	10.380 m — 34'-0-5/8"

Main Engine	1 x Sulzer 6RLB66
Horse Power	11,100 BHP MCR
Speed	14 knots - 16 MPH

Classification by
 Lloyd's Register of Shipping

100A1 Bulk Carrier
 Self-Unloader Part HT
 LMS

Complement

36 Persons

1. SUMMARY

This paper traces the introduction of Zone Outfitting and Outfit Modules in a Canadian Great Lakes shipyard following ideas put forward at a Washington, D.C. seminar in 1981.

Advances made-during construction of five 736' bulk carriers are presented showing the increase in outfit material incorporated in steel units before erection and the rapid increase in size of machinery modules from 3 - 4 tons to some of 40 tons.

The different attitudes to these changes by senior management, production supervisors, drawing office and mechanics are briefly examined.

Some of the problems encountered will be discussed along with the benefits gained by different departments in the yard. The paper will examine problems which have yet to be overcome with a look at new advances planned for future ships.

This is a report on the advantages of Zone Outfitting introduced into a yard possessing only a medium sized Technical Department and a small Planning Department, but with a willingness to accept change. We have not found all the answers, and cannot adopt all of the techniques available to larger yards, but it is hoped that our progress over a period of four years will be interesting to yards in similar situations.

2. BACKGROUND

Collingwood Shipyards has been in business for over 100 years and the yard has established a good reputation for building vessels of all types. In recent years, however, a large number of Great Lakes self-unloaders and bulk carriers have been built.

These vessels are 736' long and designed to pass through the St. Lawrence Seaway, some of these ships are full ocean going class. The shipyard normally employs about 1000 workers; the steel shops can process 15,000 tonnes of steel a year; there is one main building berth with a crane capacity of 120 tons. These resources enable the yard to construct two full Seaway size ships a year. Hulls are launched sideways into a narrow outfitting basin - this provides a popular spectacle for visitors to the town, which is positioned on Georgian Bay, an extension of Lake Huron. The area receives an annual snowfall of 100" and is the skiing center of Ontario.

In winter the temperature drops occasionally to minus 30°C. and ships cannot be launched or delivered during the first three months of the year due to ice conditions in the harbour and the closure of the St. Lawrence Seaway. Ships are normally built with the engine room at the exposed north end, of the building berth. There are, therefore, good reasons for moving as much work as possible indoors.

3. INTRODUCTION OF ZONE OUTFITTING

We have to go this way" - GENERAL MANAGER

In 1981, two members of the Planning Department and a Chief draftsman attended a seminar on Japanese Shipbuilding Technology, in Washington, D.C., given by Lou Chirillo. The seminar was repeated in Collingwood for Technical Departments and Production Supervisors. From these two seminars, a positive approach was made to include more outfit work in steel units before erection on the berth.

As the superstructure units of the ship then on the berth passed through the Assembly Shop, some pipework, ventilation trunk, heater boxes, windows and sidelights were installed before erection.

Problems were encountered almost immediately due to the location of erection butts clashing with the positions of outfit material on the deckhead. This information was passed to the Drawing Office to ensure that outfit drawings for the following ship located: material 'clear of erection butts. Make-up pieces were located where systems ran across butts. The outfitting foremen lost no opportunities in advertising problems they encountered on the first ship.

From this simple beginning Collingwood has advanced fairly 'quickly into zone outfitting. The outfit trades now expect as much work as possible to be carried out away from the berth and have begun to carry out additional work on their own initiative - surely a healthy sign.

4. DEVELOPMENT OF ENGINE ROOM PUMP MODULES

"We won't get this one out of the shop" - PIPEFITTERS FOREMAN

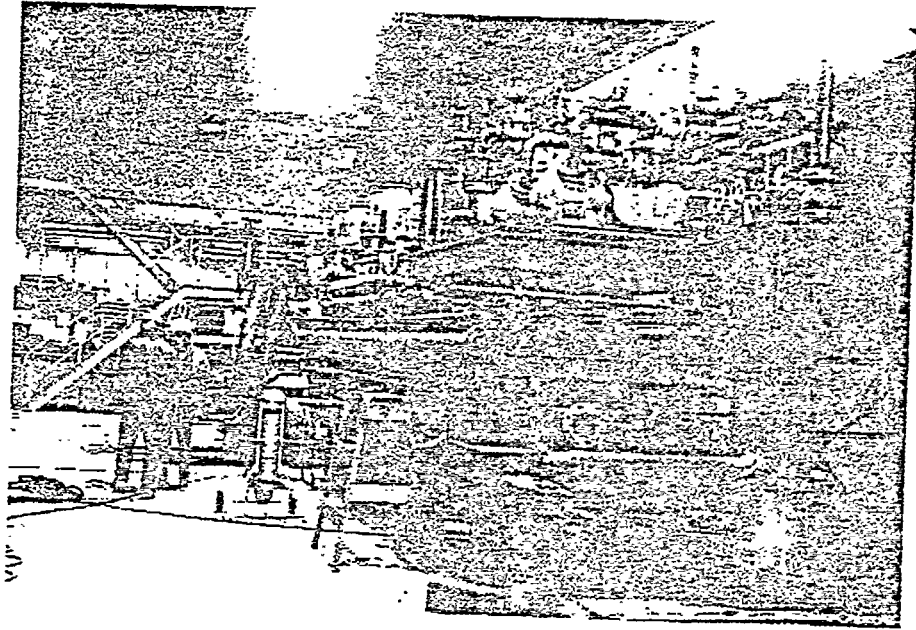
At the time of the seminars, a self-unloading bulk carrier was under construction. In this ship each auxiliary in the engine room was mounted on its own individual seat. Seats were lifted on board one at a time, installed, and the auxiliaries followed individually - pipe pieces were fitted after the auxiliaries were on their seats. This was the normal procedure.

On the following ship, some pumps were grouped closer together on larger shared seats and connecting pipework installed in the Pipeshop before erection at the berth. The seats were still made from plate and this resulted in problems when running pipes under the enlarged seats.

Seats were redesigned for the next ship (1982) using steel channel instead of plate. These were larger simpler seats with flat areas at the engine room floor level, permitting installation of floor plates at a much earlier stage of construction.

The first modules built were within the 5T lifting capacity of the Pipeshop cranes. The second ship's modules were too heavy for shop cranes and were handled by mobile cranes. By the beginning of 1984 some modules were too large to pass through the Pipeshop doors. Two new ballast modules were, therefore, built outside the shop under a small crane, installed for this purpose.

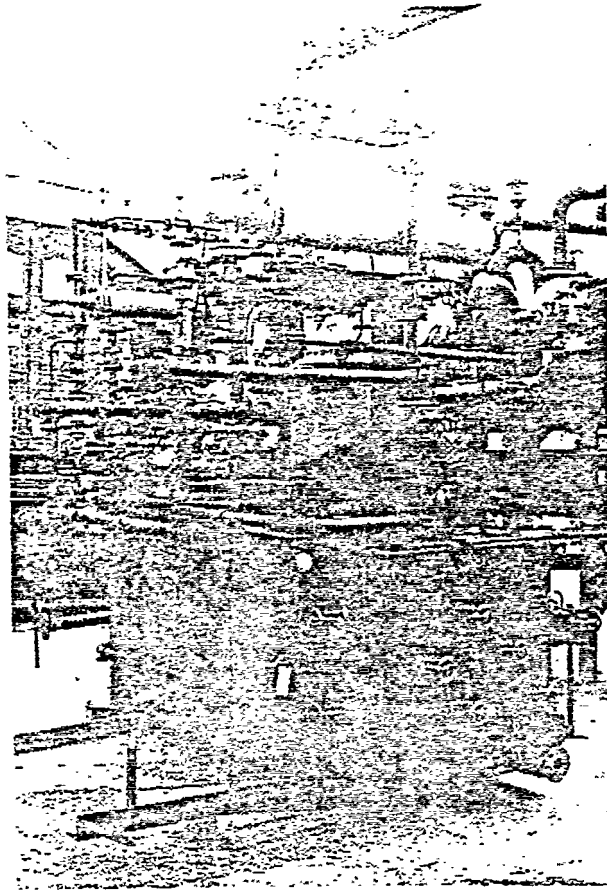
We also began to build modules for smaller diameter pipe systems, some of these were built on top of independent tanks. There had been a natural inclination at first to concentrate on larger diameter pipe systems.



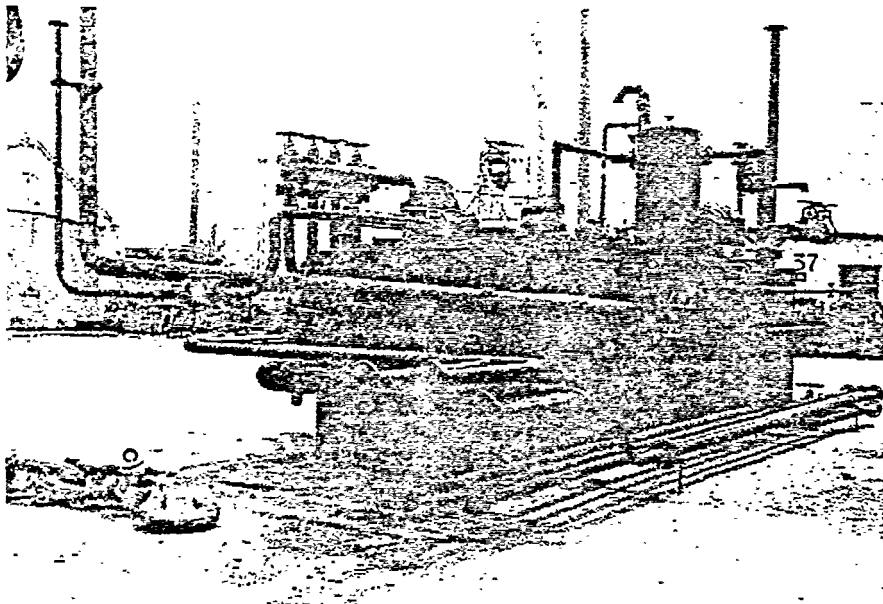
Two Modules in Pipeshop



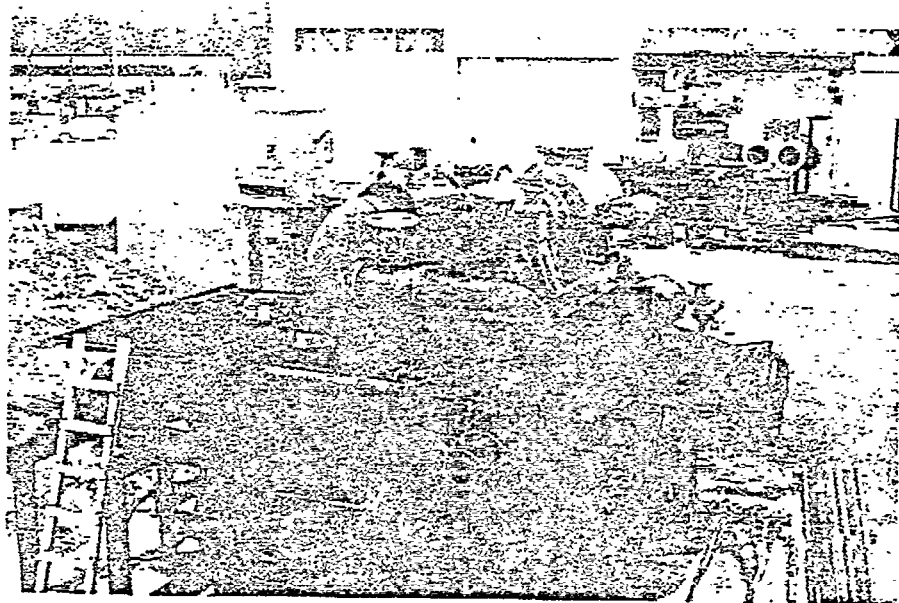
Two Modules in Pipeshop



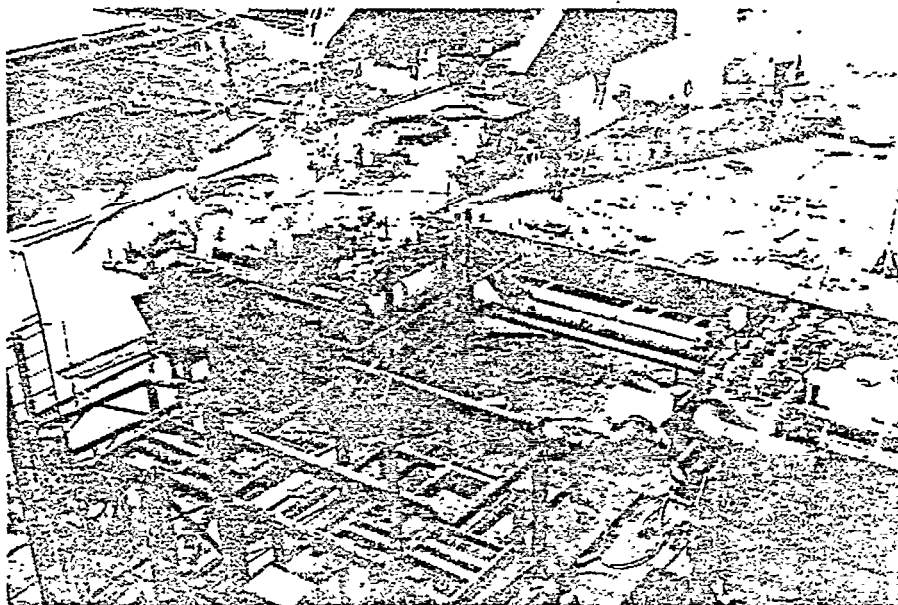
Tank used as Module Seat



Tank used as Module Seat



Ballast Nodule Construction



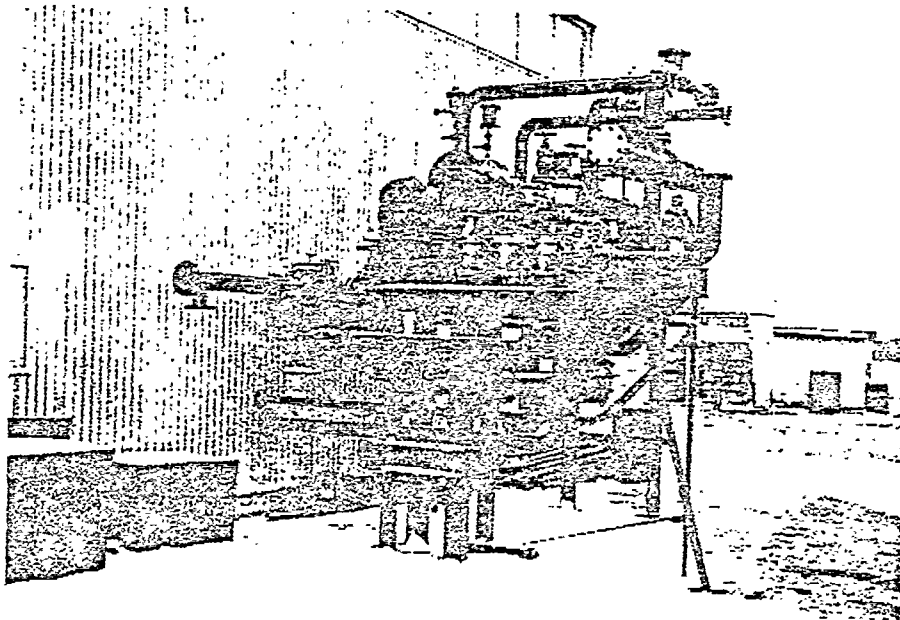
Ballast Modules on Berth

The Drawing Office had now (1984) moved to composite drawings for the Engine Room. This change led to a natural enlargement in size of modules, since a pipe from another system passing in the vicinity of a module could be relocated at the design stage and included in the module. The new "framework" seats were ideal for supporting pipework.

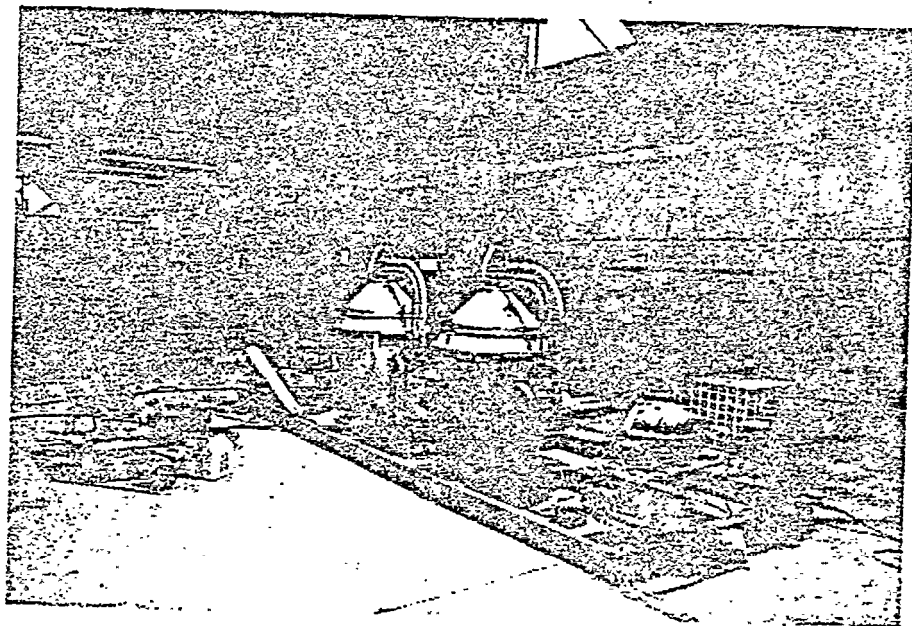
The fuel oil purifiers with their associated pumps and heaters are located in a separate compartment in Coldingwood-built ships. The compartment contains a mass of pipework which was normally installed after the major pipe systems in the lower engine room. The location of the Purifier Room in the ship prevented it from being built as a separate steel unit and outfitted at the Pipeshop. A compromise solution has been achieved by installing all auxiliaries on two low seats which have a light vertical framework fitted to the rear edge. The framework is used to support items previously mounted on the Purifier Room bulkhead.

The production of modules imposes more work on the Drawing Office since Production demands drawings for seats and modules at an early stage of construction. Some of the smaller diameter pipe systems, such as steam and purifier piping, are required several months earlier than before.

The Purchasing Department is also placed under pressure to get material into the yard earlier.



Bilge Pump Module



Purifier Module

5. ENGINE ROOM CASING MODULE

"We don't need the riggers this time" - SHEET METAL FOREMAN

Outfitting the Engine Room Casing in the short period between erection of the superstructure and launch, had always been difficult. It required 90 separate lifts by the berth cranes to install material in the casing over the eight-week period leading to launch. Staging had to be re-adjusted continually and there was always a risk of men slipping or dropping tools into the Engine Room below.

In 1984 the first Casing Module was built. This was a free-standing framework which was outfitted with ladders, handrails, walkways, ventilation trunks, exhausts, tanks, vents, main engine economizer etc. The whole structure weighed 37 tons. The construction of this module benefitted more trades in the yard than any other. The module was outfitted on the ground at the end of the berth and was very "visible" to men walking to the berth.

Installation was carried out in one crane lift, which lasted 2 hours.

Note: The casing module for the next ship has been extended by a deck and contains more equipment. For example, the lights have been run on a single "vertical" circuit to enable them to be fitted and wired.

5. ENGINE ROOM CASING MODULE

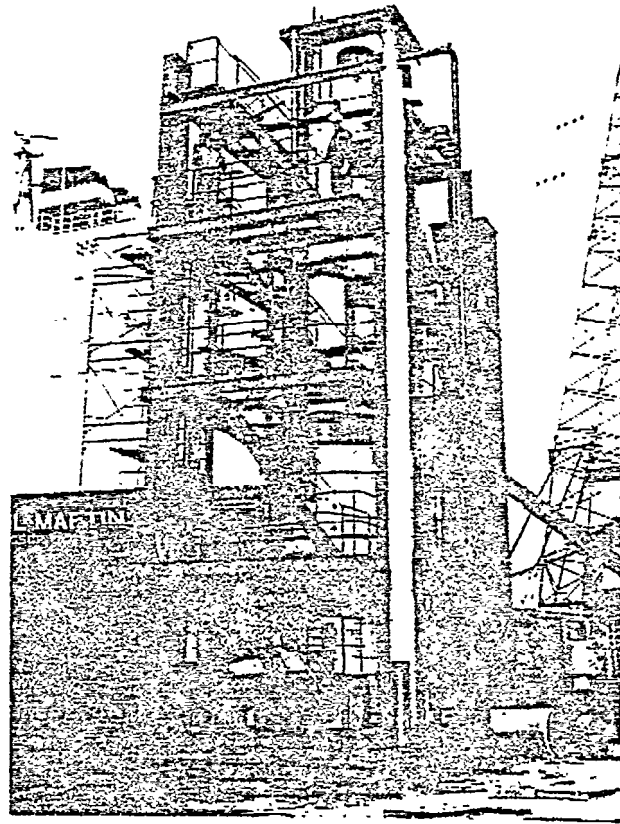
"We don't need the riggers this time" - SHEET METAL FOREMAN

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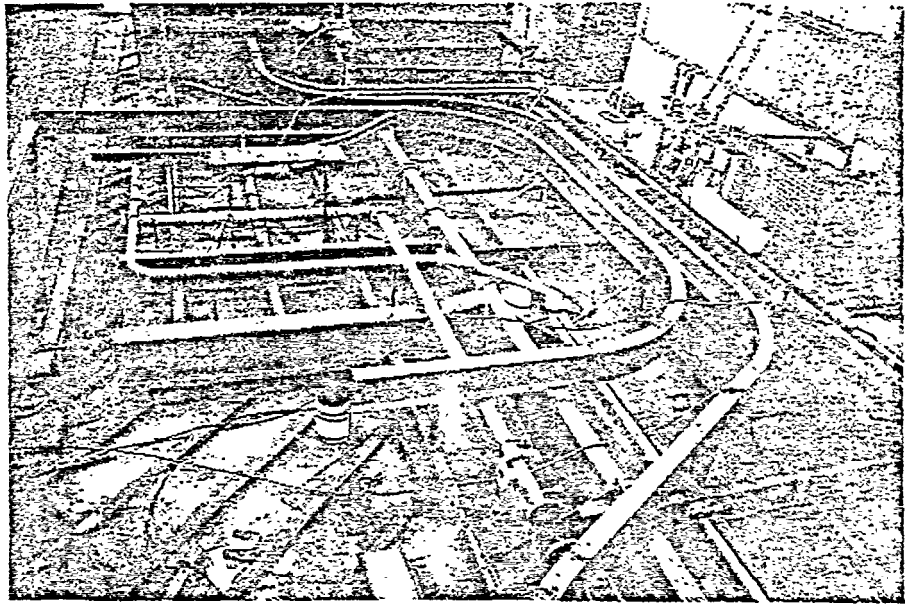
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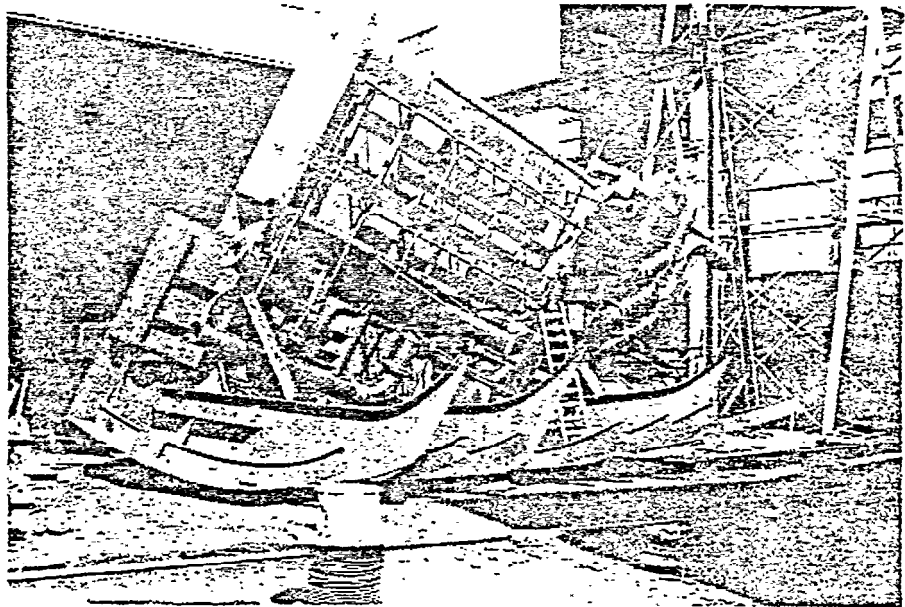


Engine Room Casing Module





Engine Room Deckhead in Assembly



Engine Room Deckhead Out of Assembly

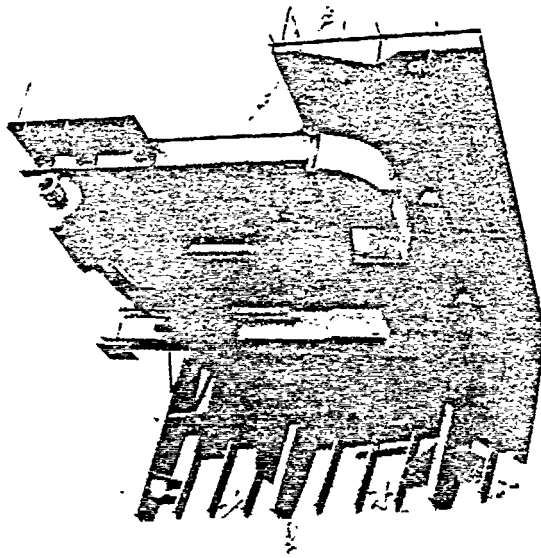
6. ENGINE ROOM STEEL UNITS - ZONE OUTFITTING

"There are too many Outfit Trades in my shop" - STEEL ASSEMBLY
SHOP FOREMAN

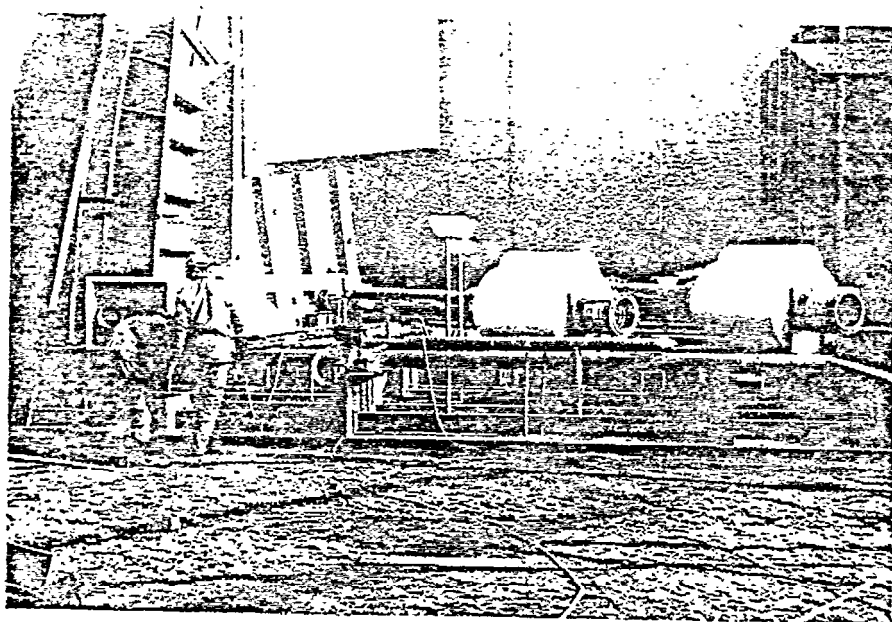
Before 1981 the only outfit -items fitted to engine room units were coolers suspended under the Machinery Deck. Zone outfitting has now progressed to the point where permanent lighting, electrical trays, lighting cables, monorails, ventilation trunk, generator silencers, exhaust piping and major pipe runs are fitted "down hand" in the Steel Assembly Shop. Seats on the deck are normally fitted when the unit is turned upright before erection. We try to apply two coats of paint before erection, but unit painting is often difficult to guarantee due to weather conditions.

When the outfitting trades were introduced to down hand work in the Assembly Shops, a separate time slot for this work was not introduced to the schedule. This was deliberate in order to discover if service trades could support outfit work in addition to steel work already in hand. There has been no noticeable delay to steel and with very few exceptions, the outfit trades complete their work before the unit is ready to move from the Assembly Shop. This method avoided setting up a separate work center for the outfit trades with supporting service trades. A covered site was not available and carrying out the work under cover in the assembly shop was regarded as being of prime importance.

On a ship launched in 1984, the permanent fluorescent lights in the lower engine room were in use six months earlier than previously, and main cable installation commenced ten weeks before launch.



Engine Room Deckhead Erection



Engine Room Out of Assembly

7. SUPERSTRUCTURE UNITS - ZONE OUTFITTING

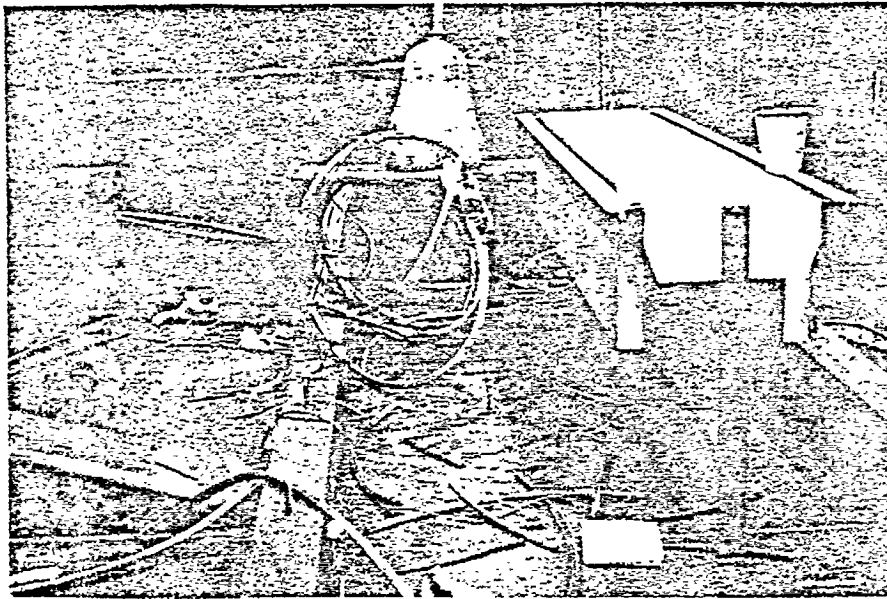
"If we weren't doing this we would be unemployed" - PLUMBER
WORKING IN ASSEMBLY SHOP.

Before 1981 the yard had fully outfitted the superstructure of a small tug before erection, but the concept of fitting material down hand had not been tried by the outfit trades and they were reluctant at first to venture into the Assembly Shop. The advantages were soon realized, however, particularly by the men carrying out the work. The trades involved, Plumbers, Joiners, Sheet Metal and Electricians, were unfamiliar with "upside-down" work but solved the problem of locations by securing a second set of drawings printed in reverse.

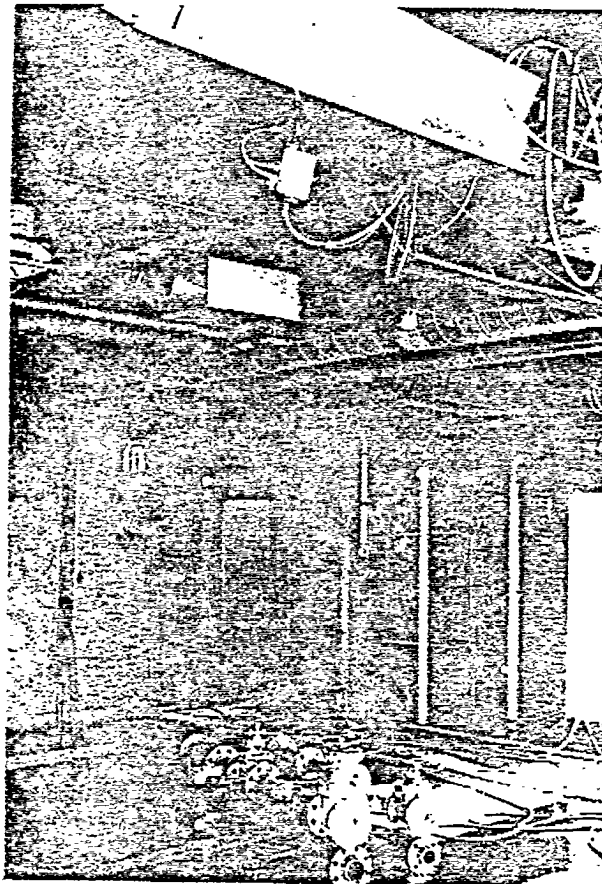
Superstructure units at Collingwood are normally erected as single tier units and are now outfitted with cable trays, lighting cables, permanent lights, waste and drain pipes, hot and cold pipes, W.T. doors, seats and auxiliary machinery, ventilation trunking, ladders and stairways. Two coats of paint are applied before erection and seats are fitted to the top of units after they have been turned upright.

Windows and sidelights have been installed but due to a new design of interior bulkhead panels, these now have to be fitted at the berth.

Composite drawings are used for installation of pipes, vent trunks, lighting etc., under the superstructure decks.



Accommodation Deckhead in Assembly



Accommodation Unit Erection

8. MID-BODY ZONE OUTFITTING

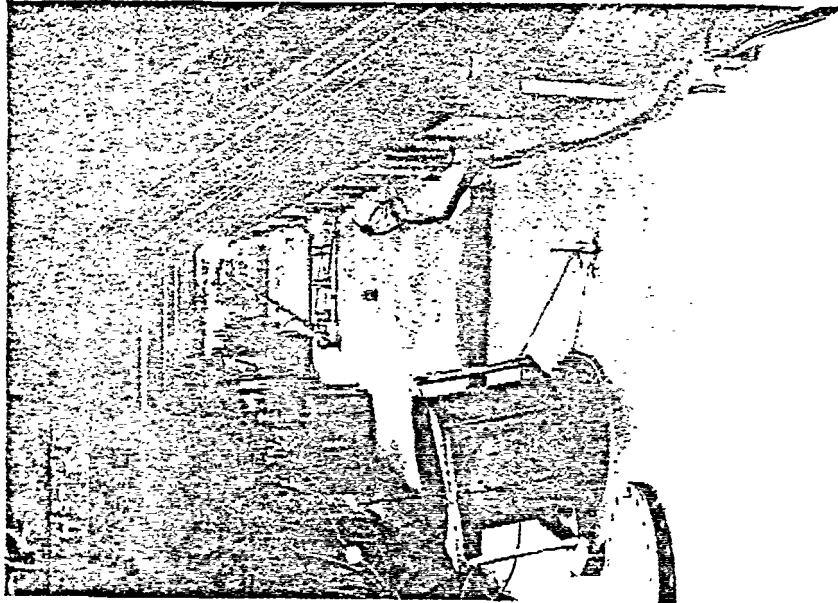
"We won't need staging" - PLUMBER FITTING VENT PIPES

There is little outfit work on the mid-body of a bulk carrier.

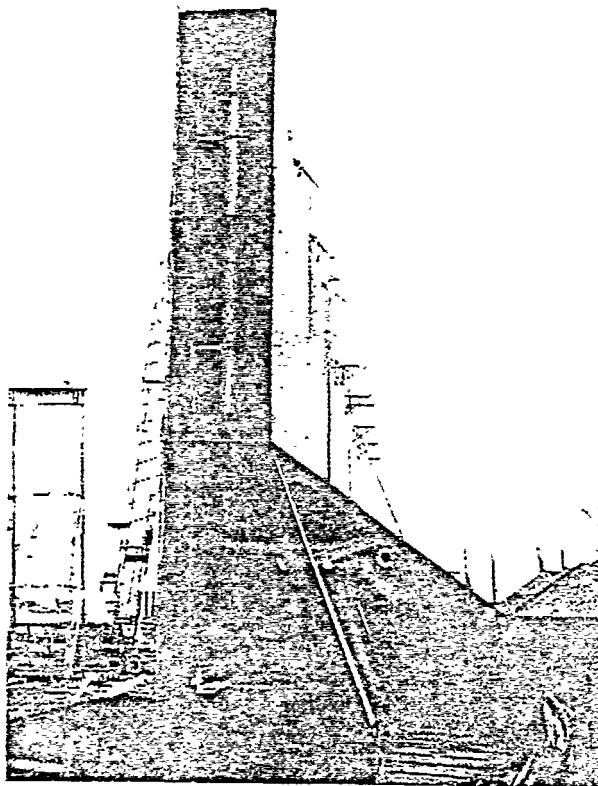
Tank vents and sounding pipes, ballast pipes, ladders and walkways are fitted in Assembly.

Additionally on a self-unloader, the permanent lighting under the hoppers, fire main pipes, HP air pipes, and center line tank pipes are fitted.

Since we started fitting permanent--light fixtures and their cables in Assembly, the number of lamps broken due to vandalism has dropped remarkably. The manhours spent on maintenance of temporary lights is now 50% less than before.



Ship's lighting in use on Berth



Mid-Body Pipes Fitted in Assembly

9. ATTITUDES

"The innovator has for enemies all those who have done well under the old conditions" - MACHIAVELLI.

The attitudes displayed by different departments in the yard to the changes being introduced were interesting. The men carrying out the work were instant converts, the foremen perhaps the slowest to accept the new methods. The former, possibly because of the obvious physical advantages of carrying out heavy work down-hand, indoors. The latter, because of a natural reluctance to accept changes in their established practice.

QUOTATIONS - ANON

"The wheelhouse will collapse if we burn the window openings before erection" (1981)

"The wheelhouse windows will crack if we fit them before erection" (1981)

"You can't fit the mast to the wheelhouse before erection" (1983)

"My cable trays will be damaged if they are fitted in Assembly" (1981)

"My cables will be damaged if they are fitted in Assembly" (1982)

"My lights will be damaged if they are fitted in Assembly" (1983)

The Drawing Office responded positively to almost all suggestions for changes and have now taken on the role of instigators at the design stage. During this period, CAD/CAM systems were also being introduced to the Drawing Office, and they were under a heavy work load.

In Collingwood, the responsibility to push the new methods fell on the Planning Department at first, since the ships under construction in 1981-82 were complete as far as drawings were concerned.

The Drawing Office influence took effect on later ships, when the methods had been seen to work and basic layout drawings for later ships started with the new concepts in mind. It is more important to sell the ideas being tried on the first ship attempted, to the draftsman, than to the mechanic doing the work. It is essential that Production management support the change. Superintendents have a wider field of view than trade foremen and can see the overall advantages, whereas a foreman quite naturally looks at life from his own trade position. The outfit foremen were all concerned that "their" material would be damaged by other trades if it was fitted in Assembly, and in some cases they were right. A few pipes, trays, and lights were damaged. Senior managers have to be behind the drive-to change to zone outfitting. Their influence must be available since demands from Production for earlier drawings, pipe sketches and material have to be met. Pump modules must be completed at the latest before the deck above is erected. This cannot be achieved with the conventional delivery dates for pumps and valves.

10. BENEFITS RESULTING FROM ZONE OUTFITTING

"How much are you saving me?" - GENERAL MANAGER

There are obvious advantages in carrying out work in the shops which had previously been undertaken at the building berth, e.g better access to stores, closer supervision, superior working conditions, less walking time. Some of these items are difficult to quantify.

(a) Walking Time

Walking time, however, can be calculated between two work centers quite easily. In Collingwood, the walking time for a man between the building berth and the Pipeshop is 4 minutes, or almost 4 hours per week, i.e. every Pipefitter working on the berth is in effect paid to "walk about" the yard for half a day each week. Looking at it another way, the man spends five weeks a year on a "Sponsored walk" by the company. This alone is good reason to move as much work as possible to the Pipeshop.

(b) Condition at Launch

Extending the overlap of outfitting work into the steel schedule will reduce the duration of the contract. Ships in Collingwood are now more complete when launched than in the past. This is not due to delaying the launch date. With only one available building berth, ships are normally launched as soon as possible to free the berth for the next contract. Fig.10(b) shows the state of completion of a number of hulls at launch over the period when zone outfitting was introduced. Note that ships are launched at a constant state of completion for steelwork, note also the increased level of outfit work, (Hulls 226 and 224 had different engines from the other ships and are not included in the "Machinery" figure).

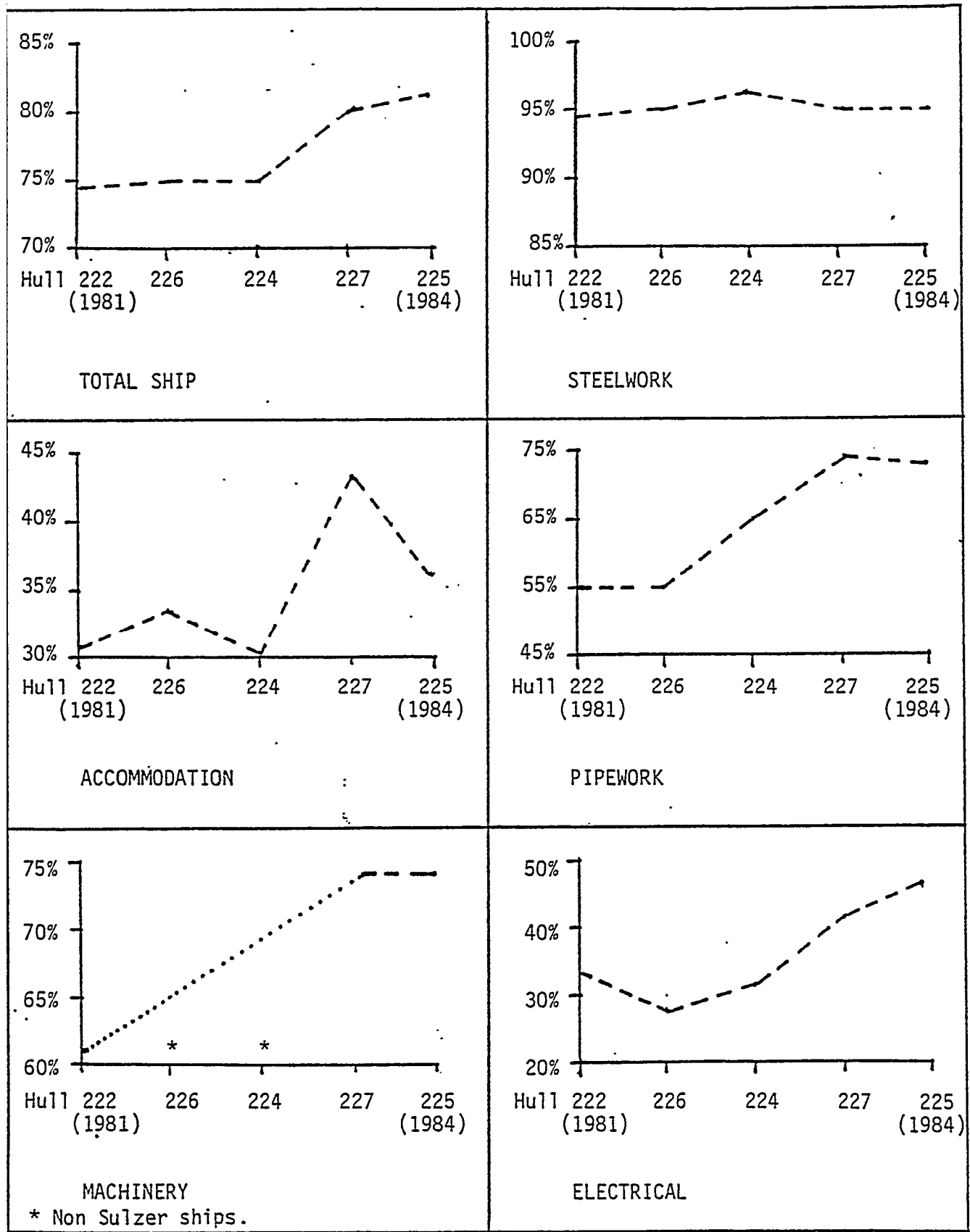


FIG 10(b)

State of completion at launch-during the introduction of zone outfitting on five ships.

(C) Engine Room Modules

There have been a number of labour cost reductions which can in part be attributed to the move towards modules. Fig.10(c) shows some of the changes. Note the rise in cost of auxiliary seats on Hull 225 compared to Hull 227, due to construction of two large additional seats for the ballast system, the cost, however, was still less than on Hull 222. The true benefits of moving to modules is difficult to calculate as-there are spin-off effects. For example, the berth cranes are now available for other systems in the ship, engine room floor plates can be fitted earlier, less staging is required, fewer men are in the engine room,

(d) Engine Room Zone Outfitting

Fig.10(d) shows some of the labour savings achieved in the Engine Room. There were again, however, a number of benefits which are difficult to measure. It took a great deal of persuasion to convince the electricians that it was possible to install and wire permanent fluorescent light fittings before erection, a few lamp fittings were, in fact, damaged as panels were erected, but the cost was small compared to the improvement in working conditions. The cost of temporary lighting was also reduced. There is no practical reason for permanent lighting on a steel unit not to be operational a few days after erection at the berth.

One advance led to another. Since almost all cable tray was fitted before erection, cable runs were installed earlier. Space heaters and fan trunking were also fitted in the Assembly Shop, the engine room can, therefore, be illuminated, heated or ventilated at a much earlier stage.

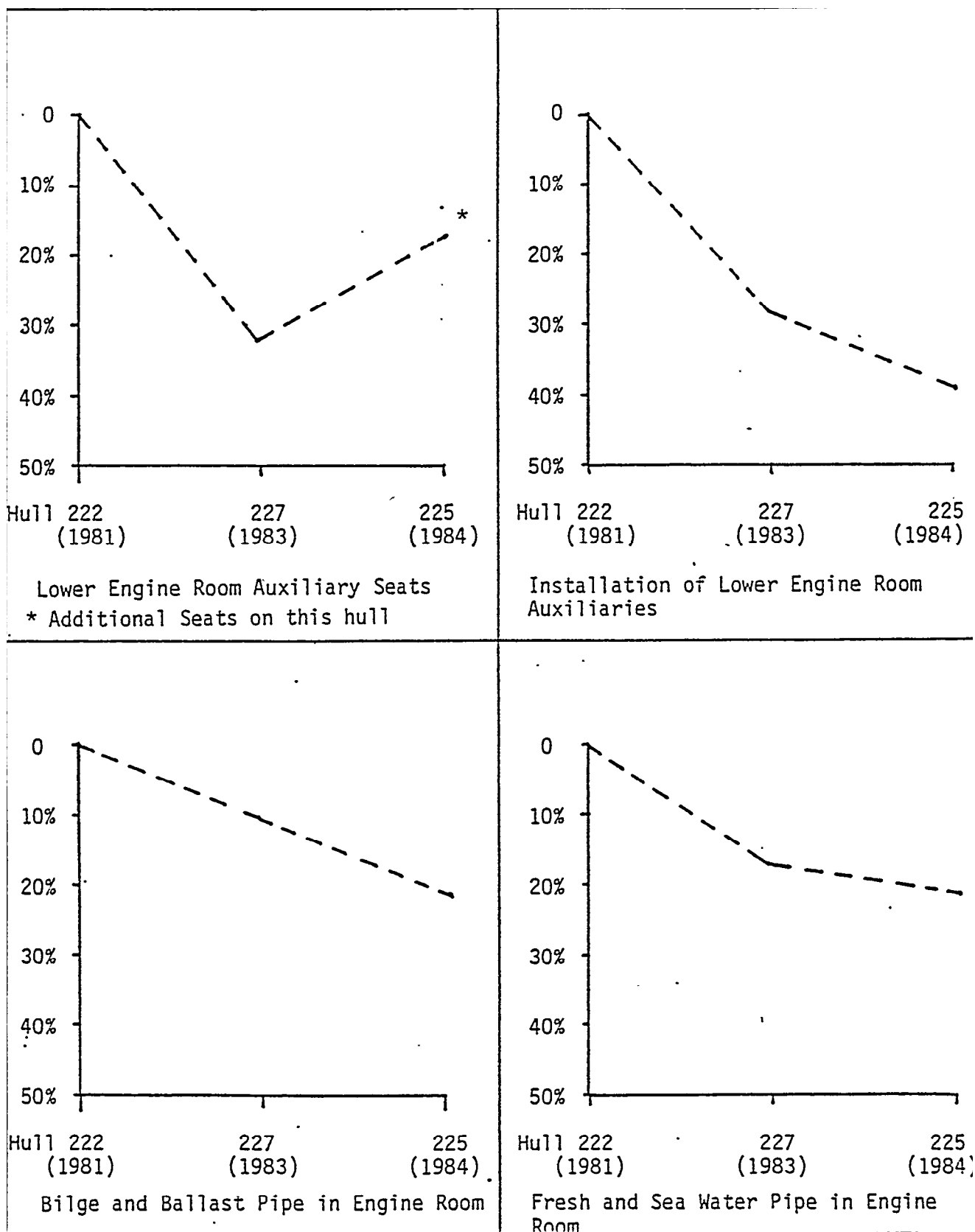


FIG. 10(c)

Reduction in Lower Engine Room Manhours following introduction of Pump Modules

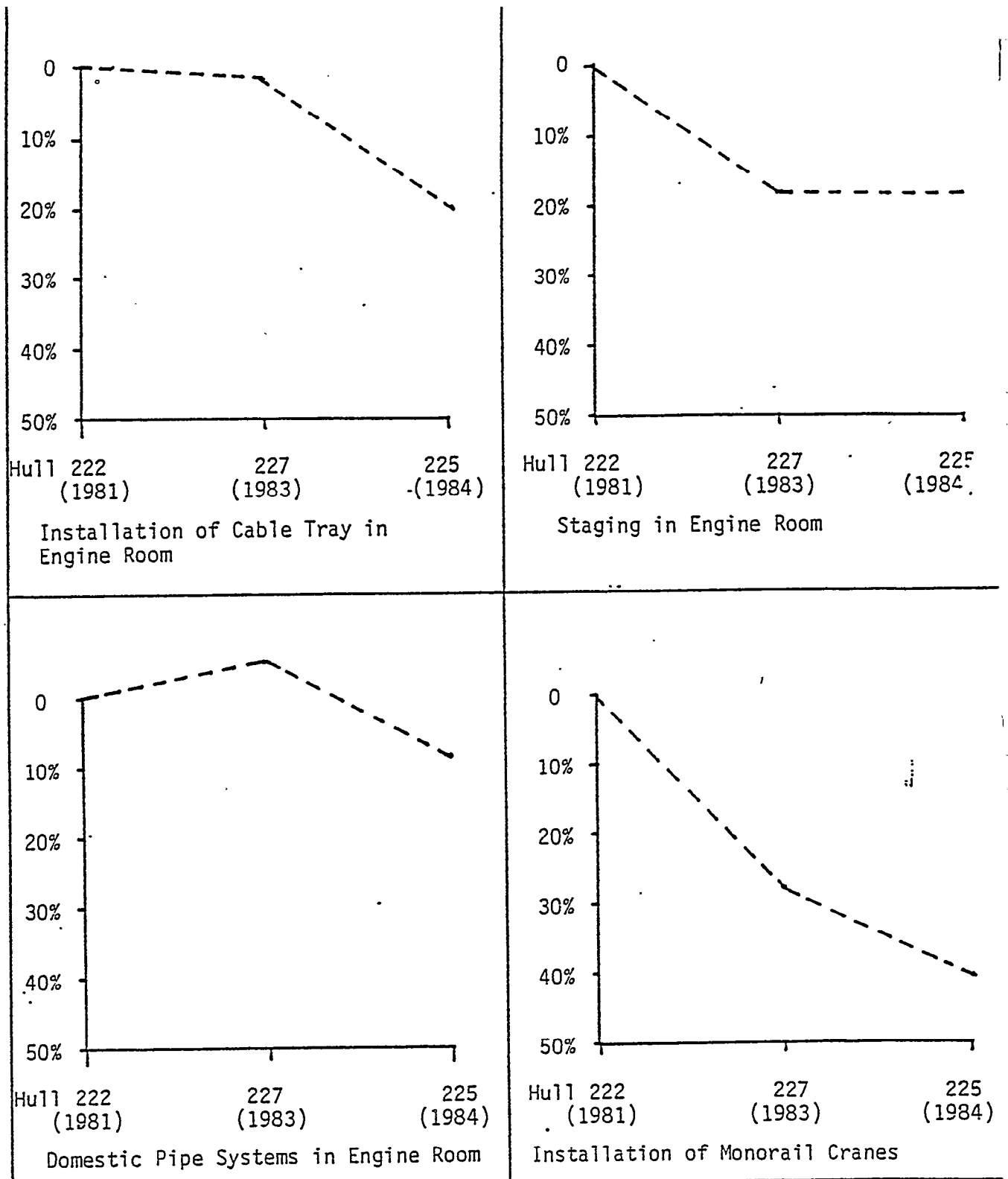


FIG. 10(d)

Reduction in manhours following introduction of zone outfitting in Engine Room.

(e) Accommodation Zone Outfitting

The advantages in the Accommodation follow the pattern of the Engine Room, better working conditions and an earlier start to some types of work. Fig.10(e) shows some of the manhour savings.

(f) Engine Room Casing Module

The first casing module was built in 1984 and was the largest and by far-the most spectacular module to date. There were the obvious advantages of construction close to the Pipeshop, no requirement for the berth crane etc. Once again, however, the less than obvious advantages became important:

The casing at the ship was open for access to the Engine Room until three weeks before launch.

Ladders, walkways and handrails in the module were available for use immediately after erection, and in fact, were used during erection of the module.

Insulation of equipment in the module was completed before erection, thereby eliminating the problem of dust falling into the lower engine room.

The pipefitters, acting on their own initiative, installed a large number of smaller pipes which had not been designated by Planning.

(g)- Safety

Unfortunately we cannot claim any positive reduction in accidents and subsequent drop in compensation payments due to zone outfitting, but common sense dictates that better lighting, less overhead work, less work on staging, earlier installation of permanent ladders and walkways is both safer and healthier for the work force.

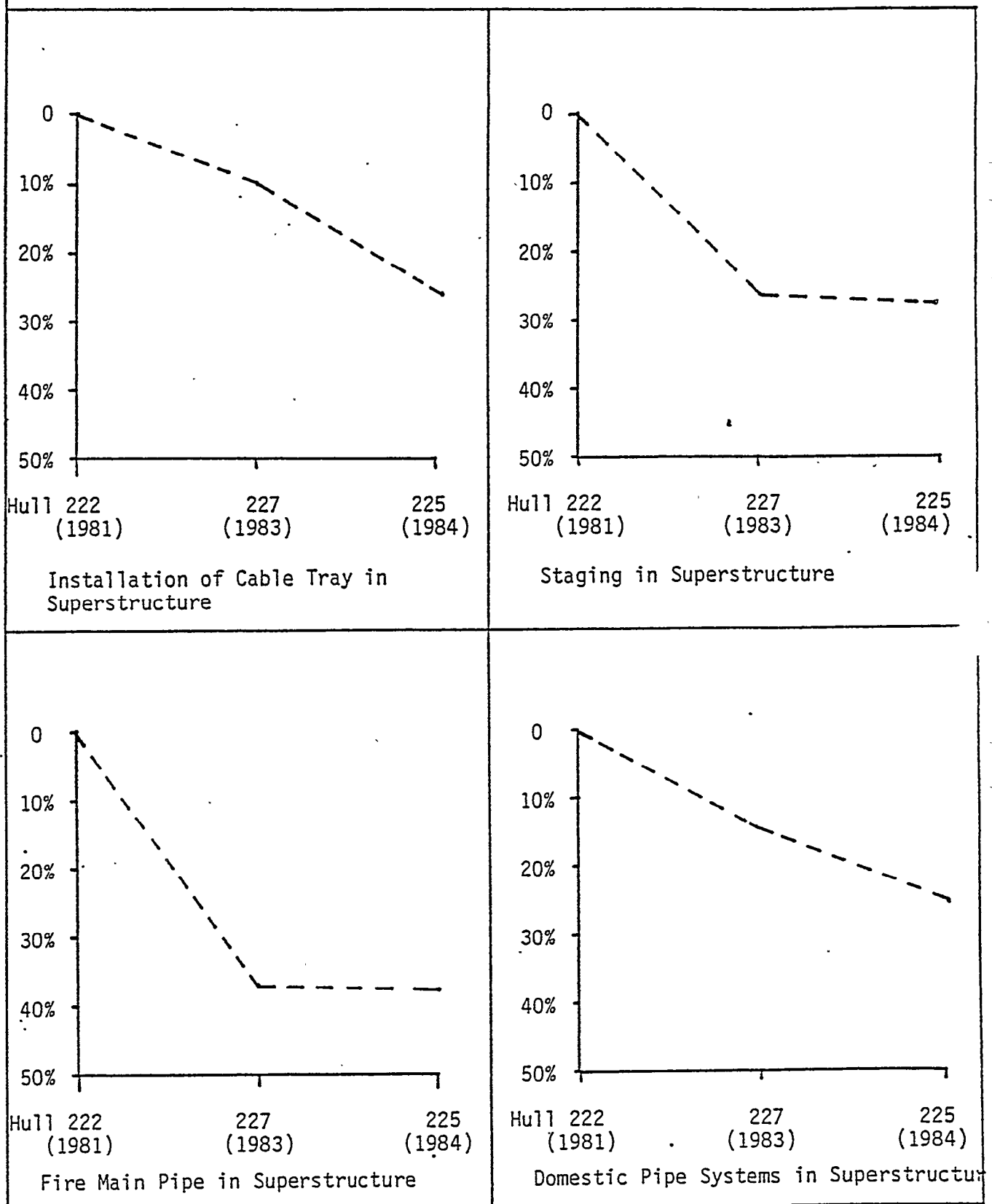


FIG. 10(e)

Reduction in manhours following introduction of zone outfitting in superstructure

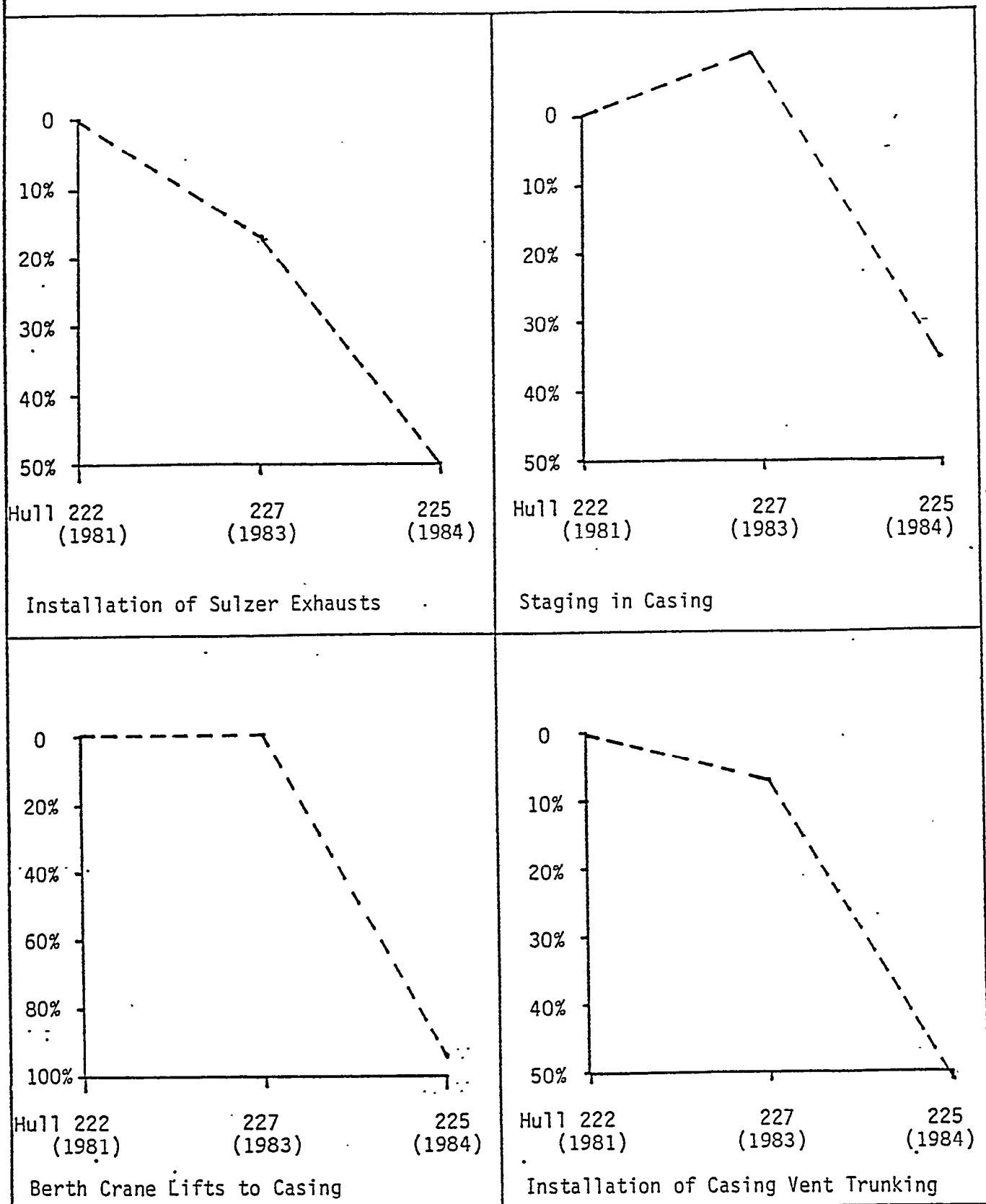


FIG. 10(f)

Reductions in Manhours From Construction of Engine Room Casing Module on Hull 225

11. HINDSIGHT AND FORESIGHT

Looking back over the last four years there are a number of different steps which, if taken, would probably have benefitted the yard.

(a) Drawing Offices

The Drawing Offices operate as four separate groups, Steel, Engineering, Hull Outfitting and Electrical, and although co-operation has improved, we do not have a zone-orientated Drawing Office, under one Technical Manager. The ships constructed during the period covered by this report were similar but not identical and we have been unable so far to design "standard components" of any complexity which could be used on other ships. The Drawing Office has operated under a full load of work for several years. when a lull in their schedule appears it may be possible to introduce designs for standardization of items such as masts, seats, minor tanks, purifier modules, pump modules, hatch covers, deck cranes etc. The introduction of composite drawings was a major advance and assisted in approaching the ship as a number of zones rather than a number of systems.

We are fortunate in the respect that the vast majority of our ships are Collingwood designed. The result is production orientated to match the facilities of the yard. We believe this is more productive than attempting to work to drawings produced elsewhere by a team of designers unfamiliar with our strengths and weaknesses.

cont'd.....

HINDSIGHT AND FORESIGHT - cont'd.....

(b) Production Department

There have been no changes in organization to match the zone concept. It might have given more impetus to the changes to have appointed a co-ordinator responsible for Zone Outfitting. In practice, the Planning Department filled this role with the co-operation of the Steel, Engineering and Outfit Superintendents. Some departments have been reluctant to move from old methods and Production was slow to force the issue.

The Painters could have carried out more of their work before steel units were erected. Weather is a problem in collingwood during the winter and painting the ship at the outfit stage after launch usually had priority over the ship being erected on the berth - resulting, of course, in a never ending cycle of unpainted units erected on the berth requiring painting later at the outfit stage.....

The electricians-had to be almost forced into the Assembly shops at the beginning of each contract but performed well once they had started. We had to repeat the same procedure when the first units for the next contract were ready.

We realize that in shipbuilding, as in other traditional industries, old habits die hard, and the "new" methods were not forced on the yard overnight. It was explained beforehand what was being attempted and we have been fortunate that the employees recognized the advantages of the changes. The result has been a minimum of labour disruptions or grievances.

cont'd.....

HINDSIGHT AND FORESIGHT - cont'd.....

(c) General

Probably the biggest mistake made in Collingwood was the failure to establish a "Steering Committee" for each contract to set out goals to be achieved in Zone Outfitting. Planning tried to accomplish this by legwork, memos and phone calls.

A formal organization could possibly have achieved more progress. The yard is now moving into Superstructure Block Outfitting.

This advance should have taken place earlier but was delayed due to the failure of a berth crane. Block Outfitting is an important step for the yard as the demand for Great Lakes bulk carriers is slowing down and our future contracts may consist of smaller, more outfit-intensive vessels:

(d) The Future

There is no doubt in anyones' mind in Collingwood that the steps described in this paper were worth taking to improve the productivity in the yard. It is worth pointing out that these changes have been made at very little cost.

Capital investments have been made in the yard during the period in question, but it is fair to say only a very small percentage of the gains achieved in outfitting can be attributed to these investments. The vast majority of capital spent on improvements to facilities have been directed towards steelwork.

cont'd.....

HINDSIGHT AND FORESIGHT - cont'd.....

An atmosphere of "wanting more" is now appearing, outfit trades are fitting additional items on units in Assembly on their own initiative.

On future contracts we will extend the steps taken to date.

We also intend redefining the steel unit structure to match additional crane capacity, the accommodation will probably be erected as multi-deck units after extensive outfitting at the block stage.

Material procurement is still a problem, more material should be ordered from diagrammatics and general arrangements. We need to reexamine the control of material in the yard and the use of pallets.' Victaulic pipe fittings have been tried successfully in one system on a ship now under construction,' the results are promising.

On the same ship a new modular bulkhead and ceiling system is being fitted in the accommodation and is now indicating a labour-saving of approximately 20% over previous systems.

As mentioned earlier, our future contracts are likely to involve vessels with a higher proportion of their cost devoted to outfitting. Zone outfitting will be essential to us to produce vessels at an economic price.

For example we are now building a Canadian Coast Guard Type 1100 Icebreaker, (a navigation aid, light icebreaker).

cont'd.....

HINDSIGHT AND FORESIGHT - cont'd.....

In this vessel, outfitting manhours are approximately the same as steel compared to a bulk carrier where outfitting manhours are approximately 75% of the steel hours.

We are using a 1:16 scale design model for the machinery spaces of this vessel to assist in carrying the concept of zone outfitting from the initial design to delivery.

From the Planning Department's viewpoint, it has been a rewarding experience over the past four years to see a shipyard adopt a number of new concepts so readily throughout all levels of the organization, but this is really only the beginning.

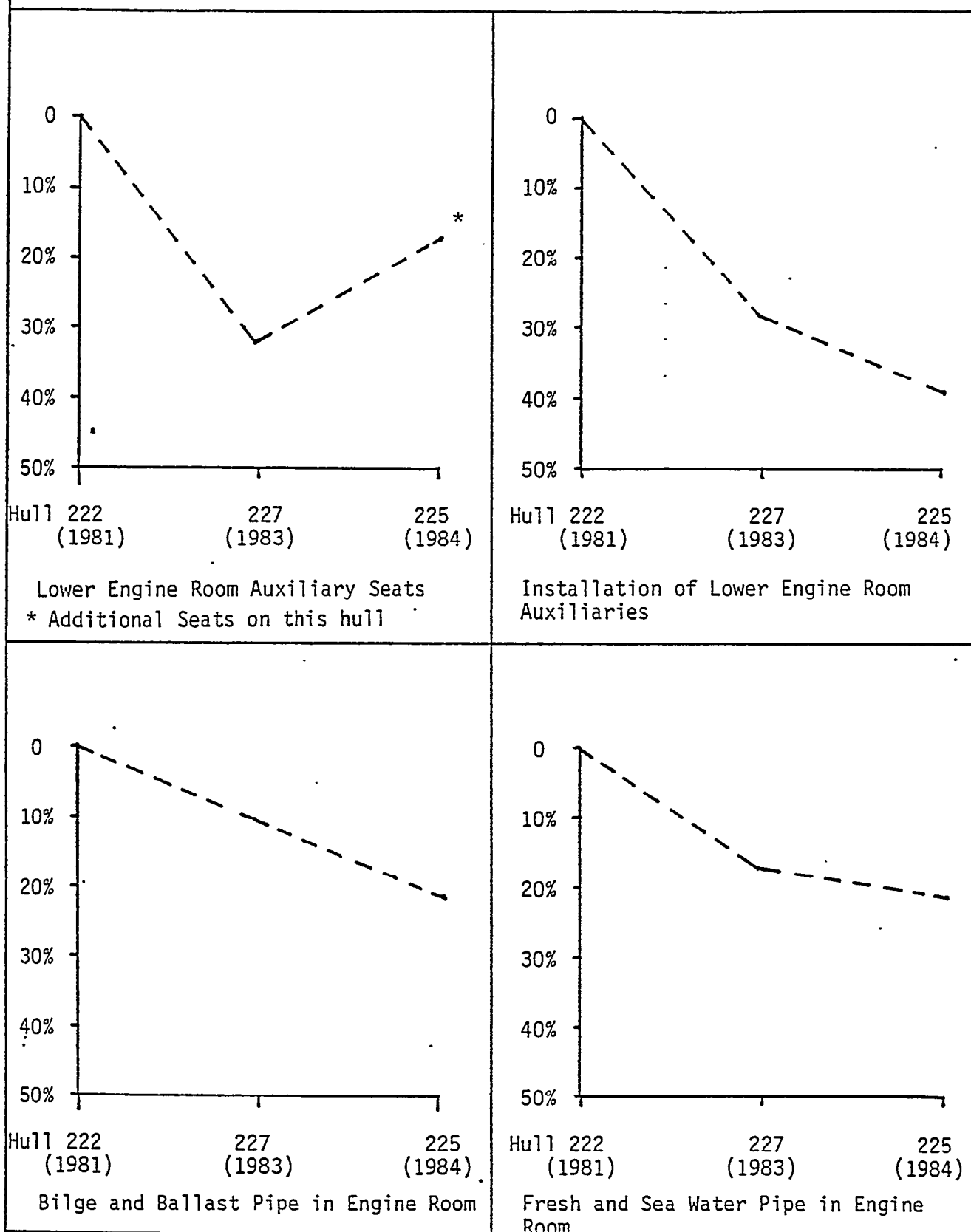


FIG. 10(c)

Reduction in Lower Engine Room Manhours following introduction of Pump Modules

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