RECENT DEVELOPMENT AT WHYALLA SHIPYARD

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WHYALLA SHIPBUILDING AND ENGINEERING WORKS
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INTRODUCTION

Construction of the Whyalla Shipyard commenced early in 1940 on a site at the western end of a newly dredged basin, which now forms Whyalla's harbour. With the benefit of a green field site, the Yard was laid out in accordance with the best British shipbuilding practices of the day. Initially, there were three building slipways, together with associated work shops. Two further slipways were added in 1941.

The total area occupied by the Shipyard today is approximately 49 acres.

The Yard operated as a conventional shipyard for almost twenty years, building vessels which were principally of riveted construction and up to 12,500 d.w. tons. The use of welding in shell and main structure connections gradually increased and, in 1957, the trend towards larger bulk carriers and tankers in world trade began to influence the development of the Whyalla Shipyard. In that year the B.H.P. Co. Ltd. decided to build two 19,000 ton ore carriers for its own fleet, and an order was received from the Ampol Petroleum Co. Ltd. to construct an oil tanker of 33,000 tons.

The first of the ore carriers, "Iron Dampier", was of combined riveted and welded construction, but the second, "Iron Flinders", and the tanker, "P.J. Adams", were virtually all-welded ships, having only the riveted seams required in welded hulls at that time to meet requirements of Lloyds Register of Shipping.

The construction of these vessels required development work on two building berths, Nos. 3 and 4, which had their original piling reinforced to withstand the higher launching loads of the larger vessels. At the same time, existing slipway cranes were re-grouped to concentrate on these two berths, and a new 40 ton luffing crane was installed to serve No.4 berth. Modifications to workshops were relatively minor but improvised assembly areas were laid out in the disused building berths and in areas adjacent to slipway cranes. This development programme, which was completed in 1960, marked the conversion of the yard to one equipped for all welded construction, and facilities provided at that time remain substantially unchanged today.

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Some new equipment and assembly facilities have been added, but the most significant changes which have occurred during the last decade have been organisational and technical, rather than in Shipyard 'hardware' and this paper is designed to outline some of these changes.

ORGANISATION:

From its earliest days the Whyalla Shipyard was part of the B.H.P. Co. Ltd. Whyalla Works Organisation. The Shipyard Superintendent reported to the Superintendent of Whyalla Works, who at that time was responsible for all quarrying operations in South Australia, transport and shipping of Iron Ore from the port of Whyalla and for blast furnace production.

In April, 1964, there was a significant change when the Shipyard became a separate division under the name of The Whyalla Shipbuilding & Engineering Works, with a Manager reporting directly to a General Manager in Head Office. A further change came on the 1st. February, 1967, when the Shipyard, together with Australian Wire Industries Pty. Ltd., Titan Manufacturing Co. Pty. Ltd., Commonwealth Steel Co. Ltd. and a number of smaller subsidiaries, was grouped under a Group General Manager, with headquarters at the Company's Head Office in Melbourne.

This move was part of a Company wide re-organisation which resulted in a division of operations into profit centres, with each General Manager directly accountable for the performance of his own centre. In actual fact, the major subsidiaries had operated in this way for many years, but the formation of the Shipyard into a separate division was an important change intended to give the maximum degree of autonomy possible, within the broad frame work of Company policy.

It meant breaking away from the centralised Whyalla Works organisation and the establishment of commercial and administrative services. Today the Shipyard medical services and staff training scheme are still administered by the central organisation, whilst the services of the Industrial, Safety, Security and other staff departments are available on a consultative basis.

There is an Executive Committee, consisting of three senior Head Office Executives, which meets each month with the Shipyard General Manager under the Group General Manager as Chairman. This Committee functions in a similar way to a Board of Directors, reviewing performance and formulating strategies and policies.

The division of responsibility within the Yard is shown in Figure 1.

Like all organisations, there are compromises, due largely in Whyalla's case, to a shortage of experienced officers to fill senior positions created in a general re-organisation which was carried out in mid 1966.

As with most Shipyard organisations, it is group based and has the overlapping areas of responsibility common to this type of organisation. This applies particularly to the Hull and Outfitting Departments. The adoption of "early outfitting" has resulted in an invasion of the building berths by Outfitting trades almost from the day a keel is laid and co-ordination of schedules and co-operation between supervisors is essential to keep work progressing harmoniously. The 1966 organisational change established the launching as the "cut-off" point of the Hull Department. From that point, responsibility is handed over entirely to the Outfitting Department, which assumes temporary control of the hull tradesmen necessary to complete the vessel.

I believe that, in shipbuilding, a project type organisation, whereby a small team under a project manager, carries a contract through from start to finish, has merit. This would eliminate the division of responsibility which now exists between Hull and Outfitting Departments, but, of course, there would still be conflict as project managers vie with each other for what they consider a fair share of the yard's resources.

Whatever the organisation, there will inevitably be conflict and personality clashes in an activity in which human relations and motivation of the individual are so vital. Provided this conflict takes place against a solid background of co-operation and understanding it is a healty sympton demonstrating that the organisation is dynamic and vital.

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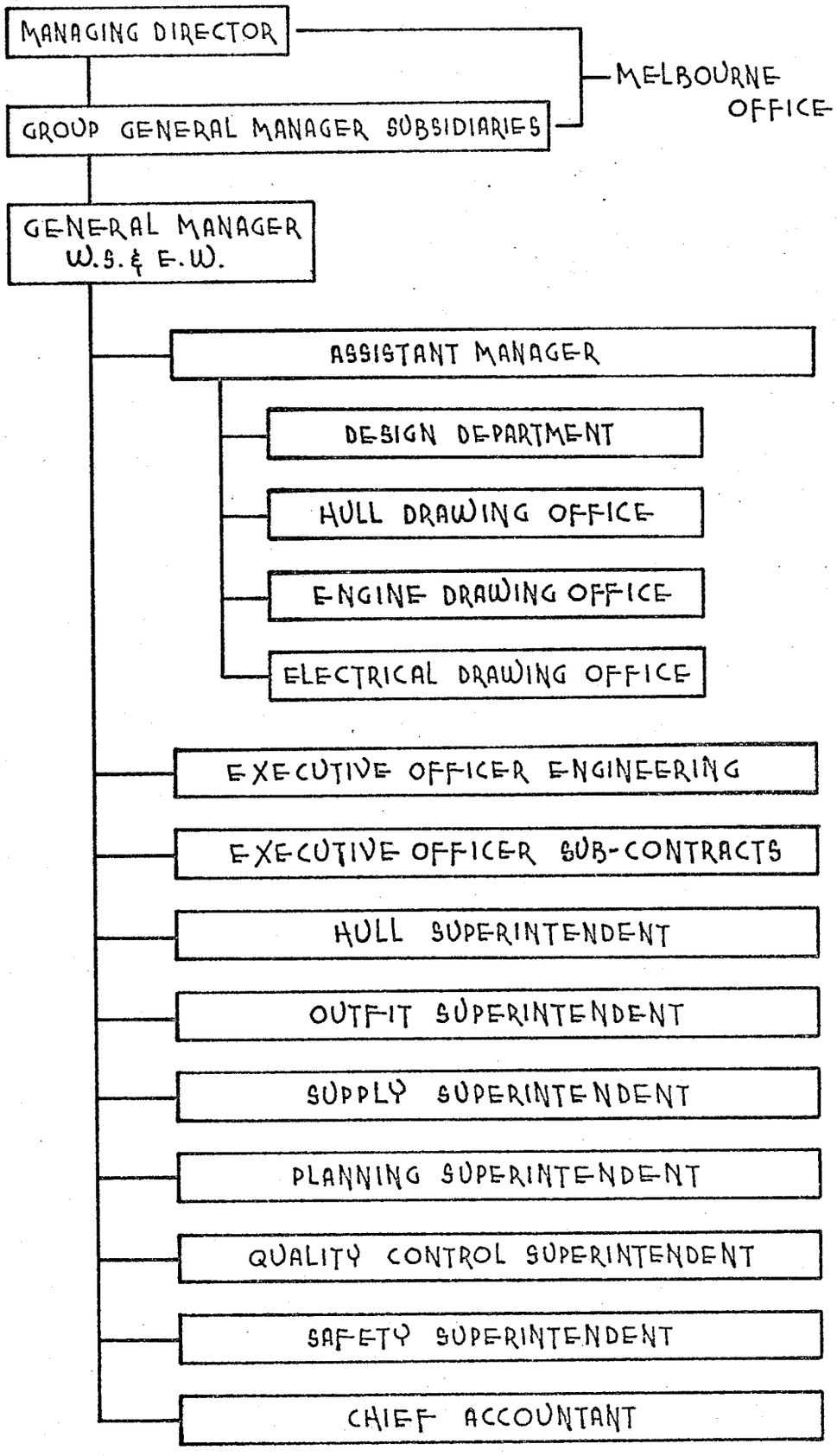
FIG. 1. ORGANIZATION CHART



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DESCRIPTION OF FACILITIES:

A general layout of the yard is shown in Figure 2.

Building Berths:

The two major slipways, Nos. 3 and 4, are angled to each other and flanked on either side by crane tracks, the inner rails being mounted on concrete walls which form the sides of the building berths. Clearance between these walls is the factor which governs the size of vessels which can be constructed in each slipway.

As the slipways were constructed on partially reclaimed ground, piling is necessary to support the keel blocks and there is heavy piling at the lower end of both slipways to withstand launching loads.

Craneage available to each slipway is shown in Table 1, from which it will be noted that the maximum lift for No.4 berth is 40 tons. Blocks up to 30 tons are frequently lifted in No.3, using a 20 ton crane and a 10 ton crane in tandem.

Smaller vessels up to approximately 70' beam can still be constructed in No.2 slipway as the cranes on No.3 track cover this berth quite effectively.

Some improvisation was necessary for the construction of the floating oil rig "Ocean Digger". Nos. 2 and 3 berths were used and a portion of No.2 crane track had to be demolished in order to accommodate the great width of the rig.

TABLE 1.

PARTICULARS OF SLIPWAYS AND CRANES.

Berth	Distance Centre to Centre Between Crane Tracks.	Number	Type	SWL.	Max. Rd.
No.2	85'-0"	1	Screw Luffing	20	105'-0"
		1	Hammer Head	10	110'-0"
No.3	110'-0"	1	Screw Luffing	20	105'-0"
		2	Hammer Head	10	110'-0"
No.4	116'-0"	1	Level Luffing	40	130'-0"
		2	Hammer Head	10	110'-0"

NOTE: The screw luffing crane and one hammer head are common to Nos. 2 and 3 berths.

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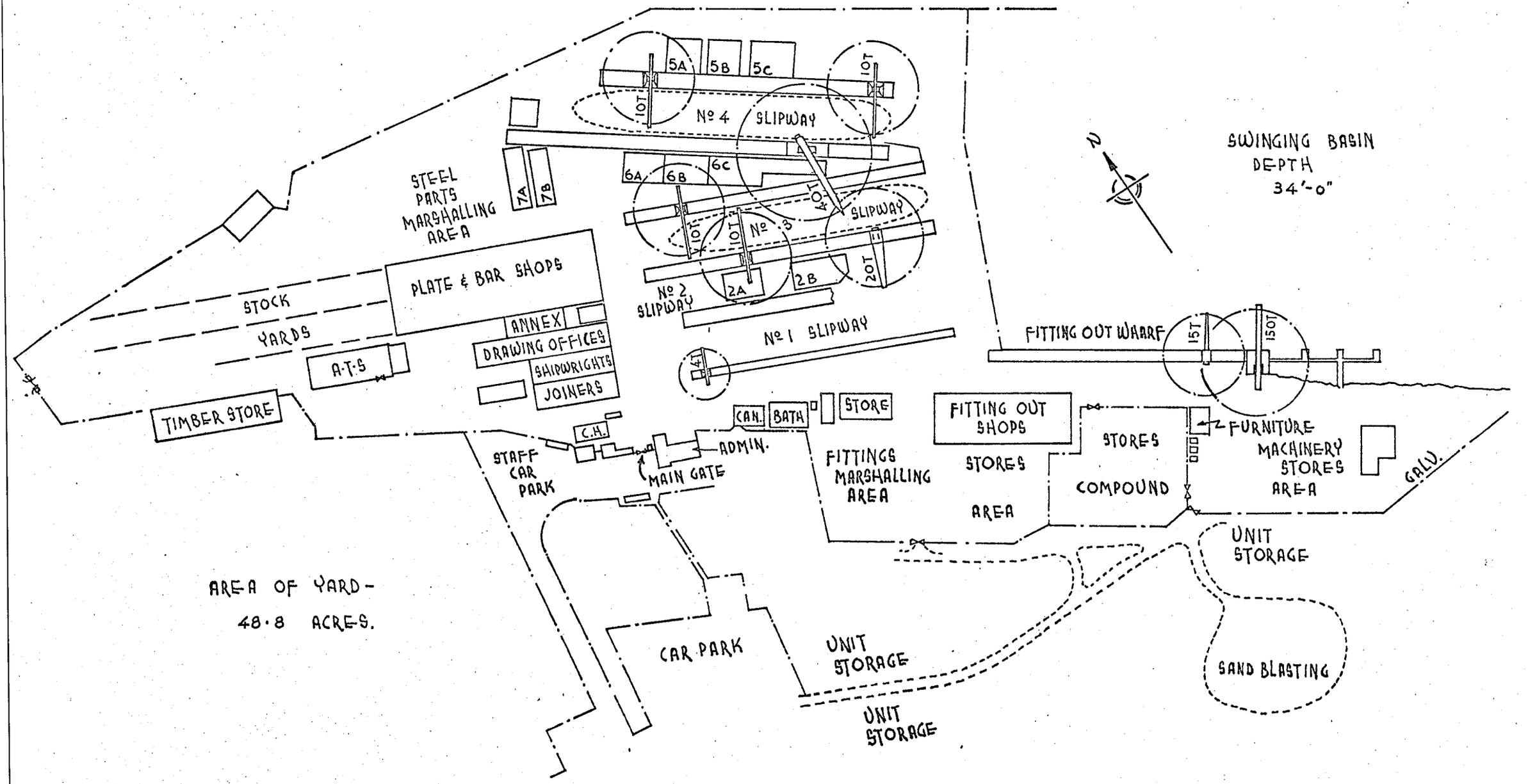
FIG.2. LAYOUT OF YARD



AREA OF YARD -
48·8 ACRES.

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Assembly Areas:

A summary of assembly areas is given in Table 2.

Areas numbers 6 and 7 have steel grids embedded in concrete pads and are provided with independent craneage. Both areas have piped oxygen and propane and constitute the only self contained assembly areas in the yard. They do, however, depend upon berth craneage for lifting and manipulating heavy units.

Areas numbers 2 and 5 are situated in building slipways and consist of level steel grids. Both these areas are completely dependent upon berth cranes for all but the lightest lifts.

Present assembly facilities are not capable of achieving production rates comparable to the capacities of other production stages, and this factor, combined with labour shortages, led to the decision to develop local fabricators as subcontractors for unit assembly and welding.

TABLE 2.
PARTICULARS OF ASSEMBLY AREAS.

No.	Approx. area Square feet.	Max. weight of unit.	Independent craneage available	Purpose
2	13,200	20 tons	None	Pre-erection and early outfitting
5	21,600	10 tons	None	Light panels and units
6	26,600	40 tons	2-6 ton gantries 1-2 ton gantry	Heavy hull and super-structure blocks. Heavy panels
7	12,600	40 tons	2-8 ton gantries	Heavy hull and super-structure blocks.

Fabricating Shops:

Fig 3 shows the layout of the Plate and Bar Shop.

The building is 500 ft. long and 160 ft. wide. It is divided into two bays each 80 ft. wide, the northern bay being equipped for working plates and the other for sectional material and for subassembly work.

Two overhead magnet cranes, one of 10.75 tons s.w.l. and one of 5.75 tons, serve the plate shop, whilst the bar shop is served by 2-5 ton overhead hook cranes.

Material stockyards at the western end of the shop and the location of the finished parts marshalling area on the northern side results in a 'U' type material flow. Small parts (up to 6'.0" x 4'-0") are marshalled as unit "kits" on pallets within the shop itself, and moved by fork lift truck to the marshalling area. Large parts are moved by trailer or mobile crane to the marshalling area for sorting and temporary storage, prior to assembly. Particulars of the major shop machines are given in Tables 3 and 4.

TABLE 3.
PLATE SHOP EQUIPMENT

MACHINE	MAKER	Q CAPACITY
Plate Leveller	Hugh Smith	11'-0" wide x $1\frac{3}{4}$" thk.
Shot Blaster	Vogel & Schemmen	11'-0" vertical
Flame Planer	British Oxygen	40'-0" x 11'-0"
1:10 Flame Profiler	MESSER "Sicomat"	2 x 40'-0" x 11'-0"
Gap Press	Hugh Smith	750 tons
Flanging Press	Hugh Smith	300 tons - 10'-0" wide
Plate Bending Rolls	Smith Brothers (Glasgow) Ltd.	32'-0" x 1" thick
Guillotine	Welded Products	7'-0" x 3/4" thick

TABLE 4.
BAR SHOP EQUIPMENT

MACHINE	MAKER	CAPACITY
Shot Blaster	Vogel & Schemmen	4'-0" wide conveyor
Vertical Press	Marfleet & Weight	600 tons
Horizontal Press	-	200 tons
Cold Room Bender	Scottish Machine Tools.	300 tons

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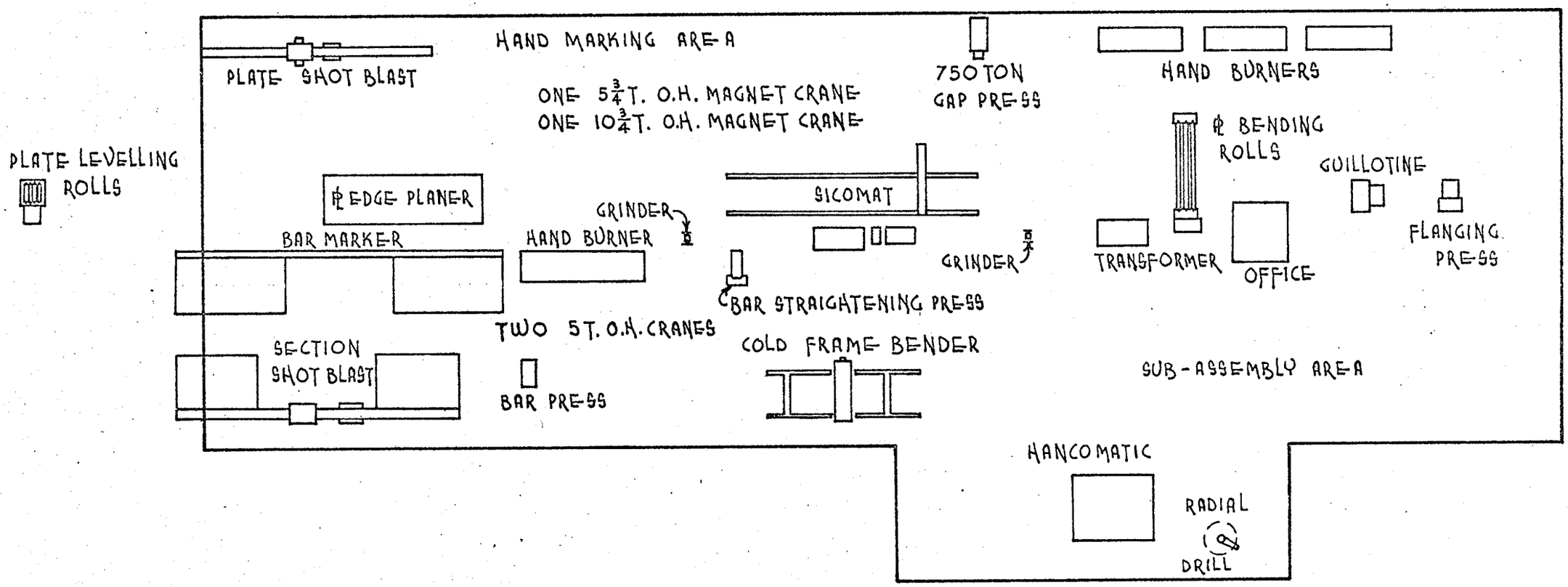
FIG. 3. LAYOUT OF PLATE SHOP, BAR SHOP & ANNEX



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OUTFITTING WHARF AND SHOPS:

There is an outfitting wharf situated on the southern side of the harbour. The wharf is approximately 600 ft. long, but a 3 dolphin extension gives effective mooring length of 900 ft and has provided safe mooring for the largest vessels built in the yard.

A fixed 150 ton revolving tower crane provides heavy lift facilities and a travelling 15 ton luffing crane is mounted on the wharf for general outfitting service. The outfitting craneage can also be supplemented by a 5 ton "Favco" building type crane which can be mounted on a portable tower either on the wharf or on the deck of the ship itself.

Adjacent to the outfitting wharf is a shop which houses boiler assemblers, electricians, a light machine shop, pipe shop, sheetmetal shop and blacksmiths shop.

The remaining outfitting section of importance is the joiners shop which is part of the group of work shops at the head of the berth. This is a self contained production shop which produces practically all of the ships furniture, joinery fittings and pre-cut bulkhead material.

Because of the development of early outfitting the pipe shop has become the key outfitting production shop. Fig. 4. shows the layout of this shop. This shop was modernised towards the end of 1966, the layout featuring three specialised production lines, two for bent pipes and one for straight pipes. Two I.H.I. Mandrel type bending machines between them can bend pipes up to 8" bore and roller conveyors simplify the feed of material to them. The other feature of the pipe shop is a line for straight pipes in which the pipe rolls from a storage rack outside the shop through work stages equipped for end cutting, flange setting and flange welding. The modernised layout and equipment has resulted in double the output possible when bending was done by filling pipes and bending with hydraulic presses.

TRANSPORT:

With welded construction and intensive production schedules transport within the yard has become an extremely important factor in smooth and efficient operation.

Rubber tyred vehicles provide the flexibility required and the yard operates a permanent fleet comprising 4 mobile cranes, ranging from 3 tons to 10 tons in capacity, 2 fork lift trucks and a semi trailer unit. There is a number of solid tyred trailers used in conjunction with mobile cranes.

The yard's equipment is supplemented from time to time by hired vehicles and themajority of the transport to and from contractors yards is handled by hired vehicles on a contract basis.

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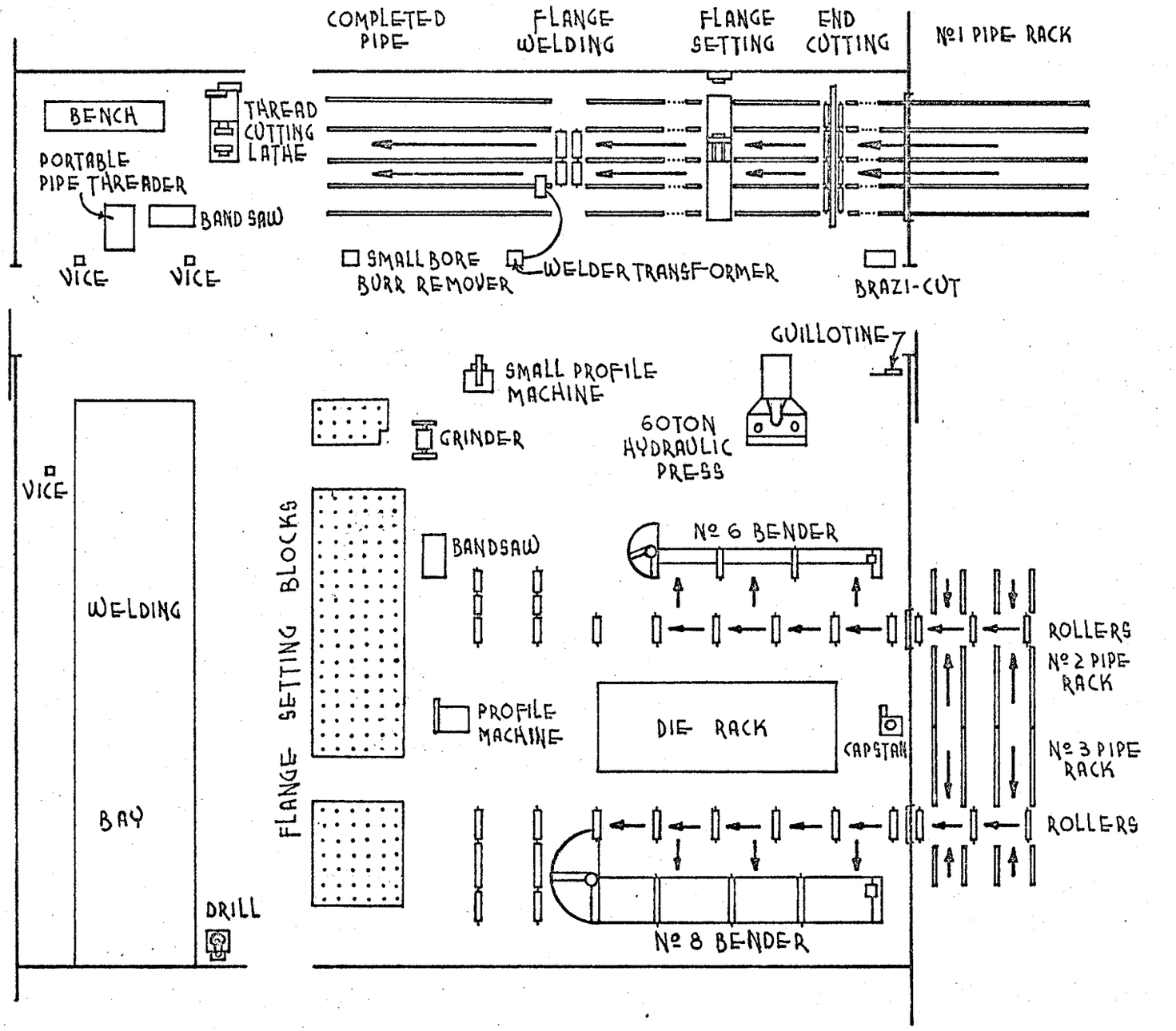
FIG. 4. LAYOUT OF PIPE SHOP



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PLANNING DEPARTMENT:

Planning methods have evolved in a way familiar to all who have been associated with yards founded on British shipbuilding principles.

In the days of riveted construction planning, much of it ad hoc in nature, was a part time duty of Yard Managers and Trade Supervisors.

Pre-fabricated and welded construction demanded more precise methods and, in 1960, a central planning department was set up to undertake the task of process planning, scheduling and co-ordinating the procurement of materials and equipment.

The 1965 decision to supplement the yard's own assembly facilities by subcontracting, resulted in an increase in production tempo. This applied extreme pressure to planning methods designed five or six years earlier. The adoption of the early outfitting principle was another important factor which caused the Planning Department to strive for more detailed and precise methods. An important step was the introduction of Critical Path Scheduling. This technique is an invaluable aid in effectively allocating yard resources for a programme which currently calls for delivery of five large ships of varied design within the next two years. Critical Path planning is applied to three basic areas; pre-production, steel erection and outfitting. The scope of these schedules is shown in Table 5.

TABLE 5.

CRITICAL PATH SCHEDULES

1. Pre-production	1.1	Tender Preparation
	1.2	Design and Drawing Offices
	1.3	Production Planning Department
	1.4	Material and equipment procurement.
2. Steel Erection	2.1	Fairing and Essential fixing involving Shipwrights, Platers and Welders. i.e. Positioning and fairing the hull block, plating and welding its plate butts and seams and plating and welding any internal connections essential to erection of adjacent hull blocks.
	2.2	Other fixing involving platers and welders engaged on work necessary to complete compartments.
3. Outfitting	3.1	Main Engine
	3.2	Engine Room
	3.3	Aft End
	3.4	Accommodation
	3.5	Pre-erection (staging, painting and early outfitting)

Cont./

TABLE 5

CRITICAL PATH SCHEDULES

Continued:		
3. Outfitting	3.6	Deck and Hull (a) Tank Testing (b) Deck Machinery (c) Catwalk (d) Painting and sand blasting (e) Heating Coils
	3.7	Commissioning (Inspections and Acceptance Trials)

Schedules for steel fabrication and assembly are derived from the requirements of the steel erection schedule.

Present day planning strives to attain a degree of detail never previously attempted. For this work to be successful, it will be necessary to collect man hours in greater detail than has been the practice in the past and to achieve this a new recording system is being introduced. Collection of this type of data is necessarily a lengthy process and refinement of planning techniques will occur progressively.

A secondary, but never-the-less, important function of the Planning Department, is the training of present and future supervisors. The importance of integrating shipyard departments into a group working towards a common goal is now universally recognised, and there is no better way of establishing understanding between departments than by an interchange of personnel.

QUALITY CONTROL DEPARTMENT:

The Quality Control Department was established in June 1966, with control of welding quality as its main function, but with a charter broad enough to enable it ultimately to extend into all phases of ship construction.

The Superintendent's staff consists of a Welding Engineer, a Radiographer and 3 Inspectors. The Inspectors, at present, are concerned almost solely with welding and steel work, two of them being assigned to the yards of subcontractors engaged on the assembly and welding of hull blocks.

The main functions presently performed by the department, are:-

1. Process Planning:

   The pre-production planning of welding procedures, including edge preparations and sequences.

2. Inspection:

   The inspection of welding in all production stages, including radiographic and gamma-ray examination.

The department has a 200 K.V.A. Balteau Spot X-Ray machine and a 13 curie source of Iridium 192 contained in a 'Ray-Guard' tank camera. The x-ray machine can penetrate steel up to $1\frac{1}{4}$" and is used for most of the x-rays taken on the ships hull. The Isotope is capable of penetration up to 3" and has been used in butt welds where difficult access restricts the use of the xray machine and for high pressure steam pipe. All radiographs are taken to a 2% minimum sensitivity. The minimum x-ray requirement of Classification Societies is invariably exceeded, the following figures being typical of vessels recently completed or under construction:-

V.44 - 55,000 ton Bulk Carrier	-	400 x-rays, plus 210 on boiler and high pressure steam pipes.
V.46 - 22,000 ton Tanker	-	500 x-rays, plus 40 on boiler and steam pipes.
V.47 - Offshore Drilling Barge	-	900 x-rays

Penetrant dye and acid etching are other non-destructive techniques in common use. Both ends of all automatic welds in plate panels are acid etched to ensure that full penetration has been achieved.

3. Produce and Maintain Manuals of Standard Steel Work and Welding Practices:

These booklets, in addition to providing guidance to production and inspection staff, are used by the drawing office in preparing steel work drawings. They are approved by Lloyd's Register of Shipping and are submitted for owners' approval prior to commencement of construction of a new contract.

4. Testing and Training of Operators:

Each newly engaged operator is required to undergo a welding test, including a vertical butt weld which is radiographically examined. On the results of his test, the operator is classified to ensure that he is assigned only to work within his capability. Operator testing applies also to applicants from outside the Whyalla area. Arrangements are made in capital cities for standard tests to be carried out and the results of these tests are considered before an applicant is accepted for employment.

As turnover of welding operators is high the proportion of top grade welders in the work force is seldom static and the Quality Control Superintendent has the responsibility of arranging training programmes as necessary to upgrade existing manual welders and ensure that adequate numbers are available for deployment in areas where high quality butt welding is called for.

The normal radiographic examination of hull welds provides the Quality Control Department with another medium of control over workmanship standards, because the name of the operator responsible is recorded in the case of each planned x-ray.

Training programmes are also held when new practices and procedures are being introduced.

5. Steel Work Quality and Accuracy:

It is now universally recognised that for welded construction to achieve full economies, dimensional accuracy and the quality of fabrication shop processing must be of a high order. Deviations from planned dimensions, inaccurate marking and poor quality shop processing, can all result in serious loss of productive effort in the assembly and erection stages and the exercise of effective control over these factors should be a prime aim of any shipyard.

This is an aspect of the Japanese shipbuilding effort which often escapes the notice of the casual visitor, who may so easily be deceived into believing that high speed production results in slackness of workmanship standards. Accuracy control, however, is an exceedingly important segment of their steel work departments and is a key factor in the achievement of fast building times and low man hour figures.

The Whyalla yard has a long way to go to achieve the desired measure of control, but studies now being made are providing data which will guide action to introduce positive control measures in areas where they are most needed.

A "Feed-back" system ensures that all significant errors discovered during production stages are investigated by quality control officers. The origin and the type of error are identified and the pattern which emerges from records is a guide to action necessary to eliminate a recurrence of similar errors.

6. New Processes and Techniques:

The Quality Control Department is responsible for evaluating new processes and techniques and for the technical aspects of their introduction if adopted.

LABOUR AND INDUSTRIAL RELATIONS:

Throughout its history, the Whyalla yard has experienced a succession of periods when labour shortages have adversely affected operations. In the past decade other industries throughout Australia have shared this problem as a buoyant economy has created a situated of full employment. However, Whyalla, a small and relatively isolated industrial community has special problems in this regard. Labour is not easily attracted when work is plentiful elsewhere, and the modern day work force is so mobile that retention of existing labour is a constant problem. In fact, it is true to say that in recent years the yard has rarely enjoyed the luxury of having a work force stabilised at the level necessary to meet scheduled requirements.

Housing is an important factor in attracting and retaining labour and, in this field, the South Australian Housing Trust has achieved notable success. The Trust, by far the largest land-lord in the city of Whyalla, is currently building homes for rental at the rate of approximately 600 per year. The Shipyard shares these with B.H.P. Whyalla Works in pr ortion to the respective work forces. The Whyalla Works has its own expansion programme and its demand for houses is expected to continue at the present rate for some time ahead. Whyalla Works labour now stands at about 4,500 compared with the work force of a little over 1,500 in the Shipyard. Figure 5 shows the relative growth of these two figures during the past four years, the steepness of the Whyalla Works graph reflecting the commissioning of the Steel Works and other major plants.

Figure 6 shows the combined total of Platers and Welders, the key shipbuilding trades, for the period 1964 to 1968. The low points in 1965 and 1967 coincide with periods of intensive local construction activity and the accompanying heavy demands on boilermaking capacity.

Efforts to recruit Shipyard tradesmen from the United Kingdom have met with moderate success only. In all 202 boilermakers and 61 other tradesmen have been brought from the U.K. since April, 1964, but only 96 boilermakers and 40 other trades remain on the payroll today. Perhaps there is some consolation in the fact that many of the tradesmen now working for subcontractors were originally brought to Whyalla by the Company.

Recent attempts have been made to intensify recruitments in the U.K. but, in spite of devaluation and a wage freeze, it appears that our wages and conditions are no longer an attraction to British Shipyard tradesmen, and families who do come are lured mainly by sunshine and a chance to make a new start in a new and growing country.

Industrial relations are complex as in other Australian yards, because of the great number and variety of industrial awards which operate in the industry. Of the Shipyard's 1,500 personnel about 1,230 are wages employees who are covered by eleven industrial awards. The main awards are:-

Federal:	Metal Trades	870 employees
	Painters & Dockers	140
	Shipwrights	65
	Engine drivers, etc.	35
State:	B.H.P. Industry	50
	Ship Joiners	45

Other awards cover Timber Workers, Polishers, Transport workers, Caretakers and Cleaners, there being fiften unions in all which can claim industrial rights over our wages employees.

This structure is basically similar to that existing in other Australian yards, but the industrial climate at Whyalla has never been characterised by the turbulence which, from time to time, afflicts yards situated in larger and long established areas.

The problems created by the complex industrial pattern needs no elaboration and it is generally acknowledged that the long term objective of having one award for the ship-building industry is a worthy one. There are formidable difficulties, however, standing in the way of achievement of this ideal and its achievement would not necessarily solve all the problems experienced under existing arrangements.

We believe that attempts to force this issue prem-aturely may not be in the best interests of the industry. That managerial frustration arises from the present system cannot be denied. To a large extent we have learnt to live with the situation as it exists in the Whyalla area and believe that firm and positive management can continue to minimise the effects of difficulties.

WHYALLA SHIPBUILDING & ENGINEERING WORKS

FIG. 5. LABOUR FORCE - OVERALL FIGURES

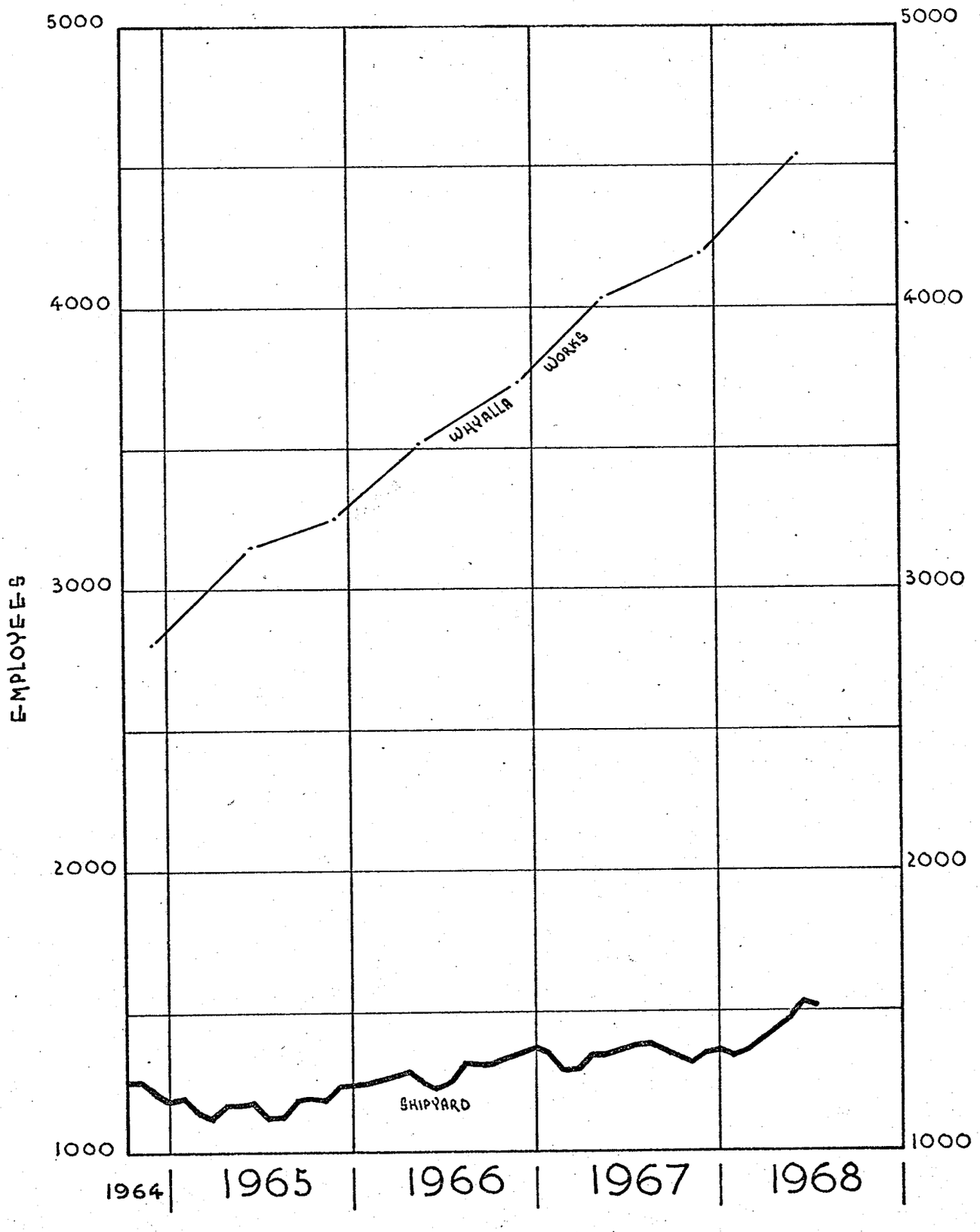

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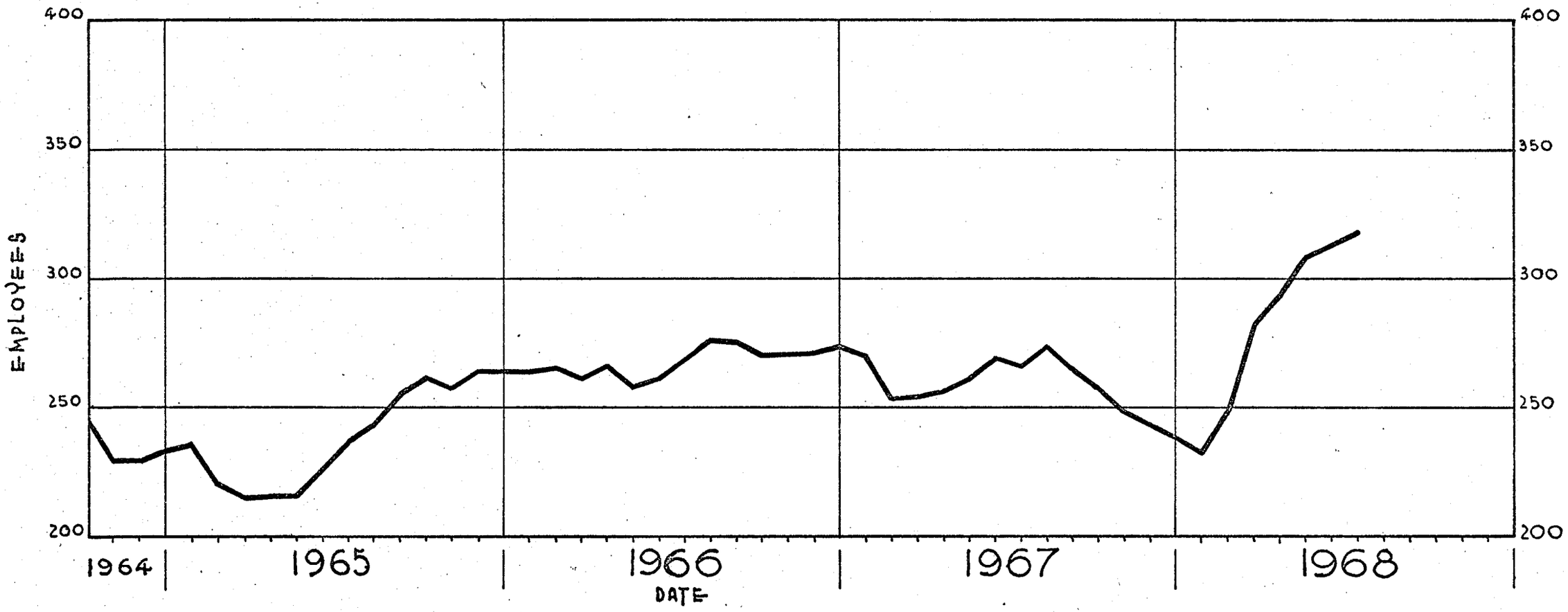
FIG. 6. LABOUR FORCE - PLATERS & WELDERS



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TECHNICAL CO-OPERATION AGREEMENT WITH ISHIKAWAJIMA-HARIMA HEAVY INDUSTRIES COMPANY LIMITED:

Since its earliest days, B.H.P. Co. Ltd. has kept abreast of technological developments throughout the world by maintaining good relations with major steel companies and by sending missions abroad at frequent intervals to study all aspects of developments in steel and allied industries.

This policy found new expression, so far as shipbuilding activities are concerned, in May 1965, when a Technical Co-operation Agreement was signed with Ishikawajima-Harima Heavy Ind. Co. Ltd., a major Japanese shipbuilder. The terms of this Agreement are quite broad and implementation initially took the form of exchanges of visits by technical officers. Three teams of Whyalla Shipyard officers have visited the Aioi Yard of I.H.I. and return visits to Whyalla have been made by I.H.I. officers. Members of these teams have been assigned the study of specific aspects of shipbuilding operations and, in applying principles learned to Whyalla operations, they have been assisted by I.H.I. officers who have spent periods of up to six weeks in Whyalla.

Speedy and successful introduction of new practices and techniques has followed each team visit and trial and error methods have been effectively short circuted. In particular, the adoption of the early outfitting principle was effected quickly and with little difficulty because of studies by drawing office and outfitting officers during visits to the Aioi yard.

The team visits have shown that new practices are more readily acceptable when officers responsible for their introduction have actually studied them at first hand. There is also a valuable secondary benefit in the good relationships and understanding built up between team members during a four or five week period abroad sharing common experiences.

More recently, the drawing offices at Aioi have produced hull steel work and engine room pipe work drawings for three vessels constructed in the Whyalla Yard. Because of shortages of skilled drawing office staff at Whyalla it was necessary to subcontract these drawings in order to have them available to meet schedules and I.H.I. agreed to undertake the work. Basic scantling drawings, layouts and diagrammatics were developed at Whyalla, leaving the majority of the working drawings to be done at Aioi.

This exercise has also meant an exchange of officers - 7 drawing office supervisors having spent periods in the Aioi drawing office as supervisors and liaison officers during the past two years.

From time to time, we have been able to call on I.H.I's design offices for assistance on specific problems and it is expected that this form of co-operation will increase and develop as time goes on.

In the past, Whyalla building programmes have made widely fluctuating demands on drawing office capacity. While this continues and while an acute shortage of skilled draftsmen persists, it will be necessary to continue to sub-contract substantial portions of drawing office work. It is our objective to establish a small team of skilled designers and a nucleus of competent draftsmen to ensure that basic designs and tendering and estimating work can efficiently be carried out at Whyalla. It is not our intention, therefore, to allow our relationship with I.H.I. to develop into one of complete dependence. Rather, we aim to use their aid to assist in the training and development of our own design team and I.H.I. themselves encourage this approach.

SUB CONTRACT:

Fig.7 shows the important contribution that subcontract assembly work has made to yard operations since 1965.

One aspect of the modern Japanese shipyard is the extent to which subcontractors are used for steel fabrication and assembly. These yards regard the assembly of the hull as their major function and attempt to confine their assembly work to the straight forward flat type of unit which can be built very efficiently in specialised areas. In some yards these assembly areas occupy spaces adjacent to the building berths and work carried out there is generally confined to the parallel portion of the ships hull. These units, being of simple construction, can be produced in a very short space of time and are lifted from the assembly area directly onto the building berth. Very precise planning obviates the necessity of moving the hull blocks into a buffer storage area and the saving of space is an important factor, particularly in some of the older yards.

Assembly operations at the Whyalla yard have always been restricted by facilities available and this problem has been compounded by shortages of skilled labour. Ever since the conversion of the yard to all welded construction the output from the assembly areas has governed erection rates. In earlier years, this was a problem which had to be lived with but the construction of the steel works, which commenced in 1959, attracted a number of steel fabrication firms, some of whom set up substantial facilities in Whyalla with the object of obtaining a share of the extensive fabrication work offering. Other contractors of local origin began to mushroom and as the construction work tapered off spare capacity became available.

In 1965 it was decided to try the Japanese practice of subcontracting and, for Vessel No.42 "Darling River", some 2,500 tons, or just over 20% of the total hull steel was let out to subcontractors for assembly and welding.

This exercise was extremely encouraging and has become standard practice in subsequent contracts.

The percentage of assembly work subcontracted on various contracts is shown in Figure 8. It will be seen that on the Semi Submersible Oil Drilling Barge "Ocean Digger" and the 22,000 ton Shell Tanker "Cellana", tonnages subcontracted reached almost 80%. This is much higher than desirable because a cost disability is incurred when units of low man hour to weight ratio are subcontracted, because this means freight charges become a significant proportion of the total cost of the unit.

Future planning will be based on the assembly of flat panel units in the shipyard, and assembly of shaped and three-dimensional units by subcontractors. This means that about 60% of the steel weight of a large bulk carrier would be assembled in the Shipyard.

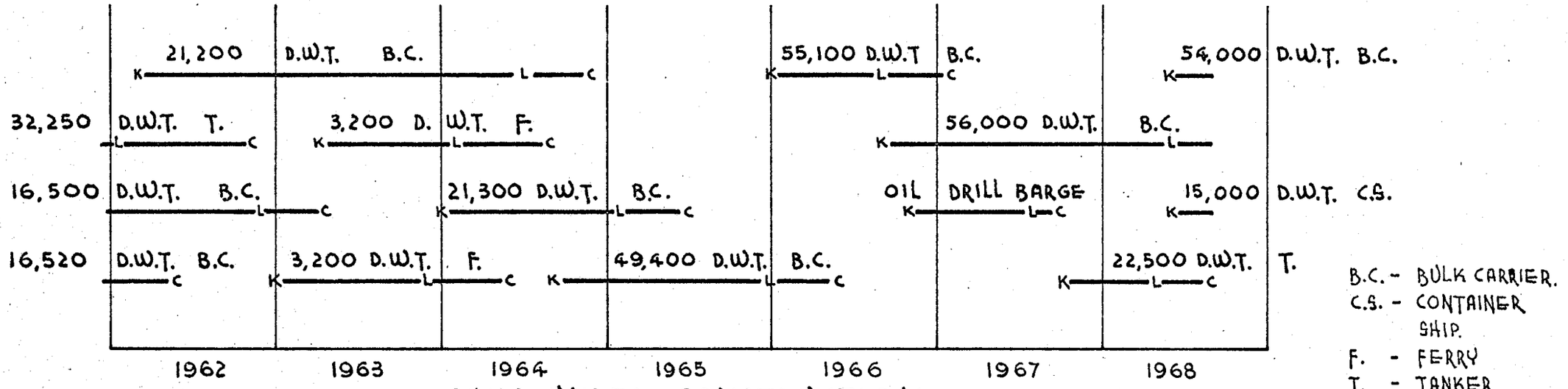
At present there are thirteen contractors being used to assemble shipyard steel in facilities ranging from open areas served by mobile cranes to well equipped fabricating shops with 40 ton over-head travelling cranes. They are currently employing approximately 210 men comprising 140 boilermakers, 20 apprentices and 50 labourers on shipyard work.

Sub-contracting of steel work calls for very intensive planning and liaison. Practically all steel work passes through the yard's fabricating shop for shot blasting and cutting and, in order to serve an increased assembly capacity, annual throughput of the shop has increased from about 7,000 tons per annum to 15,000 to 20,000 tons per annum. Shop production must be scheduled so that finished parts are delivered to contractors in time to enable them to meet their completion dates and the transport of parts to the contractors and the lifting and moving of finished units involves careful planning of transport.

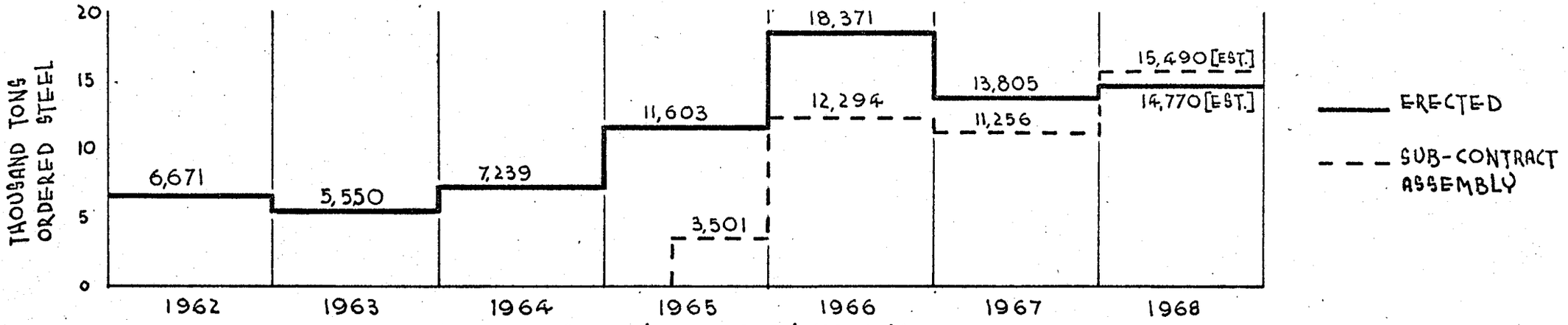
Quality control is another vital factor both for parts delivered to the contractors and for the work the contractors themselves do.

Subcontracting is the responsibility of a senior executive officer, who has two progress officers on his staff to maintain constant liaison with subcontractors.

WHYALLA SHIPBUILDING & ENGINEERING WORKS. FIG. 7.



SHIPS UNDER CONSTRUCTION - JAN. 1962 TO AUG. 1968

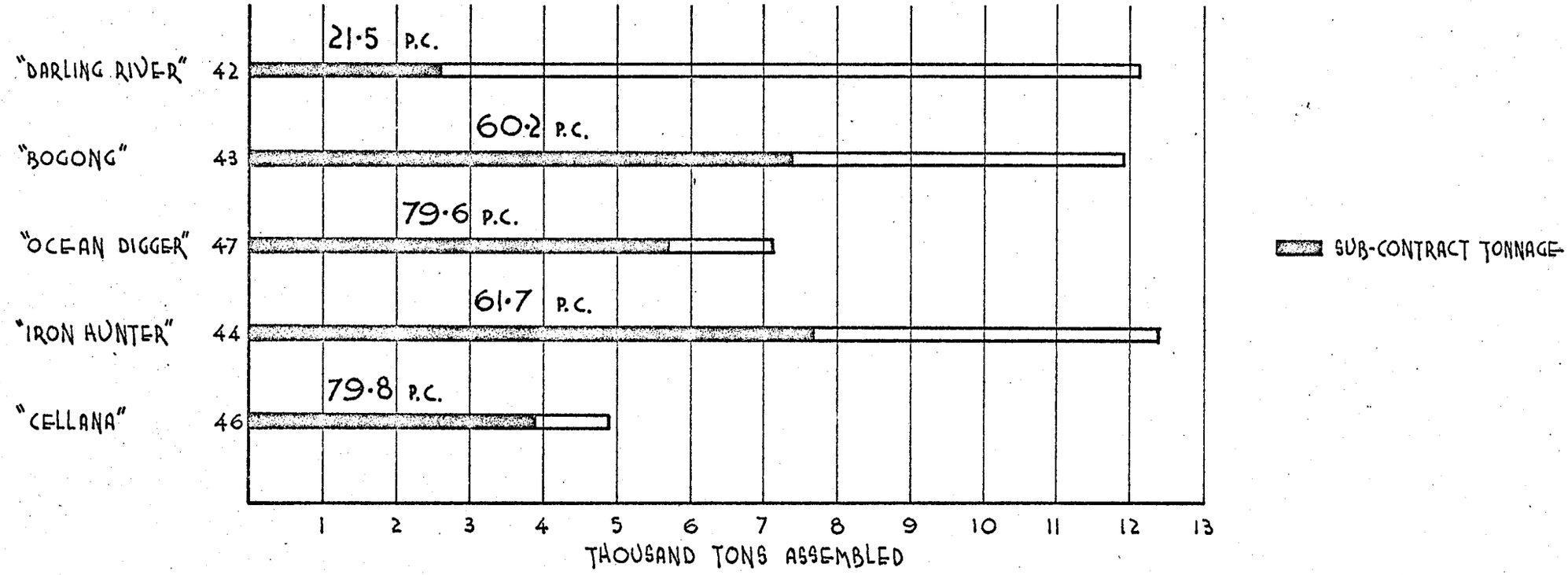


STEEL PRODUCTION

I.J.D. 13·8·68

WAYALLA SHIPBUILDING & ENGINEERING WORKS

FIG. 8. SUB-CONTRACT ASSEMBLY PERCENTAGE



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EARLY OUTFITTING:

The benefits to be derived from having outfitting work commence at the earliest possible stage has been well recognised for many years, but it was not until the Liberty Ship programme was executed so successfully in the United States during the Second World War, that the possibilities of a well planned integration of outfitting with hull construction were fully appreciated.

The Liberty ship was, of course, a standard ship, virtually mass produced. The hull blocks were constructed by widely scattered contractors and delivered to the shipyard, in many cases, with their fittings and equipment already installed. Erection and welding was then carried out at incredible speeds.

In spite of the startling results achieved by this series production approach to shipbuilding, traditional shipbuilders remainded sceptical as to the practicability of these methods under commercial, peace time conditions. It was left to a newcomer to shipbuilding, the American Daniel T. Ludwig, to exploit these methods when his shipping company, National Bulk Carriers, Inc. took a lease of the Kure Naval Yard in 1950. Some of Ludwig's engineers had worked on the Liberty programme and Japanese engineers were quick to learn when these methods were used at Kure.

The practice is now highly developed in Japan and is one of the major reasons for the remarkably short building cycles achieved there.

The main requirements for successful adoption of this practice are:-

1. Early decisions and approvals of equipment, engine room and accommodation arrangements, steel work drawings and piping drawings.

The following are typical targets for some key events which affect early outfitting work:-

ITEM:	WEEKS BEFORE KEEL LAYING:
Agree specification and basic design drawings with owner	44
Complete accommodation early outfit plans.	17
Complete working drawings for hull steel work.	13
Complete plans of engine room cable trays	11
Complete plans for engine room early outfitting.	3
Complete plans for hull early outfit.	1

2. Detailed production schedules are required to ensure that steel production, pipe production and material and equipment procurement are co-ordinated in accordance with the over-all construction schedule.

3. A systematic method of marshalling and transporting finished parts is essential. Both "brought-in" and "Shipyard produced" items must be available so that complete "kits" can be delivered to the early outfitting work areas at the right time.

4. Close co-ordination of erection schedules, particularly in the engine room area, is essential to ensure that installation of early outfitting units proceed in a way which will not hamper hull construction progress.

Early outfitting in the Whyalla Yard is classified in three broad groups:-

1. Hull Blocks:
   This group comprises pipes, fittings, cable trays and ventilation trunking, which are installed on hull and superstructure blocks prior to erection.

2. Machinery Units:
   These are items of machinery or engine room tanks, bolted to seating and with piping attached.

3. Piping Units:
   These consist of groups of piping pre-assembled in early outfitting areas, e.g. a ballast piping complex complete with valves, supports and saddles.

The drawing office issues a complete list of all pipes, fittings, clips, etc. for each unit in each of these categories. These lists are used by planning and procurement departments to ensure that items are available on the required date.

CONCLUSION:

In developing the Whyalla Yard, management has been confronted with the dilemma which is all too familiar in the Australian shipbuilding industry. That is, the question of how far to go with capital investment in an industry of marginal profitability and with an uncertain future.

However, construction of large ships requires large and expensive facilities irrespective of whether you are building one ship a year or ten and at Whyalla, expansion has been aimed at providing minimum rather than optimum requirements. Capital expenditure has, therefore, been comparatively modest and vessels are being constructed within facilities which shipbuilders from Japan or Europe would consider less than adequate. There is not much we can do about this, at least under present conditions, but I believe there is a great deal we can do for the industry in the areas of organisation and personnel.

A lot has been done at Whyalla and in other yards, on the organisational side. We have had the advice of consultants in improving efficiency and introducing modern planning techniques, but, without an amenable climate and the right standard of personnel, these systems will not work.

I believe that managements of Australian shipyards need strengthening at all levels and that this can be achieved by training(or retraining) existing personnel and by attracting more talented young people into the industry. The traditional means of entry into shipyard management positions, either up through the ranks, or from drawing and design offices, leaves too much to chance. Shipbuilding is a complex operation calling for technical and organisational skills and we need engineers trained for this task to fill upper and middle management positions. Front line supervision is another management area in urgent need of improvement. These men are the last and most important link in the communication chain which is supposed to direct and motivate the men doing the work and yet we do little more than pay lip service to the task of selecting and training them.

I believe it is up to those who occupy responsible positions in the industry to work towards raising the status of the industry and to ensure that the very real challenge that shipbuilding presents is more widely known. I believe that this challenge would appeal to many young people with the right qualifications and an infusion of this type of talent into the industry would be worth more than high investment in sophisticated equipment designed for high production shipbuilding.

CONCLUSION (CONT)

It seems to me that the two bodies meeting here tonight have some responsibility in this, and could make a positive contribution by working to raise the professional standing of shipbuilders in the eyes of the public, and by initiating a review and overhaul of the educational and training opportunities available to young people wishing to enter the shipbuilding industry.

SHIPS BUILT AT
WHYALLA SHIPBUILDING AND ENGINEERING WORKS

Ship No:	Berth No:	Name:	Type:	Owner:	DIMENSIONS Length O/A	Length B/P	Beam:	Depth:	D.W. Tonnage:	Keel Laid:	Launched:	Completed:
8	3	H.M.A.S. WHYALLA	AS & MS Vessel	R.A.N.	186'-1½"	180'-0"	31'-0"	15'-6"		24. 7.40	12. 5.41	8. 1.42
9	3	H.M.A.S. KALGOORLIE	"	R.A.N.	186'-1½"	180'-0"	31'-0"	15'-6"		25. 7.40	7. 8.41	7. 4.42
25	3	H.M.A.S. GAWLER	"	R.A.N.	186-1½"	180'-0"	31'-0"	15'-6"		15. 5.41	4.10.41	14. 8.42
26	3	H.M.A.S. PIRIE	"	R.A.N.	186-1½"	180'-0"	31'-0"	15'-6"		10. 8.41	3.12.41	10.10.42
1	1	IRON MONARCH	S.S. Ore Steamship	B.H.P.	425'	400'-0"	56'-0"	34'-6"	D.W. 8030	1. 7.41	8.10.42	12. 4.43
2	2	IRON DUKE II	"	B.H.P.	425'	400'-0"	56'-0"	34'-6"	D.W. 8030	1. 8.41	3. 5.43	1. 8.43
3	3	RIVER GLENELG	S.S. Shelter Deck Steamer	M. of M. A.S.B.	447'	425'-0"	56'-6"	36'-6"	D.W. 9116	27. 3.42	28.10.43	16. 3.44
5	1	RIVER DERWENT	"	"	447'	425'-0"	56'-6"	36'-6"	D.W. 9173	1.11.42	27. 3.44	7. 9.44
4	4	RIVER MURCHISON	"	"	447'	425'-0"	56'-6"	36'-6"	D.W. 9104	1. 9.42	18. 9.44	8. 2.45
6	3	RIVER MURRUMBIGEE	"	"	447'	425'-0"	56'-6"	36'-6"	D.W. 9139	12. 1.44	27. 2.45	10. 7.45
7	1	RIVER MURRAY	"	"	447'	425'-0"	56'-6"	36'-6"	D.W. 9236	1.10.44	23. 8.45	15.11.45
14	2	DELAMERE	S.S. Steam-Ship	"	290'-9"	270'-0"	46'-0"	21'-6"	D.W. 3046	1. 6.45	2. 3.46	15. 5.46

...2/.

SHIPS BUILT AT WHYALLA SHIPBUILDING AND ENGINEERING WORKS (CONTD)

Ship No:	Berth No:	Name:	Type:	Owner:	DIMENSIONS Length O/A	Length B/P	Beam:	Depth:	D.W. Tonnage	Keel Laid:	Launched:	Completed:
15	3	DANDENONG	S.S. Steamship	M. of M. A.S.B.	290'-9"	270'-0"	46'-0"	21'-6"	D.W. 2995	1. 6.45	15. 4.46	20. 9.46
16	1	DAYLESFORD	"	"	290'-9"	270'-0"	46'-0"	21'-6"	D.W. 2983	1. 9.45	27. 7.46	18.12.46
10	2	BARRIGUN	Single Screw Shelter Deck	"	405'-2"	380'-0"	53'-0"	33'-0"	D.W. 6315.70	1. 4.46	19. 4.47	24. 7.47
11	1	BALARR	"	"	405-2"	380'-0"	53'-0"	33'-0"	D.W. 6250	1. 9.46	24. 5.48	30.11.48
12	2	BALOOK	"	"	405'-2"	380'-0"	53'-0"	33'-0"	D.W. 6250	1.10.47	20.12.49	28. 4.50
13	1	BAROOTA	"	A.S.B.	405'-2"	380'-0"	53'-0"	33'-0"	D.W. 6220	1. 8.48	7. 5.51	1. 2.52
17	4	IRON YAMPI	"	B.H.P.	525'-0"	495'-0"	66'-0"	41'-3"	D.W. 12590	30.11.45	1. 9.47	11. 6.48
18	3	IRON KIMBERLEY	"	"	525'-0"	495'-0"	66'-0"	41'-3"	D.W. 12540	4. 9.46	4. 4.49	29. 9.49
19	3	IRON DERBY	"	"	525'-0"	495'-0"	66'-0"	41'-3"	D.W. 12420	3.10.49	11. 9.50	17. 4.51
23	3	IRON WYNDHAM	"	"	525'-0"	495'-0"	66'-0"	41'-3"	D.W. 12460	18.11.50	24. 4.52	27. 2.53

...3/.

SHIPS BUILT AT WHYALLA SHIPBUILDING AND ENGINEERING WORKS (CONTD)

Ship No:	Berth No:	Name:	Type:	Owner:	DIMENSIONS Length O/A	Length B/P	Beam:	Depth:	D.W. Tonnage	Keel Laid:	Launched:	Completed:
21	1	IRON WHYALLA	Single Screw Shelter Deck	B.H.P.	498'-0"	475'-0"	62'-0"	38'-6"	D.W. 10607	15. 3.51	31. 3.53	8. 6.54
22	3	IRON SPENCER	"	"	498'-0"	475'-0"	62'-0"	38'-6"	D.W. 10626	June 1952	23. 5.56	26. 2.57
23	3	IRON FLINDERS	Single Screw Ore Carrier	"	580'-8"	550'-0"	70'-0"	39'-6"	D.W. 19000	October 1957	29. 1.59	13. 8.59
24	1	IRON DAMPIER	"	"	580'-8"	550'-0"	70'-0"	39'-6"	D.W. 19000	September 1959	22.10.60	14. 6.61
27	1	YANDERRA	Single Screw R.Q.D.	A.S.B.	330'-0"	310'-0"	48'-0"	29'-6" to R.Q.D. 24'-0" to U.D.	D.W. 4668	April 1953	23. 1.54	2.12.54
28	2	YARRUNGA	"	"	330'-0"	310'-0"	48'-0"	"	D.W. 4688	February 1953	2.10.54	5. 5.55
29	1	LAKE EYRE	"	"	459'-3"	435'-0"	58'-6"	39'-0" to R.Q.D. 34'-0" to U.D.	D.W. 10280	23. 2.54	8. 10.55	14. 6.56
30	1	LAKE TORRENS	"	"	459'-3"	435'-0"	58'-6"	34'-0" to U.D.	D.W. 10437	October 1955	19. 3.57	26. 9.57
31	3	LAKE ILLAWARRA	"	"	459'-3"	435'-0"	58'-6"	"	D.W. 10383	June 1956	28. 9.57	28. 3.58

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SHIPS BUILT AT WHYALLA SHIPBUILDING AND ENGINEERING WORKS (CONTD)

Ship No:	Berth No:	Name:	Type:	Owner:	DIMENSIONS Length O/A	Length B/P	Beam:	Depth:	D.W. Tonnage	Keel Laid:	Launched:	Completed:
32	1	LAKE MACQUARIE	Single Screw R.Q.D.	A.S.B.	467'-6"	440'-0"	57'-0"	34'-0"	D.W. 10354	March 1957	9. 4.58	24. 9.58
33	1	MOUNT KEIRA	Single Screw Ore Carrier	"	512'-9"	485'-0"	64'-0"	35'-6"	D.W. 14000	May 1958	4. 8.59	25. 5.60
34	3	MOUNT KEMBLA	"	"	512'-9"	485'-0"	64'-0"	35'-6"	D.W. 13700	Dec. 1958	29. 3.60	29.11.60
35	4	P.J. ADAMS	Single Screw Tanker	Ampol	665'-2½"	630'-0"	87'-0"	46'-0"	D.W. 32250	26. 4.60	10. 1.62	29.10.62
36	3	WOLLONGONG	Single Screw Bulk Carrier	Bulkships Limited	539'-2¼"	510'-0"	66'-6"	39'-0"	D.W. 16520	August 1960	27. 6.61	3. 5.62
37	3	MITTAGONG	"	"	539'-2¼"	510'-0"	66'-6"	39'-0"	D.W. 16500	August 1961	3.11.62	9. 4.63
38	4	MUSGRAVE RANGE	"	A.N.L.	582'-0½"	550'-8½"	74'-0"	43'-0"	D.W. 21165	28. 2.62	9. 6.64	6.11.64
39	3	GERRINGONG	"	Bulkships Limited	582'-0½"	550'-8½"	74'-0"	43'-0"	D.W. 21260	2.12.63	19. 1.65	18. 6.65
43	3	SEAWAY QUEEN	Twin Screw Ferry	Union S.S. Co. of N.S.	370'-8½"	354'-0"	52'-0"	29'-6" to shelter d	D.W. 3155	31.12.62	19.11.63	29. 5.64

...5/.

SHIPS BUILT AT WHYALLA SHIPBUILDING AND ENGINEERING WORKS (CONTD)

Ship No:	Berth No:	Name:	Type:	Owner	DIMENSIONS Length O/A	Length B/P	Beam:	Depth:	D.W. Tonnage	Keel Laid:	Launched:	Completed:
41	2	SEAWAY KING	Twin Screw Ferry	Union S.S.Co. of N.Z.	370'-8½"	354'-0"	52'-0"	29'-6" to shelter dk.	D.W. 3155	5. 3.63	16. 1.64	10. 8.64
42	4	DARLING RIVER	Single Screw Bulk Carrier	A.N.L.	741'-7"	690'-0"	104'-0"	55'-9" to U.D.	D.W. 49000	12. 8.64	14.12.65	24. 7.66
43	4	BOGONG	"	Bulkships Limited	741'-7"	690'-0"	104'-0"	"	D.W. 55100	21.12.65	23. 8.66	
44	4	IRON HUNTER	"	B.H.P.	741'-7"	690'-0"	104'-0"	"				
45	4	YARRA RIVER	"	A.N.L.	741'6"	690'-0"	104!-0"	"	D.W. 55000			
46	3	CELLANA	Tanker	Shell Co.	560'-0"	530'-0"	80'-0"	42'-3"	D.W. 23632	1. 9.67	29. 4.68	19. 8.68
47		OCEAN DIGGER	Semi-submersible Drilling Barge	O.D.E.C.O. (Aust) Ltd.	375'-0"		300'-0"	80'-100'				