COMMERCIAL DOCKING

THE SINGAPORE STORY

BY

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In the current climate 'privatization' or 'going commercial' seem to be at the top of the list when any discussion occurs on the future. In January 1984 H.M.S. *Invincible* underwent commercial emergency docking in King George VI Dock, Sembawang Shipyard, Singapore, and indeed did it not once but twice. Perhaps the procedures used may be a foretaste of things to come; certainly it was 'different'.

Before and during these dockings the newly appointed Ministry Inspecting Officer (alias the MEO) discovered what was between the lines of the simple words in Fleet Engineering Orders on Commercial Dockings, 'The MEO of a ship being docked is to check proposed arrangements against those of the Docking Plan ...' and by the end had learned how such a docking could be set up, how the work package could be controlled, and some of the inherent advantages and disadvantages of going commercial.

Background

During H.M.S. *Invincible*'s deployment to the Far East as a unit of Orient Express, the port shaft radial displacement at high shaft speeds became excessive. Poker gauge readings were taken by the ship's diving team and, although the readings were not consistent, the worst of them showed that the port intermediate 'A' bracket bearing was worn to its limit, that both port and starboard stern bearings were worn enough to merit renewal, but that the main 'A' bracket bearings were not worn appreciably. This last was eventually shown to be a misleading indication but that is not really part of the 'docking' story.

The engineering problem of *Invincible*'s 'vibrating', 'thumping' or 'bumping' shaft/propeller became front page news in the national press of several nations and was given increased prominence by the decision of the Australian government not to allow the ship to dock in Garden Island, Sydney. As a result of the real, as opposed to the imaginary, problems encountered it was decided that the ship should dock in King George VI Dock, Sembawang Shipyard for emergency repairs.

Preliminary Negotiations

The Marine Engineer Officer, H.M.S. *Invincible* (Commander B. P. Toft, Royal Navy), the Fleet Naval Constructor Officer 2 (Constructor-Commander R. K. Pudduck, O.B.E., R.C.N.C.), and a representative of the Chief Executive Royal Dockyards (Mr. K. Patterson) flew to Singapore to check the feasibility of the work, discuss the technical details, and negotiate a work specification and contract, in advance of the ship's arrival.

Permission was obtained by signal from MODUK to disclose necessary classified information, up to Confidential, to the Shipyard in the course of negotiations and before any intention to commit to contract. This was necessary as the Shipyard had no security clearance until clause 22 of the

Standard Conditions of Contract could be invoked. Information was only passed in the presence of one of the MOD negotiating team.

Normally H.M.S. *Invincible* is docked in the home Royal Dockyards in a dock with a suitable pit for the sonar dome. At this time the King George VI (KG VI) Dock did not have a sonar dome pit and although two small ones had been put into the granite block floor at some time between 1947 and 1960 (Shipyard archives make fascinating, if incomplete, reading) they had both been filled in with reinforced concrete.

There were therefore three options for docking the ship.

The first option was to remove the dome, by a fleet diving team from U.K. and to dock the ship on normal height (1·5 m) blocks. The dome would then have to be replaced by the diving team, after docking, with the attendant risk of it not sealing properly and consequential damage occurring.

The second was to dock the ship on high (2·4 m) blocks. However, inspection of the block arrangement under the merchant ship then in KG VI Dock showed the blocks to be built up completely of baulks of local hardwood and, even though the lowest baulk could be tied to the dock floor eyebolts, this arrangement did not inspire confidence in their safety at this increased height. In addition it was doubtful if the dock could be prepared in the time available because of the non-availability of enough suitable material. It was noted that the concrete-based blocks used in the Premier Dock (the large tanker dock) and the steel-based ones used in the large floating President Dock would give more scope for docking safely on high blocks in the other docks if they had been otherwise suitable. Also it was interesting to note that the supertankers using the Premier Dock tended to go in with a draught of less than 6 m, and thus not all 'large' docks are suitable for warships.

The third option involved the shipyard excavating a sonar pit, which eventually measured 9·14 m long, 3·66 m wide, and 0·91 m deep, and then docking the ship on normal height (1·5 m) blocks.

The dockyard completed their docking feasibility and estimating stage in two days (a Saturday and a Sunday!) and on the third day of talks the team were all into nitty-gritty engineering and finance.

Considerations of the cost and risk of each option resulted in the third option being chosen and proved that anything was possible if you were prepared to pay for it. Detailed positioning of the blocks was discussed with the shipyard who were reluctant to use as many blocks as shown in the Docking Plan, preferring instead to work to a safe value of maximum loading to reduce materials required and hence cost. This approach necessitated the ship's longitudal weight distribution having to be signalled from U.K. and an interesting forenoon for FNCO and MEO as they checked the actual block loadings on each of the proposed reduced number of blocks.

The actual material and construction of the blocks was also discussed in detail and a local hardwood, balau, was specified for both blocks and capping since the materials normal for British dockyards, oak and elm were not available. FNCO spent many happy hours designing safe piles of wood to prevent crippling and tripping.

The shipyard was helpful about security. In discussion the MEO arranged that access to the dock would be restricted to those with passes (ship to provide) and that the ship would provide a sentry. This arrangement worked well. It was arranged that the ship's company would gain access to the yard using their identity cards, and other visitors would use Fleet Form 3. After initial problems this also worked well and the security staff of the main gate were polite but firm.

Safety matters were discussed between the Shipyard Chief Safety Officer and the ship's MEO. The yard rules were laid down in a document which

eventually had to be signed and adhered to by the ship. Obviously not all the rules were applicable to warships and this early discussion allowed those items that were applicable to be included in the Ship's Docking Memorandum so that the ship's company were well aware of the requirements in advance.

Availability of Services

It was hoped, and eventually arranged, that the ship's company would be able to live onboard in near normal conditions during the docking. Therefore the availability of services was investigated to see if this would be possible.

The following services were available:

(*a*) *Dockside Firemain* (7 bar). There is a good number of hydrants but in practice the pressure fell off alarmingly if there was too much offtake for auxiliary cooling.

(*b*) *Back-up Diesel Pump*. Capacity 1500 tonne/hour. It is really a cargo ballast/deballast pump but could be used on the firemain and provided 8 bar against a shut discharge at the dockside.

(*c*) *Flooding Main*. A template for flooding bonnet connections was provided to the shipyard to allow hoses to be made up for the dock flooding main which was not often used except when passenger liners were docked. (The relics of the Raj are occasionally very useful.)

(*d*) *Electrical Power*. 440/60Hz/3phase; maximum power available 2500KVA supplied from 5×500KVA junction boxes. This was not regarded as being sufficient and the docking plan therefore had to allow for the constant running of at least one ship's generator. (It is believed that a further 750KVA could have been made available, although this would have been with great difficulty.)

(*e*) *Steam*. Various capacities of auxiliary, mobile boilers are available to provide steam at 7 bar.

(*f*) *LP Air*. Wet LP Air can be provided from a main at a nominal 7 bar (but it was later found that the pressure stated was optimistic and the supply not reliable).

(*g*) *Brows*. Safe brows of several lengths were available.

(*h*) *Sewage*. There is no dock sewage main. The effluent from the ship's sewage treatment plants was discharged by hose into the dock gutters and a constant flow of water was provided to wash through. When the ship's air conditioning plants were started and discharged cooling water into the dock on the starboard side there was no need for such a special wash-down water flow as it happened automatically.

(*i*) *Cranes*. 2×30 tonne and 2×6 tonne cranes were at the dockside.

(*j*) *Garbage Disposal*. Skips were provided and emptied as required, but frequent reminders to the shipyard were necessary to maintain a satisfactory service. Plastic bags were provided for containing the rubbish.

(*k*) *Car Parking*. A limited number of spaces were provided. Initially these were not where they could be viewed from the gangway but this was soon changed.

(*l*) *Telephones*. Shipyard exchange telephones were provided. One extension was nominated for international calls which were connected by the shipyard exchange operator. Since this was the Captain's line, control of this on board was easy.

Feasibility of the Engineering

The construction of the stern bearings and the method of changing them was discussed with the shipyard. Photocopies of the relevant drawings and Books of Reference were provided to assist an assessment of the work package and time required, and hence a cost estimate.

A brief inspection of the shipyard factories showed there would be no problem with the availability of suitable boring machines or the casting of certain replacement items if required. The availability of the foundry was later to be found a crucial factor in the success of the dock work.

Contract Negotiations

Contract negotiations covered three main aspects:

(*a*) The work specification including specification of method of docking, the exact services provided, the engineering package, and the role of the ship's Marine Engineer Officer as Ministry Inspecting Officer.

(*b*) The applicability of the standard conditions of contract (Form GC/Stores/1).

(*c*) Agreed methods of costing and prices for the work and services.

This latter aspect took most of three days, and involved extensive bargaining because of the initially high quotations (particularly for services) and detailed explanations by both sides of their cases. The shipyard was only prepared to quote fixed and firm prices and tariff rates. The possibility of a cost plus contract was discarded early and this meant that an approval system for work arising had to be agreed.

It was agreed that work arising, not covered in the contract, could only be authorized by the MEO as Ministry Inspecting Officer. It also meant that a cost certificate was required for each item and standard forms for these were to be provided with the contract.

Extra work not relevant to this contract would of course have had to be covered by the provisions of Fleet Engineering Orders, or other methods of funding.

Dock Preparations and Inspection

When the sonar pit and dock block positioning had been completed the shipyard asked CINCFLEET (FNCO2) through RNLO Singapore, to confirm the acceptability of the arrangements.

From this signal the MEO and MEO(Hull) in *Invincible* were able to check the block and pit positions against the docking plan by plotting them on a microfiche printout. MEO(Hull), Lieutenant W. R. J. Nelson, was flown ahead of the ship on 3 January to check the dock arrangements and the firemain, firemain back-up, and flooding main systems; the assurance provided by this advance visit made it well worth the effort.

FNCO2 also flew to Singapore to conduct a pre-docking inspection and Mr. J. Bovingdon (PTO III(M) from Portsmouth Dockyard) arrived, initially to check the stores provided and then to provide expert engineering advice when required. The advance identification of stores before the ships arrival contributed greatly to the smooth passage of the project.

Meanwhile an *Invincible* Temporary Memorandum was produced on board detailing the ship's preparations for the docking. Sembawang Shipyard and probably all commercial yards epitomize the principle that 'time is money' and therefore detailed planning had to ensure that the ship could go safely straight into dock and allow the dock to be pumped out with the minimum of delay.

An important part of these preparations was the appointment of DOCKFLO (The Dock Facilities Liaison Officer), in real life OPS2, who soon proved to be invaluable on matters from co-ordination of bids for cranes to ensuring that the shipyard provided enough sullage skips. He liaised with the shipyard on all safety and security matters and took the non-technical workload from the MEO.

It is worth noting here that one of DOCKFLO's major tasks stemmed from the realities of a commercial docking where all services cost a great deal of money. The use of a dockside crane for ship's company, as distinct from shipyard, business was charged at a tariff rate per hour hence jobs had to be co-ordinated to minimize crane hire time. Conversely when a service (say LP air) failed this was noted and the final bill did not charge for the time out of action.

Docking Down and Dock Services

Having flown off 5 Sea Harriers and 4 Sea Kings to Singapore Air Force bases, to enable continuation flying, the ship proceeded to Sembawang where she was assisted to the dock mouth by 4 tugs. In the mouth two ship's hawsers were connected to the dock mules and the ship was drawn smoothly and safely into the dock. Although the cross wind did appear to those on the bridge to be setting the bow on to the port dock entrance knuckle on several occasions, the Dockmaster and waiting officers later confirmed that they thought the procedure had been entirely safe. From arrival at the dock mouth to being secured approximately in the correct position inside the dock took 45 minutes and very few men.

The dock was then pumped out until the keel was 2 m above the blocks and services were connected. Initially these consisted of:

(*a*) 7 out of 8 HPSW hoses.

(*b*) 5 electrical shore supplies (but two had earths!)

(*c*) Fresh water.

(*d*) Shore steam (but the boiler had to be replaced during the evening).

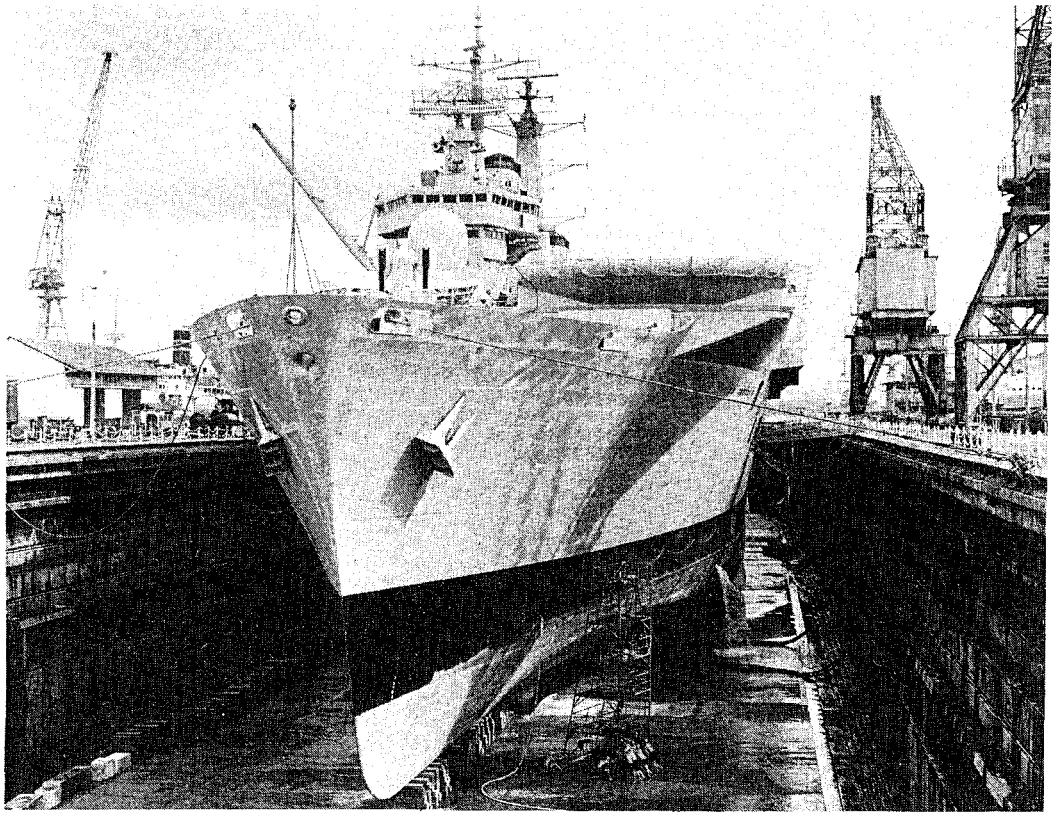
(*e*) LP air line. Initially a constant source of worry trying to get the shipyard to keep the pressure up to allow a ship's diesel generator fluidic watchkeeping panel to operate correctly.

(*f*) 2 brows out of 3.

While this was happening the Start Conference took place onboard, 'Carrier Air Group' and 'Return' stores were landed, and the ship's staff continued docking preparations and fitted discharge hoses. To save time these were limited to the outfalls that were close to the working area and other necessary ones such as from sewage treatment plants, galley, and laundry. The limited number of hoses was satisfactory only because of the tolerance of the workforce (it had been discussed and agreed with the shipyard during the initial negotiations) and the fact that no ship's bottom painting was planned.

At 0800 on 10 January the ship was accurately positioned relative to the pit and blocks; this was checked by divers and pumping out was restarted. After a further diver's check the ship sued at 1000 and the dock was dry at 1200. During this time MEO(Hull) was ashore with the Dockmaster and communications were maintained between the Dockmaster and MEO, positioned on the flight deck, using shipyard two-way radios. Unofficial trials later showed that these radios were capable of consistent communication with shore from anywhere inside the ship that was above the waterline.

The shipyard immediately started to try to fit flooding bonnets but in spite of their best efforts the bonnet weight and inconvenient hook bolt



H.M.S. 'INVINCIBLE' IN KING GEORGE VI DOCK, SEMBAWANG SHIPYARD

fixing arrangements meant that air conditioning plants could not be started until 2000. One ship's HPSW pump was also started because, with a diesel generator running on IPSW (reduced HPSW) cooling, the firemain pressure from the dockside hoses alone was only $3\frac{1}{2}$ bar.

For the majority of the time in dock the ship continued to run one HPSW pump to supplement the dockside pressure and one generator to allow 3 air conditioning plants to be run. During the first few days this generator required a watchkeeper because of the unreliable LP air supply pressure but this later improved.

After one particularly heavy rainstorm all the shipyard electrical supplies developed earths and the ship reverted to running two generators and two HPSW pumps (to allow for the extra cooling load) until the problem was overcome. Once the initial boiler problems were solved the steam supply was reliable, perhaps due in part to its theoretical capacity being about $1\frac{1}{2}$ times the maximum requirement.

Engineering Work

As soon as the dock was pumped dry the mud was washed from the dock bottom and staging erected. This latter was very quickly put up, in part due to the comparative non-rigidity of the resulting structure, in part due to the fact that all planks and ladders were securely fixed by pre-cut and pre-formed lengths of wire, but mainly because the moment the materials were required they 'appeared' in the dock bottom. This good planning of material supply was a feature of all the shipyard's work.

During the first 18 hours after the dock was dry the fast progress gave a foretaste of how the job was going to be tackled.

(*a*) 4 docking bonnets were attached.

(*b*) The necessary staging was completed.

(*c*) A complete set of poker gauge readings were taken in conjunction with ship's staff. An endoscope examination of the stern and intermediate 'A' bracket bearings was tried before dismantling but did not really add to later findings.

(*d*) All 4 bearing fairings and eddy plates were removed (here Mr. Bovingdon's expertise definitely saved time).

(*e*) Pressure load tests of both stern gland bearings and intermediate bearings were taken.

(*f*) The upper halves of both intermediate 'A' bracket bearings were removed.

The intermediate bearing liners were covered over a large percentage of their area by a scale that was proved later to be cathodic chalk. Both stern seal liners were less affected but samples were taken and collected into envelopes which were sealed and then despatched to CSO(E) Portsmouth.

Three of the bearings (starboard intermediate and both stern glands) were only part worn; the pattern of wear appeared normal from the ovality checks and, after cleaning, the shaft liners were smooth and almost in an as-new condition. However the port intermediate showed that both bearing pads in the lower housing (bottom and inboard) were worn flush with the bearing housing. Where the retaining rings had touched the liner a groove approximately 3 mm deep had been worn in the liner just beyond each end of the load bearing surface. The retaining rings had been deformed to such an extent that the ring at one end had to be machined out to remove the old pads. A new retaining ring was cast, machined and fitted in the bearing housing in 3 days, all work being done in the shipyard.

The bearing housings, once removed to the dock floor, were quickly transported to Machine Shop No. 2 where they were cleaned and checked for ovality. They were moved to the joiners shop for removal of the old pads and for the new to be fitted, with the correct end gap, and then back to the machine shop to be set up on horizontal boring machines and bored out. Two machines were used, the setting up was meticulous and the machining accurate as was later proved on the second docking. The yard had been told that the pad material contained asbestos, at the preliminary negotiation stage, and there was never any problem about this. The pad waste was collected and put into bags but the machine operators did not take any special precautions in spite of the material.

Replacing the bearing housings was in general very quickly completed using a fork lift truck to offer up each half and the welded eyebolts for slinging. Insertion of tallow was done after the bearing halves were lifted on to the shaft but because of the temperature this made turning in the bottom half a messy operation as the tallow tended to try to flow out of the large retaining cavities. 'Never-Seez' was used between the pads and liners to allow easy insertion and to help prevent subsequent scaling. After the housing nuts had been hardened up and locked with split pins, feeler gauge readings were taken of the clearances.

Both port and starboard coupling fairings, aft of the intermediate 'A' brackets were damaged. The condition of the one on the port side was well known from diving inspections and a spare fairing had been flown from U.K. and was fitted. The starboard fairing was also cracked and had several bolts missing. These were replaced and the fairing repaired in position. The

quantity of 'Epophen' putty sent from U.K., when added to the ship's stores, was insufficient to complete the fairing so this was completed using putty supplied from commercial sources.

Both stern seals were withdrawn so that modified seals could be fitted. This modification was designed to allow a greater bearing wear to occur before metal contact could take place. In both cases the condition of the face and inflatable seals were perfect and so they were left on the shaft while the new ones were vulcanized, in case the vulcanization was not successful, and in the end several attempts were required before a successful air pressure test was achieved. No problems with the seals were found on sea trials.

The new retaining ring for the modified seal necessitated modifying the cooling pipework to it and also drilling dowel holes and fitting dowels. These items were done speedily under the 'work arising' funding.

Contract Management

In spite of the efforts of the Preliminary Negotiating Team the official contract had not arrived by Take in Hand Date and so the Start Conference assumed great significance. In fact for the first week of work the shipyard worked, apparently happily, to the minutes of the Start Conference Meeting. This meeting set the pattern for all meetings, they were invariably held on board under the chairmanship of the MEO and minutes were always taken and distributed within 24 hours.

One of the shipyard safety rules is that there should always be an initial safety meeting and on this occasion it was combined with the Start Conference.

During the discussion on safety rules both MEO and DOCKFLO had to sign copies of the Shipyard Safety Rules on behalf of the ship and afterwards the Shipyard Safety Officer, in his capacity as an officer of the Shipyard Fire Brigade, was taken on a tour of the ship by NBCDO.

The timescale for the work was agreed and the tariff for services was noted. The engineering work package was stated and recorded and it was agreed that ship's staff dockwork (cleaning propellers, etc.) could be progressed provided it did not interfere with shipyard work.

It was agreed that a daily Safety and Progress Meeting would be held at 1000 each day with a standard agenda covering:

(*a*) Safety.

(*b*) Services.

(*c*) Review of work in past 24 hours.

(*d*) Future work.

This was a useful forum and the ship's Duty Lt.-Commander and Officer of the Day both attended for the first two items. Formal minutes were taken for each meeting.

Since the dock charges and engineering work were on a fixed price basis the only problem was deciding what was inside, and what was outside, the contract, particularly before the contract letter had arrived. Work arising was first discussed between the MEO and the Ship Repair Manager and, if it was both necessary and outside the terms of the original contract, a quotation was produced. Early on this was often challenged and a substantial reduction in price obtained but later, as relationships developed, the price was negotiated at a reasonable level before the quotation was submitted. The work was then authorized on a locally produced form and a running tote of the expenditure kept to ensure that the total cost of work arising was within the delegated financial approval of the MEO.

When a service provided failed to meet the contracted standard, for

instance when LP air pressure or steam pressure fell, agreement on the times involved was obtained at the daily meeting, a locally produced 'interruption to services' certificate was signed by both sides to record each failure and these were used to adjust the final cost of services.

The completion and acceptance conference took place on 20 January. It was agreed that the work package had been completed speedily and, subject to trials, successfully. The invoices were checked and signed by MEO as the Accepting Officer and the shipyard agreed to forward the top copy to RNLO Singapore for him to forward for payment.

Sea Trials—a Disappointment

Soon after sailing at 1000 on 23 January, and as soon as the shaft was rotated at above 30 r.p.m., an ominous knock was heard coming from the port intermediate 'A' bracket. At higher speeds the volume of the noise increased, the knock became a violent blow at shaft frequency and this increased up to 70 shaft r.p.m. at which speed it was obvious that damage would be done if allowed to continue. The shaft was locked and the ship proceeded to open water.

After the ship's diving team had checked there was nothing loose or visually wrong, a short sea trial was conducted to measure the effect of various shaft speeds and conditions. It was soon apparent that the noise increased markedly up to 70 shaft r.p.m. whether the shaft was driving or being trailed and it was therefore a function of rotational speed and not power.

Meanwhile DMEO (Lieutenant-Commander R. A. Hedley) used his newly acquired Singapore cassette tape recorder to good effect to record the noise at various speeds and later provided an audio demonstration to shipyard and MOD personnel using this recording.

The ship had signalled RNLO Singapore early to inform him of the problem and after he had informed the Shipyard the Dockmaster stopped preparing the dock for the next ship. This was a fortunate and vital decision, saving both time and money for dock preparations, and was in many ways remarkable as at the time the decision to return had not been made.

After the decision to return had been made MEO (Hull) was flown ashore to re-inspect the dock, on-board docking preparations were made and the ship re-entered KG VI dock at 1500 on 24 January.

The Second Docking

The actual docking down was to the same pattern as the first and demonstrated again the speed and accuracy, laced with proper caution, of a good commercial ship repair yard. The required dockside services were negotiated in the same manner as for the first docking except that two extra fire hoses were arranged to try to keep the firemain pressure up even with one ship's generator on. Although some improvement was made, the pressure was not satisfactory even with these extra hoses.

Since the previous contract had been completed a new contract was required; tariff rates for services were negotiated to be the same as on the first contract except that the charge for flooding main cooling was reduced because the hoses were already made up. The charge for dock preparation was only slightly more than one day's dock rent, which must have been a bargain and demonstrated the shipyard's good faith, and the work package and its estimate were built up over the first few days as its extent became clearer. The negotiations for the previous contract made the contractual process much easier than on the first occasion. The main part of the work was to renew the port main 'A' bracket bearing.

Renewing the pads in the port main 'A' bracket bearing was done as expertly and efficiently by the shipyard as their previous work and was only marred by the so called 'bearing pad kit' not containing enough pads.

The shipyard carefully removed the old pads so that the best ones could be used again in the forward part of the bearing, with the new ones aft where the maximum wear had occurred. Again a retaining ring distorted on removal and this time a new one was cast and machined in 30 hours. From starting to undo the bearing retaining nuts to re-securing them took less than 4 days.

In order to eliminate any suspicion of shipyard poor workmanship or any damage on the port intermediate 'A' bracket, this bearing was also withdrawn for examination. Not only was it undamaged but it was concentric to within 0·002 inch even after having been immersed. Removal of this bearing also allowed the shaft to be turned to provide a rough check for any permanent shaft set. Since the maximum run out at the intermediate 'A' bracket was found to be 0·027 inch, this was well within tolerance.

During this second docking the head of the MOD transmission group and one assistant arrived to help with shaft fault diagnosis and to give on-the-spot advice. By the time they had arrived the whole ship had dubbed them 'shafting experts' and were eagerly awaiting demonstrations of their expertise.

Unfortunately the combined work of the shipyard, the experts, and the ship's company was unavailing in curing the problem but this was no reflection on the docking or the standards of workmanship of the shipyard.

Sembawang Shipyard Work Practices

The work rate in this shipyard was remarkable to those used to normal DEDs in Royal Dockyards and several factors contributed to this.

The first is that there is only one Shipyard Union and many of the jobs were done by the nearest man or the one who happened to be on the spot. Anybody seemed to drive the fork lift truck, everybody helped with the slinging, and the workers tackled whatever job was required with gusto after it had been explained to them. It should be mentioned that the work was mainly done by a 'Tail End Gang' who specialize in shaft, propeller and rudder work.

On this point mention should be made of the guidance provided by Mr. Bovingdon from Portsmouth Dockyard who was often able to speed the process by knowing from experience what should be done and in what order. Also the ship's staff always had an Engineer Officer of the Day doing rounds of the dock and workshops to bowl out snags or provide information without any delay. These duty officers worked a 12 hour 'shift'.

The second point was about shipyard planning. It was noticeable that if scaffolding was required, it and the necessary crane were organized so that nobody had to wait, fork lift trucks were used to good effect in the dock bottom for lifting bearings and transporting heavy materials, and the right number of people always turned up at the start of their shift.

Apart from the major meal breaks little time was lost in a shift, even tea arrived in polythene bags, was consumed on the spot and cleaned up afterwards. Everything was organized to reduce time in hand.

Amongst all this speed, safety was still of great importance and rules were strictly adhered to. Whilst the ship was in dock no shipyard worker even approached the dock without a hard hat, no attempt to weld was made without a thorough gas free inspection and a fully briefed fire-watcher in attendance, and the workers were only allowed to use shipyard lifting devices.

It is interesting to note that the workers also held Japanese style 'circle' meetings at which fresh ideas for productivity, criticism of their own and other people's efforts, and of the management, were freely discussed.

Relationships with the Yard

During the time that the ship was in hand excellent rapport was built up between ship's staff and the shipyard at all levels. The management invited ship's officers to 'Sundowners' each Friday and the shipyard canteen was a favourite haunt of the ship's company. The shipyard made no objection to ship's staff work going on in the dock alongside their own, or to the many outfalls from the ship that were not hosed in the interest of speed of docking down. This spirit was manifest in everything from official meetings to the friendly football match that was arranged.

Conclusions

Many lessons were learned, or relearned, during this period in Singapore but those pertaining to the docking and dock work were:

(*a*) The contractual work was completed speedily and to a high standard of workmanship, but it was comparatively straightforward.

(*b*) Work such as casting and machining replacement parts was easily and quickly arranged and completed.

(*c*) The shipyard's facilities would be more than adequate to support the Mechanical and Hull items of a DED or Refit. It is believed that electrical expertise and facilities would also be adequate but sub-contractors would be necessary for all Weapons tasks. Also the yard tends to work to fulfil its contract in the quickest and most efficient way possible, thus any Defect List would have to be comprehensive and unambiguous. Work arising or extras could be very expensive.

(*d*) Round the clock supervision by ship's officers and the Portsmouth dockyard representative eased the work considerably.

(*e*) An advance negotiation team is necessary to check the facilities, the safety of the dock arrangements, explain the work package, and negotiate a price.

(*f*) Even having agreed dock block positions it is necessary for the actual positions to be checked immediately before docking.

(*g*) The ship's MEO can be a suitable Ministry Inspecting Officer.

(*h*) Formal daily Safety and Progress Meetings are necessary to ensure that the work continues smoothly.

(*i*) Proper ship co-ordination of ship services, e.g. cranes and fork lift trucks, is necessary to minimize cost. A DOCKFLO is essential.

Final Reflection

These dockings were not, of themselves, enjoyable experiences but many people, and not least the Ministry Inspecting Officer, learned a lot and as dockings they were very successful. Acknowledgement must be made of the help and friendship offered and gratefully received, during the work, from the shipyard staff, RNLO Singapore, the MOD 'Shafting Experts', from John Bovingdon of Portsmouth and from 'Remote Control' in CINCFLEET Technical Staff. During the dockings it was teamwork that mattered, but the team should take no blame for anything in this paper as all the stated views are entirely those of the author.
