VACUUM PUMPING SYSTEM

FOR SEWAGE AND GREYWATER REMOVAL

BY

LIEUTENANT M. A. FIELDSEND, BENG, RN
(HMS Sultan, formerly DMEO HMS Ariadne)

ABSTRACT

Several RN ships do not have the capability to store or treat their 'black' or 'grey' water, which precludes them from operating in areas with a strongly enforced pollution prevention policy. This article describes the setting to work, after initial design, of the Vacuum Pumping System as fitted to HMS *Ariadne* and HMS *Minerva*.

Introduction

Marine pollution has become a very sensitive issue. Since 31 December 1988 the Royal Navy has been obliged to conform with the regulations laid down in Marine Pollution paper number 73/78. The disposal of any garbage from a vessel is subject to these regulations, as far as practicable, despite the exemption given for compliance to warships and Royal Fleet Auxiliaries. In addition, national/local regulations may also apply in foreign territorial waters and the Royal Navy is expected to comply with those if operating there.

The regulations regarding discharge of sewage and greywater are also dictated by MARPOL 73/78, which does not give specific instructions regarding its disposal. This has not yet been ratified by the United Kingdom; a date of mid 1992 is the earliest present forecast. Again, regulations imposed by individual nations are to be adhered to by ships operating in their waters.

Now classed as a 'Special Area', the North Sea and English Channel are subject to the regulations of MARPOL 73/78 with respect to waste. Rules for sewage and greywater discharge have yet to be changed in UK home waters but it is expected that this change may not be far off.

Birth of the Vacuum Pumping System

The Dartmouth Training Squadron (DTS) was programmed to visit Baltic ports for its 1991 Summer Deployment; the severity and strictness of the regulations with regard to sewage and greywater discharge in those areas highlighted the need for action. The squadron comprised HMS *Ariadne*, *Minerva* and *Bristol*, the latter alone being capable of holding her sewage and greywater for limited periods in her three separate holding tanks. With newer and stricter regulations being enforced by the prospective host nations, a very real need arose for immediate tasking to design a system whereby the frigates could participate in the programmed visits without infringing those territorial regulations.

C-in-C Fleet's Hull group was given this formidable project and tasked with designing such a system. Upon return to the UK from her DTS Spring Deployment (21 March 1991), *Ariadne* took the lead for the squadron by working alongside the group to procure and set to work the designed system.

During her period in base port and throughout the first half of the DTS deployment, *Ariadne* continued to modify, trial and test the Vacuum Pumping System (VPS), providing feedback and liaison with *Minerva* and the Hull group, in order to establish a workable system for the future.

By the end of May enough experience had been gained to produce comprehensive feedback on the VPS, and to claim that a workable system had been proved. A video was produced for training purposes.

Initial Design

The VPS comprises 3 inch inside diameter flexible opaque plastic hoses which are linked together in series via elbow, T-piece and Bower Coupling female end fittings. The three types of galvanized mild steel fittings have different sized inlets and common 3 inch outside diameter outlets, allowing insertion into the plastic hose. The inlet sizes vary from 1¾ inches to 3 inches to accommodate the different types of greywater/sewage ship's side outlet.

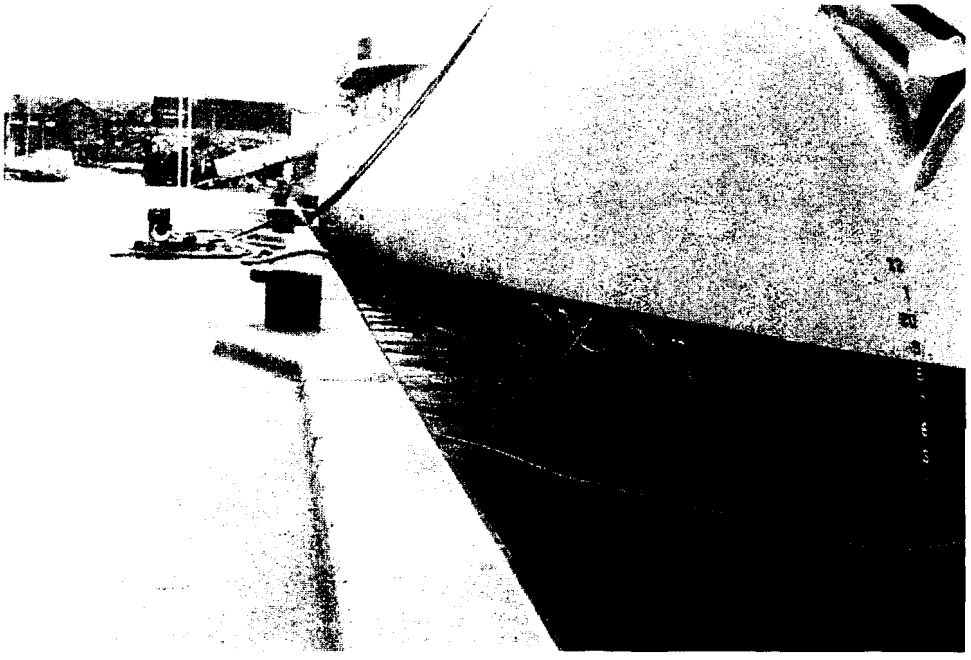

FIG. 1—FORWARD OUTLETS LINKED TOGETHER. THE FORWARD PUMP AND MANIFOLD CAN BE SEEN ON THE JETTY

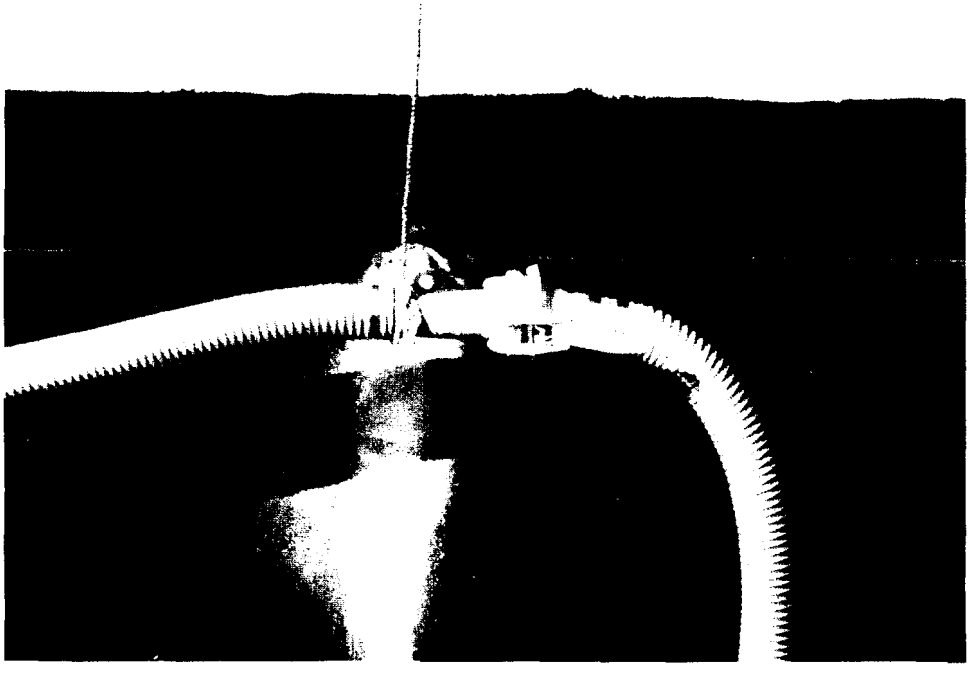

FIG. 2—BOWER CONNECTION PIECE

Groups of two, three, four and five outlets were linked together (FIG. 1), culminating in the Bower connection piece (FIG. 2) which linked that group via single lengths of 3 inch hose to a suction manifold situated on the jetty or on a barge alongside.

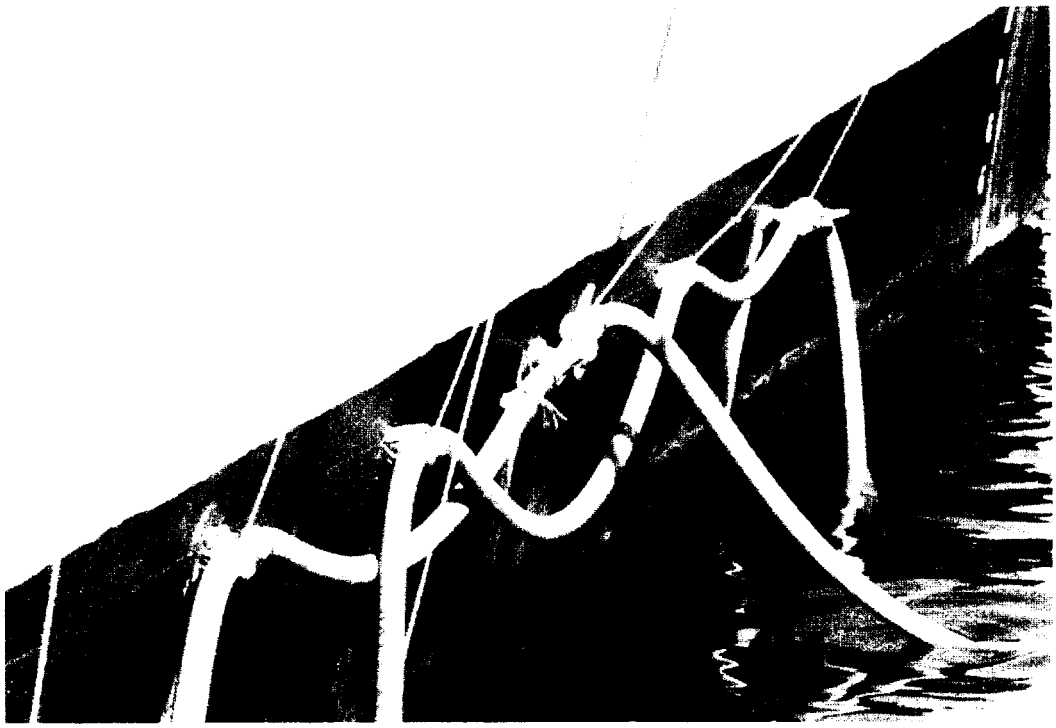

FIG. 3—FITTINGS ARE SECURED IN PLACE WITH SOFTWOOD DC WEDGES

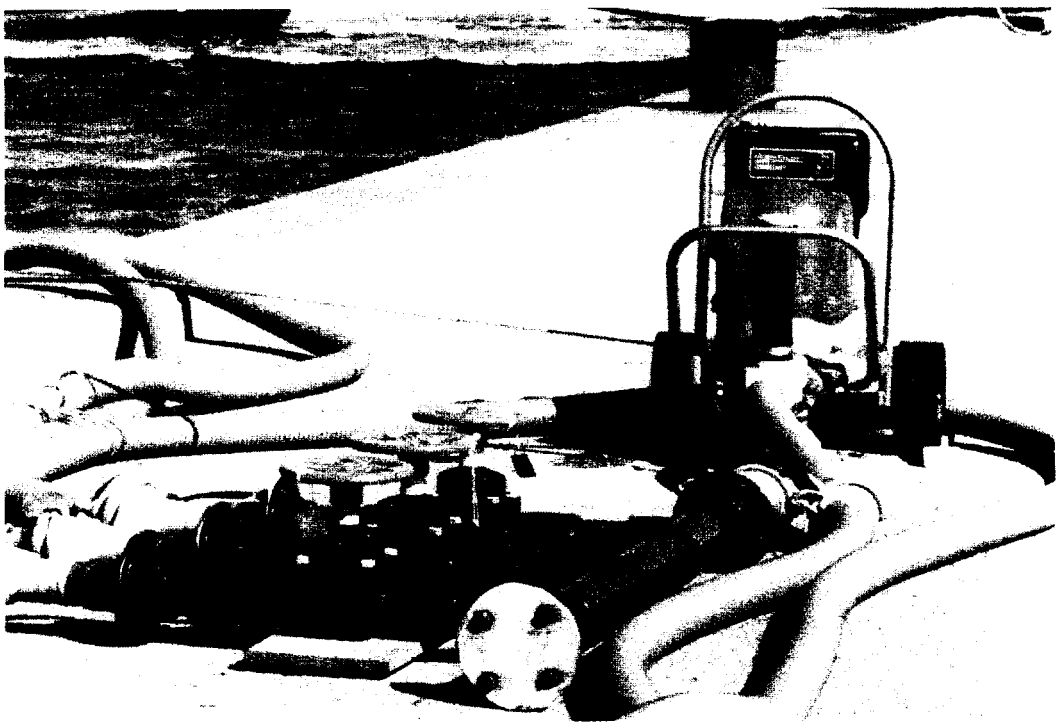

FIG. 4—THE FORWARD MANIFOLD AND PUMP

Sewage and greywater outlets were kept totally separate to avoid the possible back pressuring of greywater with sewage, should the system fail. The ship's side fittings were secured in place using softwood damage control wedges which had been split to form 'firewood' sized pieces (FIG. 3).

The system employed by *Ariadne* required 26 outlets to be fitted. The eight sewage outlets formed three separate groups, while the eighteen greywater outlets formed another four separate groups. Since the mixing of sewage and greywater was discovered to be possible at the bowser, the ship's forward services (two grey, one sewage) were connected to a manifold and pump placed on the jetty in line with the bow (FIG. 4).

The ship's aft services, comprising the remaining four groups, were split to utilize the two remaining pumps, with one taking suction solely from the all-important galley and laundry services. The other groups, two sewage and one greywater, were connected to a manifold and pump placed on the jetty in line with the stern.

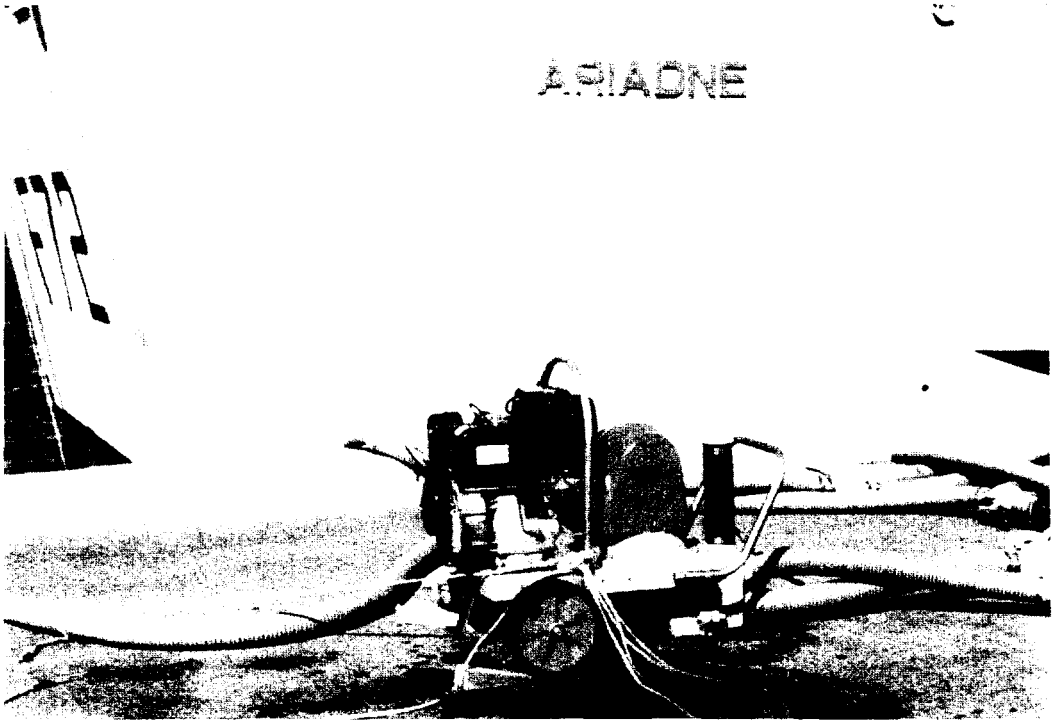

FIG. 5—ANOTHER VIEW OF ONE OF THE PUMPS

The pumps used were two-man-portable diesel-driven, carrying the brand name of 'Wizard' (FIG. 5). Both frigates carried three pumps for the duration of the Baltic deployment, allowing a spare if the configuration allowed in that particular port. The pumps have single cylinder action driving to a pair of reciprocating arms acting on a neoprene rubber diaphragm. The pumps were therefore able to provide constant suction with maximum head of 20 ft; they did not require to be primed, and were also capable of discharging to a maximum delivery head of 20 ft. Three spare rubber diaphragms were provided with the pumps. Lub oil and other spares were ordered via Naval Stores.

Enough flexible hose was carried on board to allow a considerable distance between the pumps and the discharge collection point, thus catering for berthing situations which required extended hose runs (FIG. 6). With the system configuration described above, a single discharge hose was used from pump to bowser, the latter being placed aft on the jetty in line with the ship's stern. This reduced the clutter of pipework running along the jetty in front of the ship.

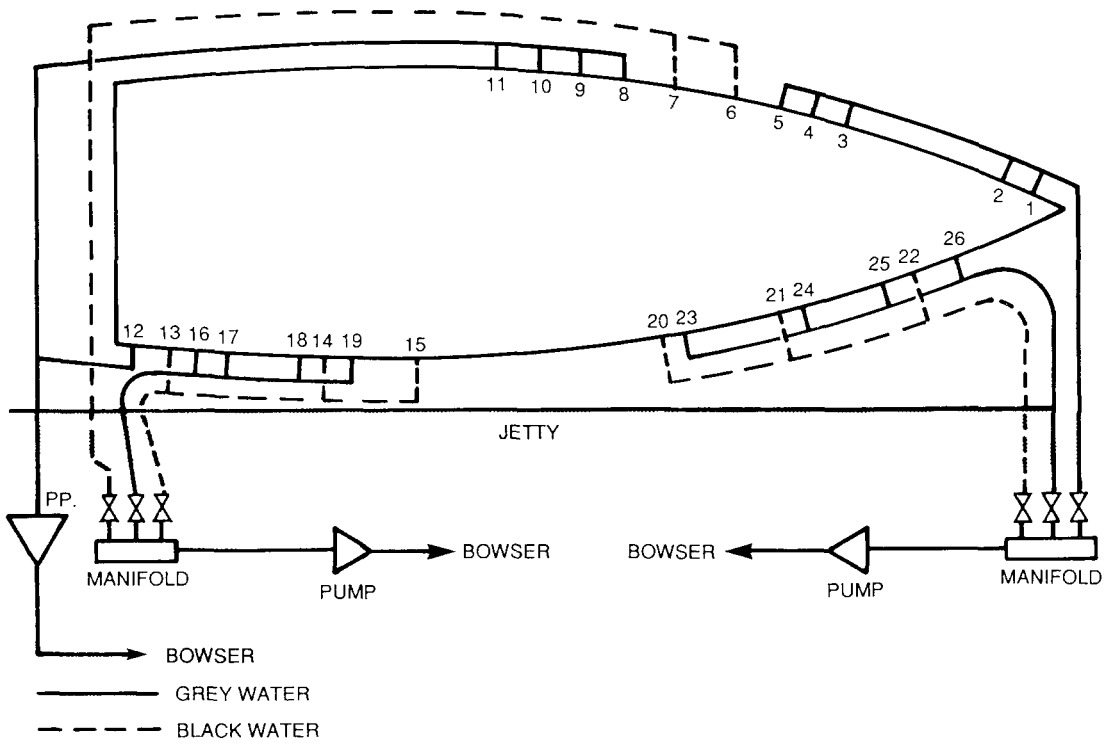

FIG. 6—PIPEWORK AND MANIFOLD LAYOUT FOR LEANDER CLASS

1. Fwd JR bathroom scupper
2. Fwd JR bathroom scupper
3. officers' cabin drains
4. wardroom galley
5. officers' bathroom
6. 1H CPO's heads
7. wardroom heads
8. main galley
9. galley GDU drain
10. sink drain/potato peeler
11. scullery drain/pot wash
12. laundry
13. JR heads
14. SR heads
15. sickbay heads
16. JR bathroom scupper
17. JR bathroom scupper
18. SR heads scupper
19. SR bathroom scupper
20. Captain's heads
21. JR heads
22. SR heads
23. Captain's bathroom scupper
24. SR/JR heads scupper
25. SR bathroom scupper
26. JR bathroom scupper

(abbreviations as in TABLE I)

The Preparation, Fitting and Use of the VPS

Preparations

In the LEANDER Class, the positioning of the ship's side outlets necessitated berthing starboard side to, allowing access to the port fittings which were all midships. The starboard side fittings were either all forward or aft, remaining easily accessible via Gemini or paint punt due to the inward flare of the bow and stern.

One hour before berthing the pumps and rolls of pipework were laid out on the flightdeck, and the manifolds were retrieved from their stowage. All sewage and greywater pipe groups were laid out along the upper deck in the appropriate position ready to be lowered over the side once the ship had berthed. This was

hardly noticeable from the jetty and did not counteract the aesthetics of the ship's berthing evolution. A check was made at this point to ensure that the stabilizing ropes were secured every three or four metres. At the appropriate time before entry to harbour all heads, bathrooms, galley sinks, garbage disposal units (GDUs), potwashes and the laundry were put out of bounds.

Fitting

Immediately after berthing, the team of 12 moved the connecting pipework lengths and suction manifolds on to the jetty. The crane that positioned the gangway was used to place the pumps on the jetty. (When using the narrow ship-to-ship brow, the crane was the only solution other than manhandling the pumps using Damage Control timber to form a cradle, or using the swimmer of the watch gantry.) The Gemini was lowered, and the driver and worker moved around to beneath the starboard bow laden with the small firewood-sized softwood wedge pieces and a hammer. The fireground 'Green Bean' was found to be an ideal clothing item for this task (Multifab too hot). Magnets were also carried to control the position of the Gemini as the team moved up and down the ship's side.

Working forward from the captain's heads, the forward system was fitted first. It was essential to keep at least one man on the ship's upper deck above the boat as it moved along, ensuring that the stabilizing ropes could be loosened or tightened accordingly as the connections were secured by the boat's crew. When the Bower connection had been fitted (usually the last one in each group), the boat's crew took the male end of the connecting hose from the team on the jetty and manoeuvred themselves into position to lock the coupling adjacent to the ship's side. Stabilizing ropes were then attached as required to the ship and/or jetty, ensuring that all pipework remained afloat even when full of fluid.

The boat's crew then moved to the starboard forward greywater system whilst the jetty team connected up the manifold, pump and discharge line to the bowser. Provided that the bowsers ordered were present on arrival, the single system connected, in this case the forward senior rates', junior rates' and captain's heads, was put into use and opened up.

The process of securing the ship's side outlets with the small softwood wedges was repeated. The pipework was connected up and each system put on line. TABLE I shows the fitting order used in *Ariadne*. It was noted that the process was considerably easier when the ship was light in the water. As each system was connected, the respective compartments and facilities were opened up. All manifold valves were clearly labelled showing their particular service, and the pumps were checked regularly by the ship's staff.

A time of 2½ hours to rig the complete VPS was consistently achieved by *Ariadne*'s team.

TABLE I—*Sequence used for fitting, and for derigging, in HMS Ariadne*

1	Captain's Heads
2	For'd JR Heads
3	For'd SR Heads
4	Captain's BR Scupper
5	For'd SR/JR Heads Scupper
6	For'd SR BR Scupper
7	For'd JR BR Scupper (stbd)
8	Main Galley
9	Galley GDU/Drain
10	Sink Drain/Spud Peeler
11	Scullery Drain/Pot Wash
12	Laundry
13	1H CPO'S Heads
14	Wardroom Heads
15	Officers' BR
16	Wardroom Galley
17	Officers' Cabin Drains (port)
18	For'd JR BR Scupper (port)
19	For'd JR BR Scupper (port)
20	Aft JR Heads
21	Aft SR Heads
22	Sickbay Heads
23	Aft JR BR Scupper
24	Aft JR BR Scupper
25	Aft SR Heads Scupper
26	Aft SR BR Scupper

BR: bathroom
CPO: chief petty officers
GDU: garbage disposal unit
JR: junior rates
SR: senior rates

Education of the Ship's Company

The rigging and maintenance of the VPS is a whole ship problem which requires a structured education programme to ensure that everyone understands the procedure involved and the restrictions imposed. This was initially found to be difficult, since most believed that the VPS really was not their problem. The fixing in place of the ship's side connections is frustrating, unpleasant and almost impossible when unlockable services such as galley GDUs and drains are used when all other services are out of bounds. Many instances occurred when the rating fitting the system battled against GDU food waste and soapy water as he attempted to insert the connections. Education of all personnel is essential.

Monitoring the VPS during Port Visits

Once the system had been connected up it was found necessary to have a nominated team ready to be called out to deal with any difficulties as they occurred throughout the visit. The Upper Deck Sentry was tasked with checking the security of the ship's side connections as he made his tours around the upper deck, and a watch system was introduced to cope with defects or problems. A duty VPS senior rate with two junior rates from the duty watch were nominated for each day. A kill card was produced for the senior rate in charge who worked on a one-in-three roster to supervise any trouble-shooting. Any problems with the VPS were dealt with by the junior rates, having followed the simple instructions on the card. The on-watch Auxiliary MEM took responsibility for the pumps.

Blockages

Blockages occurred with irregularity but impeccably bad timing during the first visits. There were two basic causes: disposal of hand towel down the heads and failure to use the GDU flushing water for a sufficiently long period. Congealed rice in the ship's drainage pipework caused many repeated blockages. Again education of the users is essential.

Derigging the VPS

Derigging time was virtually dependent on the number of men available. *Ariadne* used 12 plus the Hull section and DMEO (as overall supervisor) to rig, and 16 to derig. The latter process was almost the complete reverse of rigging. Derigging started approximately 1½ hours before sailing. The forward heads flushing valves were operated for approximately three to five minutes during which time the pumps were left running to partially clear the lines, ensuring that only sea water was present in the pipework. Once flushing was complete the heads and bathrooms were locked. Once the forward pump had been shut down the Gemini team removed all the starboard side forward ship's side connections and disconnected the Bower lever lock couplings. A team stood by on the upper deck to haul inboard the dangling sewage and greywater pipework, while the jetty team dismantled the manifold connections and retrieved the connecting pipework from the Gemini crew. This pipework was then dragged across the gangway and recoiled on the flight deck while the pipework groups, still complete with connections, were stowed.

The process of flushing and derigging was repeated around the ship leaving the aft heads and bathrooms until last to minimize the discomfort enforced upon the ship's company. All pumps, pipework and manifolds were then brought inboard and secured immediately before sailing.

Hygiene

During the rigging-derigging process, contact with the pipework was kept to a minimum by the use of industrial gloves. The worker in the Gemini used black

NBC gloves whilst fitting the wedges and connections although these were removed on many occasions in order to gain better control. Cuts and abrasions were experienced; however use of antiseptic hand cleaner prevented any infections throughout the deployment.

The derigging process provided more opportunities for direct contact with sewage or greywater, particularly by the boat's crew as they removed the ship's side connections. However the flushing procedure described earlier prevented this happening on virtually all occasions; even then the wearing of the gloves and 'Green Bean' provided the working party with adequate protection.

Aesthetics

While alongside, the ship had to have a mass of green pipework running along the jetty from bow to stern, with 3 pumps running noisily around the clock and a large road bowser or holding tank parked nearby. This obviously detracted from the ship's formal appearance. No matter how tidily the equiment was arranged, the whole set up had a very Heath Robinson image. Despite this, most comments were of a receptive and favourable nature since the 'British warships were seen to be doing something positive towards counteracting pollution'.

Storage of Hoses and Pumps

The storage facilities onboard *Ariadne* were comparatively extensive, since she did not carry a ships flight. HMS *Minerva*, a more typical LEANDER, made use of the upper deck, in particular under the Exocet launchers, by the base of the funnel, and on the Seacat deck. In her case the tiller flat was once used, but then it was considered more hygienic to store all pipework on the upperdeck.

In *Ariadne* the preformed ship's side connecting groups of pipework were stowed either forward or aft behind the fo'c's'le half screen and in front of the Gambo, respectively. No problems were experienced with unwanted discharges from the pipework whilst being stowed, since flushing had been satisfactory and the pipe coil ends were locked together at the coupling where applicable. The manifolds were stowed aft under the Gambo.

Discharge to Barge or Bowser

In all but the final DTS visit, sewage and greywater was discharged together into one common bowser. This method only proved satisfactory when a second independent bowser was available around the clock as required to empty the first, which was left in position to allow uninterrupted use of the VPS. During the peak periods (0630–0930 and 1600–1930) one bowser was found to last approximately five hours per ship. However, the local contractors used their own level sensors on the bowsers to predict and arrange emptying times, preventing disruption to the ship's company.

In Kiel both *Ariadne* and *Minerva* discharged sewage and greywater, as before, into one common barge. This was berthed adjacent to the ships on the other side of the narrow pontoon jetty and was emptied regularly by an efficient road bowser service which again prevented any interruptions to the system.

Providing that a regular watch and emptying service is provided by the contractors, there was no evidence to show that either method is preferable. The necessity to place the barge either outboard, forward or aft of the ship may in some cases preclude its use, since the amount of extra discharge pipework required would be more than that carried. Whilst in Kiel both *Ariadne* and *Minerva* operated at their discharge distance limit as a result of this fact. With a jetty bowser, at either the ship's bow or stern, this problem does not arise.

Discharge to Main Drainage or Sewage System

The opportunity to discharge into a port's main drainage or sewage system did not arise during the deployment. This could be a viable method for disposing of ship's sewage and greywater in the future, and would be financially attractive since it could reduce or even negate the hire cost of a bowser or barge.

Summary and Recommendations

The VPS provides a method, although somewhat archaic, of allowing ships without sewage treatment plants to visit foreign ports that enforce strict Marine Pollution regulations. The system was used regularly and proved to be successful within the DTS. Once the VPS was running smoothly it provided a perfectly adequate means of temporary ship's survival, however not without considerable extra effort from duty personnel and the ship's Hull section.

In order for this system to succeed beyond its present level, more of the hassle has to be removed by the design and procurement of a simple system allowing quick and easy fitting of the ship's outlet connections. During the DTS deployment HMS *Minerva* moved towards that goal by fitting flanges to her ship's side. These allowed her VPS to be fitted via the use of 3 inch instantaneous connections. As a ship with water compensated fuel tanks (WCFT) this fixing method became a necessity when it was realized that the more time-consuming process used by *Ariadne* (without WCFT) was virtually impossible due to the water line level of many of her discharges.

Providing that future users of the VPS have time to build, trial, arrange stowage and maintain their individual systems, and given the life expectancy of typical users (LEANDERS and Type 42s), they will be serviced adequately by the present system for most foreign visits. Unless a pump with a stronger suction capability can be found, then very little modification and improvement can be made to the jetty side part of the described system. Concentration towards quick release and easily stowable ship side connection methods may provide a more efficient and hassle-free system for the short-term future.