THE DESIGN OF LAUNDRIES FOR H.M. SHIPS

BY

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Introduction

'Home and, being washing day, dined upon cold meat'.

Thus wrote Pepys in his Diary on 4th April, 1666. Now, three hundred years later, the Navy's back-room boys at Headquarters, appreciating that his ship is the sailor's home and realizing that he needs something better than cold meat on washing days, endeavour to provide an efficient laundry facility in as many ships as possible.

The designer of a laundry in a ship of the Royal Navy is faced with a number of problems not found, normally, in a shore-based, commercial laundry. These include:

(*a*) A general shortage of space

(*b*) Restricted headroom

(*c*) Awkwardly shaped compartments

(*d*) Obstructions such as hatches, uptakes, trunking, steam pipes, remote control rods, tank sounding tubes, filling funnels, etc.

(*e*) Special air-conditioning and ventilation requirements

(*f*) The need for weight restriction and balanced distribution of machinery

(*g*) The need to minimize noise and vibration

(*h*) Inadequate (or frequently non-existent) steam supply

(*j*) Direct current and 60 cycle AC power supplies

(*k*) Spares coverage

(*l*) Semi-trained or untrained machine operators (in some cases these are Asiatic civilians who are anti-machine).

In addition to the foregoing problems, the fact that a naval laundry must be capable of operating at sea during heavy weather and in arctic or tropical conditions must be constantly in the designer's mind.

This article attempts to show the effect of these problems, how they are tackled at the moment, and the steps being taken towards improvements in the future.

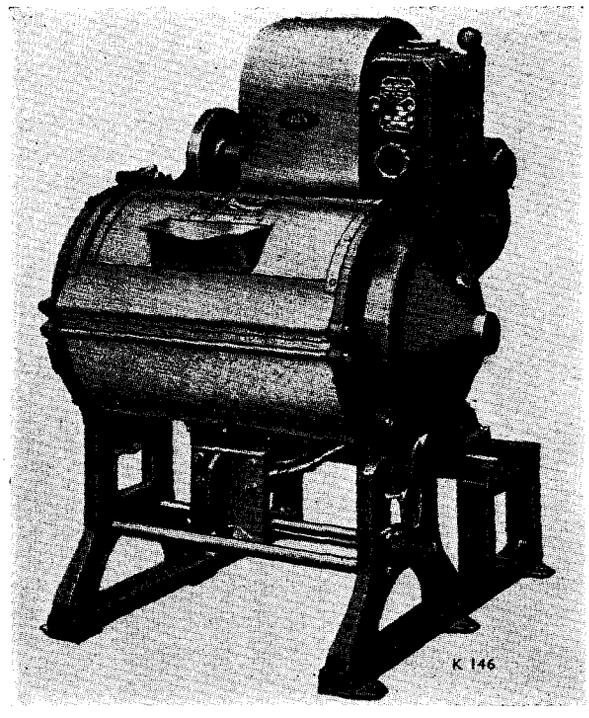


FIG. 1—TYPICAL WASHING MACHINE 25 YEARS AGO—OUTPUT 12 LB/HR (WASHED ONLY), FLOOR SPACE OCCUPIED 43 IN. × 39 IN.

FIG. 2—MODERN WASHER/EXTRACTOR (AUTOMATIC CONTROL)—OUTPUT 24 LB/HR (WASHED AND SPIN-DRIED), FLOOR SPACE OCCUPIED 39½ IN. × 27 IN.

THE PROBLEMS

Space

The space required for the laundry in a new construction surface ship is directly related to the amount of equipment necessary to deal with the weekly requirements of the full complement. How these requirements are calculated is dealt with later. Desired areas vary between 200 square feet for frigates and 1,800 square feet for aircraft carriers. As laundries are not vital to the fighting efficiency of a ship, the areas desired are seldom provided, priority being given, understandably, to the needs of operational equipment. During six years in the laundry 'chair', it has been observed that the compartments allocated for laundries have been progressively shrinking and becoming more and more awkward in shape. This is no doubt due to the fact that ships are becoming smaller overall and operational equipment is becoming more complex and varied.

However, there are now signs of new thinking in ship design. For the first time details of the space required for the laundry in a future ship (the design of which is probably being planned by Network Schedule) have been requested. Whether the laundry will fall on the critical path, however, is open to doubt.

In the meantime the spaces allocated must be utilized to their fullest advantage. Some of the methods used are as follows:—

(*i*) Installation of dual purpose machinery such as combined washer/extractors instead of orthodox washing machines and separate hydro-extractors

(*ii*) Installation of automatically-controlled machines, thus economizing on manpower and releasing space for more machinery

(*iii*) Provision of portable plates in bulkheads for maintenance access to the rear of machines which can then be installed close to bulkheads

(*iv*) Installation of small domestic-type machines.

Objections can be found to all of these methods. For example, (*i*) is somewhat expensive; (*ii*) is not possible where D.C. current, only, is available; (*iii*) is not always possible, e.g., where the bulkhead is a watertight one or where the adjacent compartment has a special function such as a refrigerated space; and (*iv*) the effective working life of these machines rarely exceeds 3,000 hours.

Certain steps are being taken to overcome these objections. For example, the possibility of using a compact DC/AC invertor, to widen the field for automatically-controlled machines, is being investigated; machinery manufacturers are persuaded to design machines which can be maintained from the side (this avoids the necessity to pierce a bulkhead); as an alternative to the domestic-machines a small, rugged and unsophisticated washing machine has been designed and is now being developed by a laundry machinery manufacturer. A small, simple drying tumbler is in its preliminary design stage.

Headroom

The normal headroom in H.M. ships laundries is 6 feet 6 inches from deck to beams. If the deck-head is lagged, this height is, if course, reduced.

Many commercial machines cannot be accommodated within this height but a number of firms' standard machines have been modified successfully to overcome this problem. The large-capacity washer-extractors which are proving so successful in land-based laundries cannot be fitted in H.M. ships due to their height and the necessity to mount them on a slab of concrete up to 18 inches thick.

The minimum height of a washing machine largely depends on the operating height of the door and the diameter of the cage. For example, a typical 100 lb capacity washing machine is 3 feet 6 inches from the base to the centre of the door and has a 42-inch diameter cage 32 inches deep. Allowing for a 4-inch high seating to raise the machine above the deck tiles and 2 inches for the outer casing, the total height is therefore 5 feet 9 inches. This leaves little room under normal beams for pipework which, in consequence, has to be modified. One may ask why the required cage volume of this machine cannot be achieved by reducing the cage diameter to 2 feet and increasing its depth to 8 feet, leaving the operating height at 3 ft 6 in. There are two objections to this:

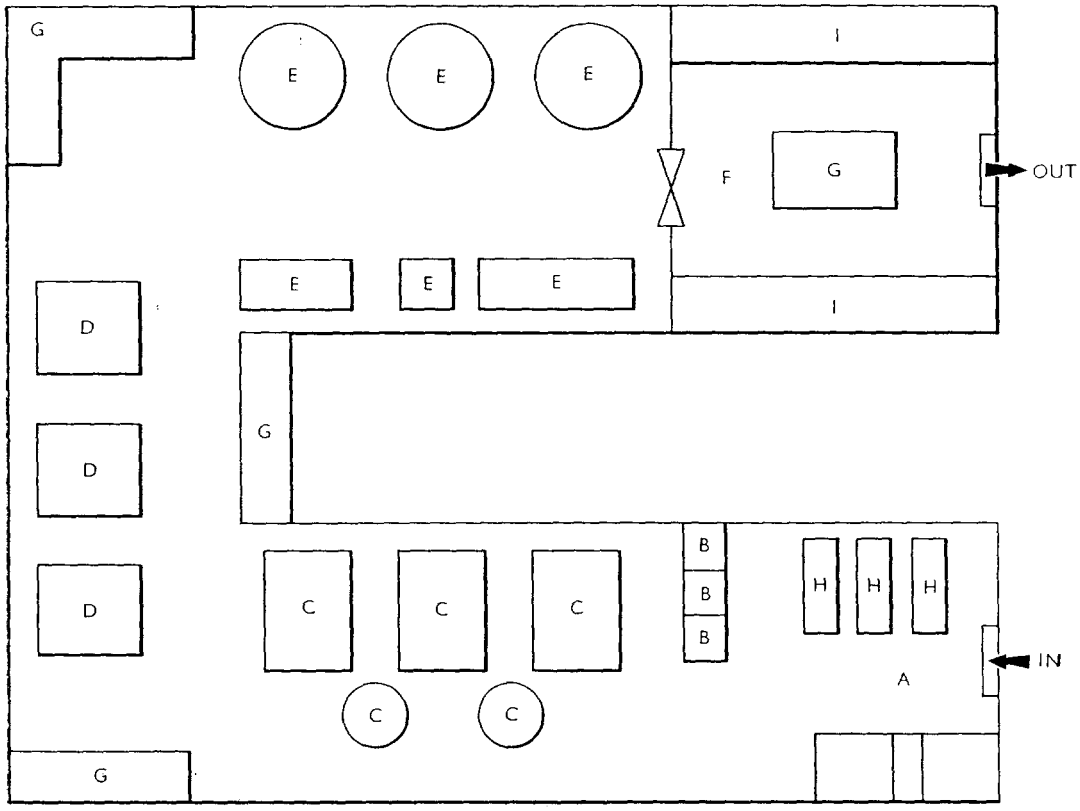
(*i*) The floor area of the 42-inch diameter machine is approximately 10 square feet while that of the 24-inch diameter machine would be about 18 square feet; and

(*ii*) The lift and plunge of the work in the 24-inch diameter machine would not be sufficient to achieve the mechanical action necessary for an efficient wash.

Consequently, unless the convenient operating height is sacrificed, we have no alternative but to either modify the upper pipework or install two machines of smaller capacity.

Inconveniently Shaped Compartments

Ideally, a laundry compartment should be so shaped that the flow of work can proceed from receipt to issue in a continuous, unhampered stream. The sequence of processes in a medium to large laundry is as follows:



LEGEND

A	RECEIPT–SORTING–MARKING	F	ISSUE
B	CLASSIFICATION	G	TABLES
C	WASHING–EXTRACTING	H	TROLLEYS
D	DRYING	I	RACKS
E	PRESSING		

FIG. 3

Receipt — sorting — marking — classifying — washing — spin-drying — tumble-drying — pressing — folding — sorting — packing — issue.

To achieve this work-flow there should be sufficient machinery to obviate bottle-necks and the piling up of work at any stage in the process; enough work tables, bins and racks to ensure neatness and cleanliness; and an adequate number of operators. An ideal shape, which has yet to be seen, is shown in FIG. 3.

The worst shape with which to deal is a long, narrow compartment with a single entry at one end. In such cases the washing machine is sited at the end furthest from the entrance so that the work moves back through the process towards the issue bins sited near the entrance. In this way, finished work is less likely to be impaired.

However curious the shape of the compartment allocated may be, it has been found that patience, ingenuity and close attention to work study usually result in a reasonably efficient layout.

The possibility of obtaining the ideal shape shown in FIG. 3, in all new ships at some future date (which, incidentally, would deprive the laundry designer of a great deal of enjoyment) is unlikely, at least until Their Lordships

can be persuaded that a ship's laundry service is more important than her armament and radar.

Obstructions

Obstructions such as those listed in the Introduction are a laundry designer's nightmare. Where these are prolific the most outrageously unorthodox measures have to be taken. One example is the main laundry in H.M.S. *Forth* which is sited above the FFO tanks. In this laundry, filling pipes, sounding tubes, air escape vents, hand-wheels, bilge ejection pipes and raised hatch covers in the deck combine with the erratic contours of the compartment to make this the most peculiar laundry in the Fleet. This example shows the importance of sensible siting of a laundry at an early stage in the ship's planning.

Air Conditioning and Ventilation

Imagine a frigate at sea in the tropics, with weather conditions so bad that the laundry has to be operated in the closed state. The importance of efficient ventilation and adequate air conditioning will be apparent.

Inside the laundry all the machines are working; the temperature in the washing machine is probably 180 degrees F; that in the drying tumbler 160 degrees F and, at the press 350 degrees F. Steam is escaping from a few joints; from the soap boiler; from the washing machine and drying tumbler when opened and from the garments being pressed. In addition there are probably three or four men working. Without efficient ventilation and air conditioning this laundry would be uninhabitable.

Apart from the habitability aspect (which is carefully checked during the machinery trials) there is the danger of combustion in the exhaust trunking due to a build-up of fluff at bends. To reduce this risk, the exhaust from the drying tumbler (the chief source of fluff) is kept separate from the compartment exhaust and led direct to atmosphere. When a laundry is low down in the ship this can be quite a problem, which is overcome by either fitting an extra fan in the exhaust trunking or by accepting the exhaust from the tumbler into the main trunking through special lint traps.

Weight

Excessively heavy machines are now avoided wherever possible. For example, flatwork ironers which incorporate a large cast iron bed and which weigh two tons are being superseded by rotary presses, weighing one ton, which process flat work equally well. Weight distribution is not a vital problem except where the laundry is fairly high up in a large ship and runs athwartships from ship-side to ship-side. In such cases the layout must be arranged so that the heaviest machines are nearest to the middle line and the lightest machines are sited towards the ships' sides. This policy was adopted when designing the laundry for the late lamented CVA.01 in which the c.g. coincided exactly with the middle-line, fortunately without sacrificing the efficiency of the work flow.

Noise and Vibration

The worst offenders in this respect are hydro-extractors and combined washer/extractors. The former rotate at high speed on a vertical axis and, if loaded with care and properly maintained, should not produce unacceptable noise or vibration. Indifferent maintenance and careless loading, however, result in noise and vibration which can be quite frightening

Unlike hydro-extractors, washer/extractors rotate on a horizontal axis and, in consequence, out-of-balance loads create considerable vibration. It is essential to install these machines on seatings sufficiently rigid to accept, in the case of the 12 lb capacity machine now in service, an out-of-balance load of 2,000 lb at 610 rpm. In a recent case a steady bracket has been fitted between the machine and the deck-head as an additional safeguard against vibration.

This vibration problem is one reason why washer/extractors in H.M. ships are, at present, restricted to small capacity models with $20\frac{1}{2}$-inch diameter cages. Machines of 50 and 100 lb capacity have been investigated under operational conditions and all have been found to be unacceptable for naval laundries by reason of either size, foundation requirements or the method employed to distribute the load prior to high speed extraction. There is, however, one ray of hope. A 50 lb capacity washer/extractor incorporating a three-speed motor has been developed and production is expected to start this year. Cage speeds of this machine are:

(*i*) 42 rpm—washing and rinsing

(*ii*) 275 rpm—distribution of load

(*iii*) 550 rpm—extraction.

This machine is, of course, suitable only for ships having an AC power supply.

Steam Supply

Steam-heated laundry machines are more efficient than electrically-heated ones. Saturated steam at 80–100 lb/sq in. is required for washing machines, drying tumblers and presses. While wide variations in pressure do have an effect on the efficiency of washing machines and drying tumblers, this is not usually severe enough to upset the balance between the washing and drying functions. Pressing, however, becomes progressively slower as steam pressure falls and at pressures below 70 lb/sq in. the pressing unit cannot keep pace with washing machine output.

Where steam is not available, electrically-heated machines must be accepted. An electrically-heated washing machine connected to a hot water supply is not a great deal slower than a steam-heated machine connected to the cold water supply. An electrically-heated drying tumbler, however, is considerably slower than a steam-heated one. For example, a steam-heated tumbler rated at 40 lb per hour will dry two loads, each of 20 lb, in 60 minutes. Its electrically-heated counterpart takes approximately 90 minutes to achieve the same output. To maintain equality of output either a larger capacity tumbler is fitted (where space permits) or a bigger heater is provided (where power supplies permit). When neither of these alternatives is possible, a limited improvement can be made by giving the work a final rinse at about 120 degrees F. This practice opens up the fibres of the material, facilitating extraction and relieving the tumbler of the necessity to heat up the load from cold. Absolute equality of washing/drying output is, of course, only required when work which does not need pressing is being laundered.

The number of electrically-heated laundry presses in service is small. They are not particularly suitable for H.M. ships as the head temperature must be maintained at 350 degrees F to achieve an acceptable production rate.

Power Supplies

The power supply to the majority of laundries in H.M. ships is either 220 volts DC or 440 volts, 3-phase, 60 cycles AC. A few laundries have 110 volts DC or 230 volts single-phase, 50 cycles AC. The electrical portion of a laundry machine must, with very few exceptions, be to Admiralty standards.

These electrical requirements are not met in the standard, commercial products of the laundry machinery manufactures in the U.K., many of whom decline to modify their standard product. Fortunately there are enough firms who are willing to meet our specifications at the moment but, as the changeover to automation develops there is little doubt that obtaining the laundry machinery which we demand will become increasingly difficult. The need for DC/AC conversion equipment, acceptable for service in ships' laundries has been emphasized for some years, so far without success. Such equipment would mean that many more machines could be obtained 'off the shelf', automatic controls could be used and deliveries would be quicker.

Spares Coverage

The range of machinery fitted in the laundries of H.M. ships has been rationalized for some time (a fortuitous anticipation of the SYMES policy) and Depot spares therefore present few insuperable problems. The quantity of items issued with each machine as 'on-board' spares is assessed from experience and general engineering knowledge, augmented by information received from S.M.A. from time to time, and giving due consideration to the ship's global activity. For example, a carrier on a Far East commission of 18 months' duration needs fuller on-board spares coverage than does a vessel in the Home Fleet.

Operators

The output of a ship's laundry and the standard of finish achieved depend as much on efficient operation as on efficient machinery. The laundry designer's most painstaking efforts to provide adequate and up-to-date machinery can be nullified by incompetent operation. Manning the laundry is the responsibility of the Laundry Officer and it is appreciated that suitable personnel are often difficult to find and, when found, are frequently unavailable on a permanent basis. Laundry work does, however, appeal to some ratings, and officers are reminded of the facilities provided by the Fleet Laundry Training Unit, H.M.S. *Drake* (DCI(U)429/65 refers). This Unit is staffed by highly competent instructors and any laundry operator taking the full course should return to his ship well qualified to achieve the best results from the machinery under his control, and thereby bring benefit to all on board.

Qualified instruction in the correct operation of laundry machinery is also important from the safety angle. Hydro-extractors in particular hold serious hazards for the untrained or careless operator, as a recent incident shows. (DCI(U)158/67 refers).

THE FUTURE

The foregoing gives a broad picture of the laundry situation as it is today. Improvements are being made all the time, however. Design projects in hand at the moment are:

(*i*) The small washing machine referred to earlier

(*ii*) An electrically-heated drying tumbler tailored to fit narrow spaces

(*iii*) A soap boiler which uses 100 lb/sq in. steam

(*iv*) A standard, unitized marking and sorting table

(*v*) A do-it-yourself laundry trolley kit

(*vi*) An improved braking system for direct-drive hydro-extractors.

A compact steam-heated, air-operated press has been designed for small ships and this is already in production. B.R. 1277, the R.N. laundryman's bible, has been completely re-written and brought up-to-date. It is not known when the revised edition will be available but it is hoped that this will not be too far into the future.

Dry Cleaning

R.N. ships are not equipped, at present, with dry-cleaning facilities but a new construction ship now being designed will have a dry-cleaning plant in addition to its orthodox laundry. This decision is a major step forward and, although many new problems will no doubt arise, this project is looked forward to with relish.

Selection of Equipment

Ideally, the equipment installed in a ship's laundry should have a capacity and output adequate to meet the requirements of the full complement in accordance with the weekly weight allowances (tropical) as laid down in DCI(RN)694/67, in a working week of 40 hours.

The wash-load is the foundation stone on which the rest of the equipment is built up. The hourly output required is calculated by the formula:

$$\frac{18a + 15b + 12c + d}{40}$$

where a = Officers; b = CPOs & POs; C = Junior Rates and
d = full complement.

A quicker, but reasonably accurate figure can be found by the formula $\frac{3d}{8}$

Example:

The hourly requirement in a ship of 400 complement is 150 lb. The desired scale of machinery would therefore be as follows:

One 100 lb capacity washing machine (120 lb/hour)

One 20 lb capacity washer/extractor (40 lb/hour)

One 21-inch hydro-extractor (130 lb/hour average)

One 30 lb capacity drying tumbler (150 lb/hour)

One general purpose press.

As previously stated, it is usually not possible to achieve the ideal, due to space limitations, and if the problem cannot be overcome by using special machinery, either the weekly allowances must be reduced or the length of the working week increased.

CONCLUSION

It is hoped that this article will indicate that the provision of laundries in H.M. ships is not a matter of guesswork and that the back-room boys are constantly striving to give the boys at sea the laundry service which they deserve. Information from sea, however trivial, could lead to further improvements, and would be welcomed.

A list of relevant publications is given in the Appendix.

APPENDIX

Publications Relating to R.N. Laundries

BR. 1277	Laundry Manual (1955)
BR. 1907 (1A)	Laundry Equipment—*Valiant*
BR. 1964	Laundry Equipment Domestic Type
BR. 2985 (Pts. 1 and 2)	Laundry Equipment Submarines
BR. 3801	Washing Machine—Manlove Alliott
BR. 3802	Washing Machine—Armstrong
BR. 3805	Hydro-Extractors—Bradford
BR. 3806	Washing Machines—Rhodes and Westlake
BR. 3807	Drying Tumbler—Rhodes and Westlake
BR. 3808	Hydro-extractors—Watson-Laidlaw
BR. 3809	Washing Machines—Baker Perkins Jaxons
BR. 3810 (and Supp.)	Rotary Presses—Weston
BR. 3811	Hydro-Extractors—Broadbent
BR. 3812	Drying Tumblers—Armstrong
BR. 3813	Presses—Baker Perkins Jaxons
BR. 3816	Flatwork Ironer—Bradford
T.P. 64	Air Compressor—Ingersoll Rand
T.P. 432	Washing Machine—Electrolux
T.P. 433	Drying Tumbler—Armstrong
DCI (RN) 429/65	Fleet Laundry Training Unit
DCI (RN) 530/65	Laundering Curtains, etc.
DCI (RN) 603/65	Detergent, Laundry, Synthetic
DCI (RN) 158/67	Hydro-Extractors—Brakes, etc.
DCI (RN) 694/67	Laundries—Provision in Sea-going Ships