

AD612266

Technical Report

R 368

RECOVERY OF LAUNDRY WASTE
WATER FOR SHORE STATIONS

11 March 1965

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INTRODUCTION

The objectives of Task Y-F015-99-01-055 are to in-service test a laundry waste-water-recovery unit and to determine the practical application of the reclamation process to actual field conditions, particularly with regard to inclusion of the unit in the functional component system.

The treatment plant tested was originally designed, developed, and fabricated by a laundry machinery company under BuDocks contract NOy-24740, starting in 1951. The plant was installed and operated in its original form at the Boston Navy Yard during the period 1952-1954 with good results. The plant was then assigned to NCEL for further development and testing. The required work included simplification of the chemical control system and development of treatment methods for waste water containing various kinds of synthetic detergents. This was accomplished, and a technical report¹ was issued by the Laboratory with recommendations for design and construction of a new unit for use at an overseas base.

The Bureau contacted a number of stations with water problems, and the Key West, Florida, and Midway Island stations indicated interest. Cognizant person¹ at Key West determined that the process was unsuitable for that location, but at the request of the Navy Ships Store office, the laundry at the Midway Island station was selected as a test site. However, to minimize costs, the experimental plant already used at Boston and NCEL was to be used rather than a new plant.

MIDWAY TEST

Description of Plant and Installation. The reclamation treatment used in the laundry waste-water-recovery plant is a flocculation - flotation process. The process operates at a temperature of 140° F, and when a mixture of waste water, acid, alum, air, and sodium hydroxide is introduced at the bottom of the clarifier tank, a chemical floc floats dirt to the surface of the tank, and clear water is drained from the sides of the tank. A detailed flow diagram of the process is shown in Figure 1. Figure 2 shows the flow paths within the clarifier.

The designed capacity of the plant is 1,000 gph, but on the basis of operations at NCEL, it was indicated that up to 2,400 gph might be treated. Cost of the reclaimed water was estimated¹ at about \$2.00 per thousand gallons, with offsetting savings on water, heat, and soap, reducing the net cost to about \$0.40 per thousand gallons.

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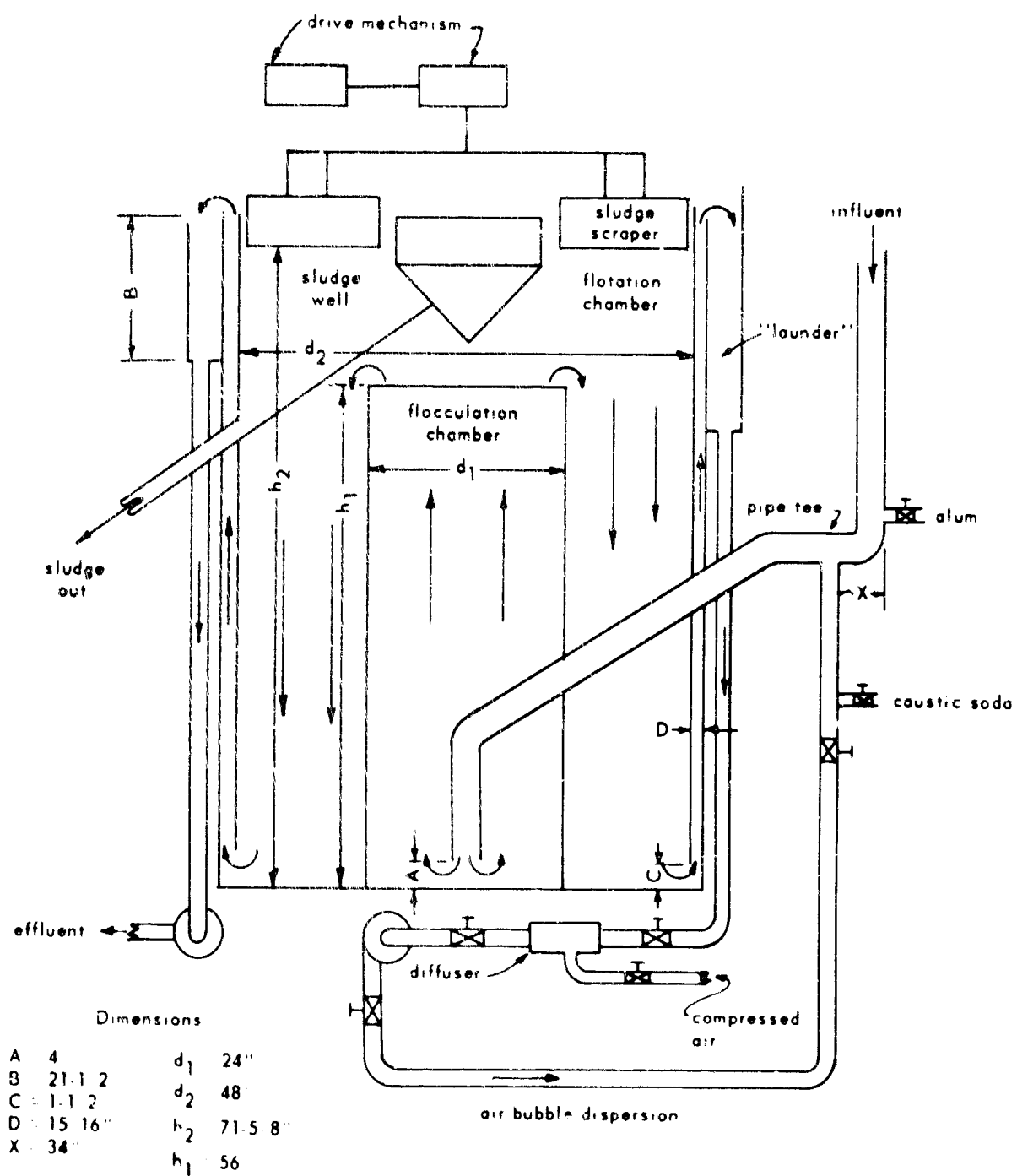


Figure 2. Flow paths within clarifier.

The installation at Midway was designed by the Fourteenth Naval District Public Works Office. The treatment plant was actually installed by personnel from Public Works Center, Pearl Harbor, and was completed in February 1963. Figure 3 shows the installation at Midway.

An attempt to start treatment operations was made under NCEL supervision during the period February-April 1963, but a number of difficulties developed that made treatment impractical and certain modifications of the installation necessary. Problems included inadequate lint screening, a defective float switch, failure of the pH meter, insufficient capacity for storing dirty and clean water, improper piping connections from laundry machines, and failure of the process to operate as anticipated using only alum for acidification.

The storage capacity deficiency was caused by the high-capacity laundry machines at Midway; there are five machines with a total capacity of about 2,000 pounds per hour of clothes (two 42 x 64 inches, two 40 x 96 inches, and a 36 x 36-inch machine). This is at least twice the expected maximum laundry capacity for the waste treatment plant. Abbreviated wash cycles and half-day use of the machines alleviated the capacity problem somewhat, but much greater storage capacity was needed to balance the waste flow and extend the time that the treatment plant could operate.



Figure 3. Installation at Midway laundry.

Because of these problems, the recovery plant was shut down for modifications, which were made during the period of June to December 1963. Changes included an increase of waste-storage capacity from 1,000 to 4,000 gallons, an increase of clear-water storage from 1,000 to 2,000 gallons, revision of chemical feeding to use sodium bisulfate in addition to alum for acidification, a greatly enlarged lint filter, a new float switch, and piping changes to permit use of either fresh or reclaimed water in the laundry machines. The pH meters were repaired at NCEL, and a spare unit was ordered so that it would not be necessary to try to operate again without a meter.

Test Results. Operations were resumed in January 1964, and the laundry mechanic and laundry manager were trained to operate the unit. The rate of treatment was set at 1,200 gph, and results were generally good. Figure 4 shows the clarifier sludge mat during a successful run. Fresh water was used for the rinse in the washers, as the warm reclaimed water did not seem to give a satisfactory rinse. The reclaimed water also contained a considerable amount of surface-active agent from the washing detergent, and this contributed to the rinsing problem.

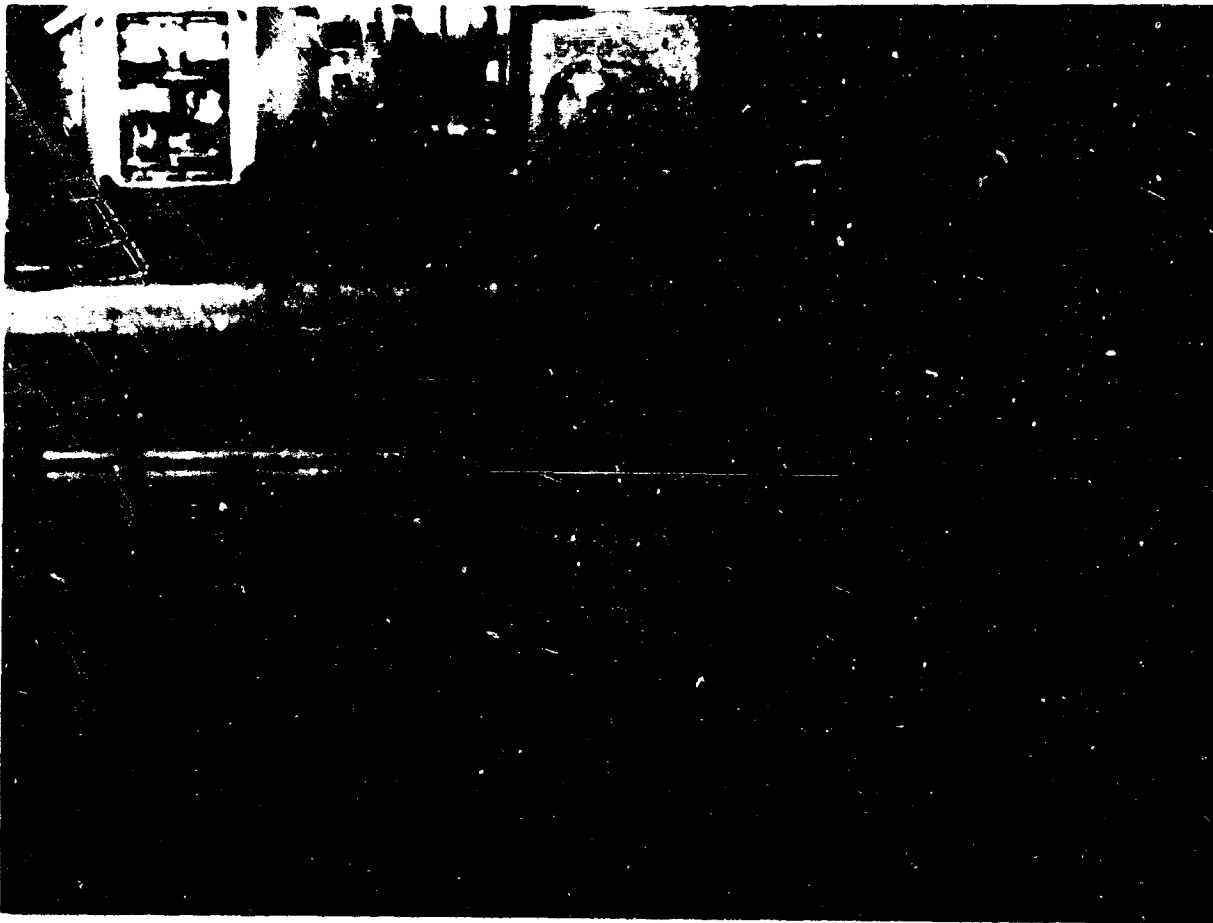


Figure 4. Top of clarifier, showing skimmer and foam mat.

Operational problems encountered during the training period centered mainly on the scum overflow system, which required frequent cleaning, and floc carryover to the clear-water storage tanks. The laundry mechanic, who became the plant operator in addition to his other duties, was able to alleviate these problems after additional operating experience.

During operations in January 1964, the chemical requirements and treatment results were about the same as experienced at Boston and NCEL. With the additional storage, the 1,200-gph treatment proved adequate in 4 to 6 hour's operation to handle the laundry waste. The washers were generally operated 2-1/2 to 3 hours. Because of the use of fresh water for the last rinse, the reclamation was about 80%, since these washers are filled only five times per load, and one of these five fillings is fresh water.

One of the secondary objectives of the Midway installation was to determine the useful maximum capacity of the clarifier. As noted previously, the results at NCEL had indicated that the capacity was about 2,400 gph, but this had been determined on the basis of very brief periods of operation because only small amounts of waste were available. After smooth operations had been established at 1,200 gph, treatment at 1,500 gph was attempted and worked well. Treatment was then tried at 1,800 gph, and results deteriorated after about an hour's operation so that this rate could not be maintained successfully to produce a clear effluent. It would appear that 1,500 gph is the maximum reliable rate, but clarity was even better at 1,200 gph.

Some of the cost advantages calculated¹ were not realized at Midway. The larger storage tanks resulted in cooling of the water, both before and after treatment. Consequently, reheating before treatment was necessary. The stored, treated water was usually about the right temperature for the first and second rinses, but needed heating for the wash cycle. (Direct steam injection is used for heating the wash water.) On the other hand, it was sometimes too hot for the break, and this was an annoyance to the operator. The net heat saving is probably very slight.

Actual detergent savings also appeared to be too small to be significant. No reduction in the use of washing compound was made by the operator. Although there is a considerable amount of surface-active agent returned in the reclaimed water, the washing compound is still needed to supply the other cleaning elements. The surface-active agent, normally, is only about one-third of the washing compound.

Table I is a recalculation of reclaimed-water costs, based on the Midway installation. The actual cost at Midway is much higher than estimated¹ because of increased installation costs and much smaller daily output. The estimate was based on 16 hours per day at 2,500 gph. A similar calculation for water distilled by the use of waste heat is included for comparison. Costs shown in these calculations could easily fluctuate greatly, depending on capital cost and operator time. Costs for fuel and chemicals are small in comparison to total cost and about equal for either method. Waste-heat distillation would be particularly applicable to Midway, since there is a very large diesel-generator capacity.

Table 1. Treatment Costs for Laundry-Waste Reclamation and Distillation at Midway (8,000 gallons per day — 2,500,000 gallons per year)

Item	Use	Unit Cost (\$)	Total per 1,000 Gallons (\$)
Reclamation Costs			
Alum	35 gr/gal	0.05/lb	0.25
Bisulfate	35 gr/gal	0.05/lb	0.25
NaOH	15 gr/gal	0.06/lb	0.13
Capital Cost	10 yr	50,000 (5,000/yr)	2.00
Maintenance	5% of capital cost	2,500/yr	1.00
Operator	1 man, 1/2 time	5,000	<u>2.00</u>
			5.63
Waste-Heat Distillation (400-gph unit — 20 hr/day)			
Fuel (400:1)	2.1 gal/100 gal	0.20	0.42
Capital Cost	10 yr	50,000 (5,000/yr)	2.00
Maintenance	5% of capital cost	25,000/yr	1.00
Operator	1 man, full time	10,000	<u>4.00</u>
			7.42

Since the water problem at Midway has been greatly reduced by additional catchment area and storage built between 1960 and 1963, the plant was operated for only brief periods after the initial training period. The plant was also shut down because of the failure of the pH meter and a skimmer. The skimmer failure occurred when the skimmer wheels did not track properly and the skimmer arms jammed. Figure 5 shows the skimmer damage. The basic design allowed for the possibility of the wheel-tracking problem, and it had occurred at NCEL a few times without damage. The jamming at Midway was probably caused by wear, but no direct substantiation of this has been made. A new skimmer drive was ordered to replace the damaged one. However, the recovery unit was put back in service in November, before the new drive arrived. Evidently, necessary repairs had been made at Midway, as information from the laundry manager indicated that he was operating the unit at 16 gpm with good results. (The mechanic had been transferred in the meantime.)

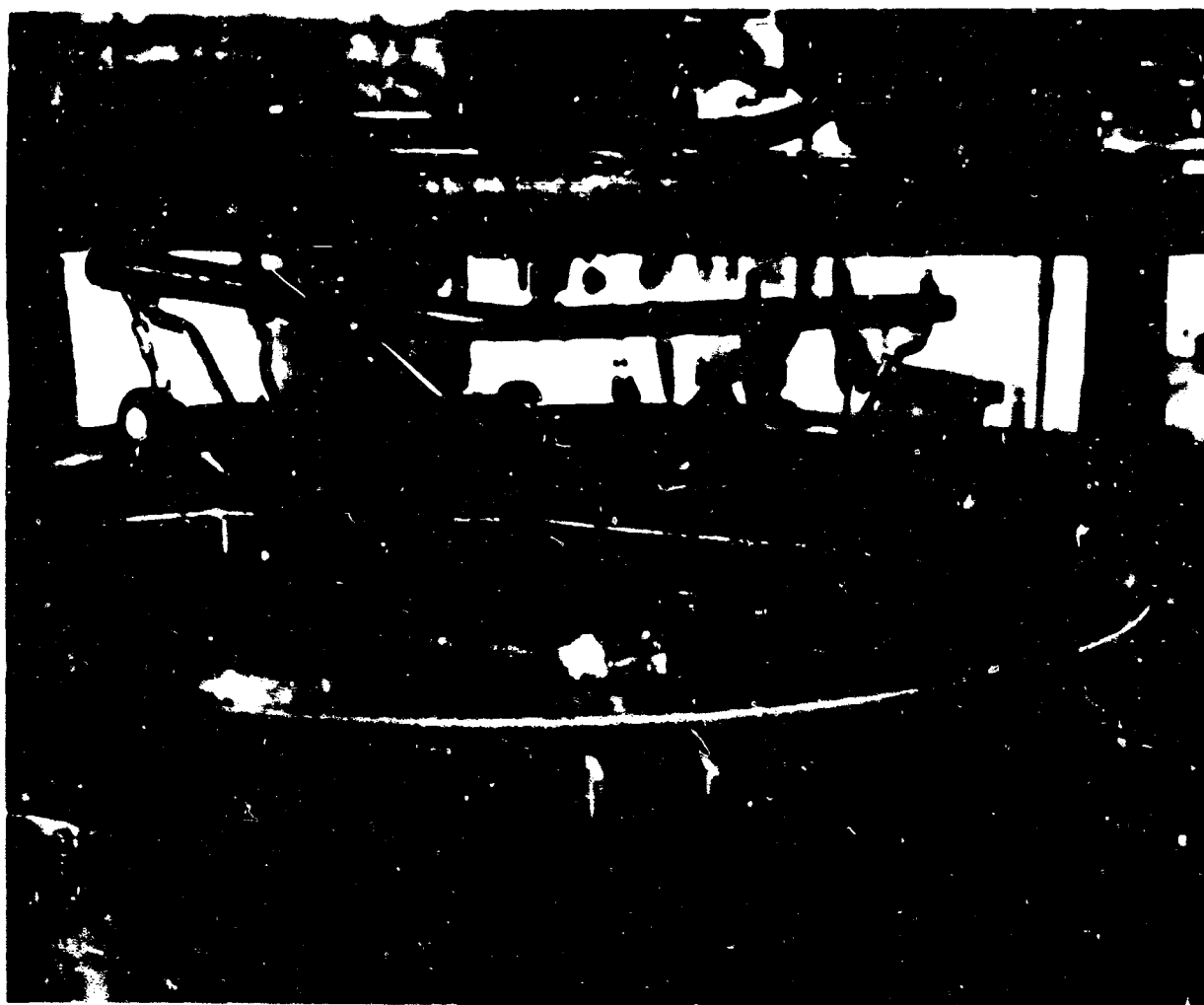


Figure 5. Skimmer damage.

GENERAL WATER PROBLEMS AT MIDWAY

The water supply system at Midway uses three sources and has three separate distribution systems. Sea water is distributed in one system for toilet flushing, and brackish water from wells is distributed in other pipes to showers and wash basins. Rain water from runway catchment areas and storage tanks is piped in a third system to drinking fountains, galleys, and other potable water uses. During rainy periods, potable water is pumped into the brackish-water system to minimize draft on the wells. About twelve million gallons of potable water is stored, and the island population is about 3,000. A part of the storage is for fire fighting. Rainfall averages 56 inches per year, and the period without rain may be 90 to 120 days. Potable water has been used in the laundry continuously for about 2 years. Before that, considerable brackish water was used in the laundry.

Because of the three piping systems and the large storage facilities, cost of water on Midway is quite high. However, a specific estimate is difficult to make. Division of costs between the three systems built by various methods at various times is difficult. Building plumbing installation and maintenance is very high because of the three separate systems and the corrosiveness of the waters. The most practical method of estimating the cost of the water used in the laundry is probably on the basis of the cost of added storage needed for laundry water for a long, dry spell.

Consumption at the laundry is about 50,000 gallons per week compared to potable water use totaling over 500,000 gallons per week. If a 14-week dry spell is assumed, the laundry adds 900,000 gallons to the required storage capacity. According to BuDocks information,² the unit cost for large tanks at Midway is \$0.117 per gallon capacity. At this rate, the addition of 900,000 gallons storage would cost \$105,300. On a 10-year life with 2% per year for maintenance, the annual added storage cost is \$12,636. Since this added storage volume is used only once per year, the stored water cost is approximately \$14 per thousand gallons. (Because the basic storage capacity is used several times a year, this cost should not be considered to apply to the main island water supply.)

Even at \$5.63 per 1,000 gallons, reclaimed water is a great bargain at Midway. The distillation costs shown in Table I indicate that distillation is also attractive as a supplementary supply for this type of station. It is quite conceivable that a distillation apparatus of the multistage type could be added to the Midway power plant without requiring any additional operators. In this case, the cost of distilled water could be as little as \$3.50 per 1,000 gallons. It certainly would appear desirable to use distillation instead of adding more storage if the island requirements increase in the future.

ADAPTABILITY TO FUNCTIONAL COMPONENT SYSTEM

Training of Personnel. Aside from economic and technical considerations, the most important factor in judging whether this unit is suitable for inclusion in the functional component system is the suitability of the unit for operation by Seabee personnel. During the two different periods of operation under NCEL supervision, three different enlisted men were assigned to learn the operation of the unit. None of these were Seabees, but had laundry or mechanic ratings. Two were storekeepers, and one was a mechanic. One of the storekeepers seemed to be a poor choice for this assignment, but it was during the period of maximum break-in problems that his training was attempted, and training was never completed. The mechanic learned the operations quite well, and his familiarity with pumps and piping was a valuable asset. The other storekeeper received less training, as his duties as laundry manager occupied most of his time. However, he was able to get the unit back into operation, including supervision of necessary repairs, after the mechanic had been transferred.

The response of these men to their training and their ability to make the unit run under less than favorable conditions would seem to indicate that the operation is within the capability of trained enlisted personnel. The fact that the necessary "know-how" survived both the transfer of the principal operator and a several months period when the unit was shut down is probably the best evidence of this. The amount of training a Seabee utilities man with a better background of chemical treatment would require is probably somewhat less than the laundry men needed. It is estimated that about 2 weeks of training and experience are needed, with emphasis on actual experience in operating.

Compatibility of Equipment. Another factor relating to the adaptability of the unit to the functional component system is the compatibility of the unit with related elements in the system. The basic laundry machine in the component system is the 100-pound machine, which will handle about 120 pounds of clothes per hour. These are used singly, or in groups up to six in number in various component laundry assemblies to give assemblies capable of handling up to 720 pounds per hour. At the tested maximum capacity of 1,500 gph, the Midway experimental plant would be about the proper size to use with the 720 pounds per hour laundry component. The recovery plant works well at capacities down to 500 gph, or a 240 pounds per hour laundry. With this range of capacities, a single recovery plant with the same capacity as the experimental unit is adaptable to all the existing laundry components above 240 pounds per hour.

Potable-Water Supply. Another relative factor is the proportion of the camp potable-water supply involved in the laundry. Studies by Clark & Groff³ and Hostup and Lyons⁴ indicate a range of 5 to 12%. The proportion at Midway was about 10%. However, if a portion of the water requirement is fulfilled by sea water,

the data in Clark & Groff can be interpreted to indicate that a proportion of up to about 20% of the camp potable supply may be used in the laundry at an advanced base with a fairly well developed utilities system. This would indicate that the laundry waste recovery can supplement the basic supply by about 20% at best.

Number of Situations. A final important factor is the question of whether or not there are an adequate number of situations in which the recovery unit will be useful to justify incorporation into the component-equipment lists and the establishment of the necessary training programs in either the Seabee or Ship Stores personnel systems. On the basis of the foregoing discussion, recovered laundry waste could conceivably be useful as a supplementary supply for advanced bases using distillation or catchment-and-storage water systems. However, the continually improving economics of distillation systems indicate that such systems will probably provide the sole water supply at most future advanced bases in water-short areas. The figures in Table I show that a slight advantage in cost may be gained from laundry-waste recovery, but the addition of the equipment and training required to already crowded component lists and technical training schools does not seem justified by the gain of only 5 to 20% supplementary water. A distillation system adequate for all requirements should yield greater simplicity and reliability for the functional component system.

ADAPTABILITY TO OTHER SHORE-BASED ESTABLISHMENTS

Although it is judged that laundry-waste reclamation is not suitable for inclusion in the functional component system, the demonstrated feasibility of the process does indicate that permanent stations with water-shortage problems might well use the process as an economical supplement to the existing supply. The advantages of the processes could best be exploited in recovery plants specifically designed and coordinated with the laundry. The use of separate water-cooling tanks to make part of the reclaimed water useful for break and final rinse operations would then be possible. Integrated design of flow systems, tank insulation, and heat exchangers would permit much better heat recovery. In a more advanced laundry operation, the benefits of the leftover surface-active agent in the reclaimed water might be exploited. In these circumstances, the \$0.40 per 1,000 gallons cost estimated¹ would very likely be realized, and at this rate could be useful to water-short permanent stations.

CONCLUSIONS AND RECOMMENDATION

The laundry-waste recovery plant can produce water that is usable in most laundry processes at a cost of \$0.40 to \$5.63 per 1,000 gallons, depending on the adaptability of the plant and the degree of conservation of heat and surface-active agents in the waste water. Use of the plant in the functional component system is judged to be not desirable, but the process may be suitable for water-short permanent stations.

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RECOVERY OF LAUNDRY WASTE WATER FOR SHORE STATIONS, by
W. R. Nehlsen
TR 368 16 p illus 11 Mar 65 Unclassified

1. Laundry waste water - Recovery I. Y-F015-99-01-055

A laundry waste-water-recovery unit was in-service tested at the Midway Naval Station Exchange Laundry. Treatment results were comparable to those obtained at NCEL, although costs were higher than previously estimated. An analysis of test results indicates that the unit is not suitable for inclusion in the functional component system. However, the process itself may be used at permanent stations to supplement water supplies by 5 to 20%.

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	Water reclamation	8					
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