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Naval Undersea Warfare Center Division Newport Utilities Metering - Phase 1

D. M. Carroll

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Pacific Northwest Laboratory
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Preface

The goal of the U.S. Department of Energy Federal Energy Management Program (FEMP) is to facilitate energy-efficiency improvements at federal facilities. This is accomplished by a balanced program of technology development, facility assessment, and use of cost-sharing procurement mechanisms. Technology development focuses upon the tools and procedures used to identify and evaluate efficiency improvements. For facility assessment, FEMP provides metering equipment and trained analysts to federal agencies exhibiting a commitment to improve energy-use efficiency. To assist in implementing energy-efficiency measures, FEMP helps federal agencies with identifying efficiency opportunities and in implementing energy-efficiency and demand-side management programs at federal sites.

As the lead laboratory for FEMP, Pacific Northwest Laboratory (PNL)[a] provides technical assistance to federal agencies to better understand and characterize energy systems. The U.S. Navy Naval Underwater Warfare Center (NUWC), in cooperation with FEMP, has tasked PNL to assess the energy supply, distribution, and end-use systems at its facilities and to make recommendations for improvements with energy-efficiency potential. The recommendations resulting from that assessment are presented in this report.

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[a] Pacific Northwest Laboratory is operated by Battelle Memorial Institute for the U.S. Department of Energy under Contract DE-AC06-76RLO 1830.

Executive Summary

Pacific Northwest Laboratory developed this report for the U.S. Navy's Naval Undersea Warfare Center Division Newport, Rhode Island (NUWC). The purpose of the report was to review options for metering electricity and steam used in the NUWC compound, and to make recommendations to NUWC for implementation under a follow-on project. An additional NUWC concern is a proposed rate change by the servicing utility, Newport Electric, which would make a significant shift from consumption to demand billing, and what effect that rate change would have on the NUWC utility budget.

Automated, remote reading meters are available which would allow NUWC to monitor its actual utility consumption and demand for both the entire NUWC compound and by end-use in individual buildings. Technology is available to perform the meter reads and manipulate the data using a personal computer with minimal staff requirement. This is *not* meant to mislead the reader into assuming that there is no requirement for routine preventive maintenance. All equipment requires routine maintenance to maintain its accuracy.

While PNL reviewed the data collected during the site visit, however, it became obvious that significant opportunities exist for reducing the utility costs other than accounting for actual consumption and demand. Unit costs for both steam and electricity are unnecessarily high, and options are presented in this report for reducing them. Additionally, NUWC has an opportunity to undertake a comprehensive energy resource management program to significantly reduce its energy demand, consumption, and costs.

Specific recommendations include the following:

- Meter the electric feeders to account for the consumption of steam and electricity by the NUWC compound (including both facility consumption and line/transformer losses). This majority of the NUWC compound can be metered at four points with remote reading meters either tied into the Naval Education and Training Center's (NETC) supervisory control and data acquisition system or reporting directly to NUWC via an automated meter reading or direct digital control network.

- Meter selected buildings to develop energy end-use information for a comprehensive energy resource management program.

- Initiate a comprehensive energy resource assessment, acquisition, and management program to minimize energy consumption and demand. A properly designed and applied program should be able to achieve significant cost reductions with minimal up-front capital investment on the part of NUWC.

- Work with NETC to reduce the electricity surcharge of 21% to a more reasonable level. The surcharge includes line losses of 11% (see Appendix A), which are high for a system the size of NETC's. These losses are probably an indication of failing to account for all consumption rather than actual distribution losses.

- Work with NETC to reduce the cost of thermal energy. As an alternative, assess the cost effectiveness of installing either distributed hot water boilers or a central high-temperature hot water (HTHW) plant to supply the thermal loads of the NUWC compound.

Contents

Tables

1.0 Introduction

The Naval Undersea Warfare Center Division Newport, Rhode Island (NUWC) is the largest tenant at the Naval Education and Training Center, Newport (NETC). The NUWC compound has more than 85 buildings with bills in excess of $6.5 million per year for electricity, steam, water, and sewage. Currently, those bills are based on engineering estimates and steam meter reads of doubtful accuracy. Electricity and steam account for 95% of NUWC's total utility cost, and are the focus of this report.

In an effort to determine its actual energy consumption, and thereby costs, NUWC commissioned Pacific Northwest Laboratory to

- Determine whether existing metering devices are appropriate to measure NUWC's energy use.

- If not appropriate, provide a plan and cost estimate to adequately meter the electric and steam systems.

The ultimate goal as stated by NUWC is to determine NUWC's fair share of NETC utility bills, and also to evaluate impact of the proposed Newport Electric rate change. Actual implementation of the metering recommendations are beyond the scope of this project, and will be done as a follow-on project.

A site visit was conducted by PNL on September 8 through 11, 1992, during which contacts were made with Mr. Bill Mudge (NUWC), Mr. Joe Navin (NUWC), Mr. John Alfano (NETC), and Mr. Robert Parent (NETC).

Evaluation of the data collected during the site visit made it clear, however, that ensuring that NUWC is billed for its actual consumption is not the only issue here. NETC tenant utility rates are high, and options for reducing the unit cost of utilities and for reducing overall energy demand and consumption are also addressed in this report. A detailed analysis of selected options can be performed as a follow-on project if NUWC wishes to pursue the issue.

This report contains six sections. Section 2 reviews the energy sources, historical consumption, and utility rates. Section 3 makes recommendations for NUWC follow-on actions based on an economic analysis of the available options. In Section 4, the issues, both initial and those uncovered during the data analysis, are reviewed. Options for metering electricity and steam at the NUWC compound are outlined in Section 5. Options for NUWC consideration for reducing the unit cost of its utilities are presented in Section 6.

2.0 Background

NETC is responsible for procuring or producing utilities and maintaining the distribution systems for all Navy activities at Newport. Utilities are sold to tenant activities at rates set using the Utility Cost Analysis Report (UCAR) prepared by the NETC Public Works Department. The UCAR allows NETC to establish utility rates that cover the costs of raw energy purchase and/or production, distribution losses, and the labor, material, contracting, and general expenses of operating and maintaining the distribution network. Separate rates are set for Navy activities and non-Navy (commercial) activities. The most recent UCAR information available at the time of the site visit is summarized in Appendix A.

2.1 Electric

NETC purchases electricity from Newport Electric (NE) under a Wholesale Power Service rate, with the initial block (5,000 kW and 1,700,000 kWh) at a higher price and all additional power at a reduced price (see Appendix B for a breakdown of the electric rate schedule). Peak demand ranges from 18,000 to 20,000 kW throughout the year. Power is received at Substation 1 at 69 kV and stepped-down to 13.8 kV for the NETC primary distribution loop.

The NUWC portion of the electrical distribution grid has 65 transformers serviced by seven feeders. Electric meters capable of recording demand and consumption (General Electric VM64S meters with M90 registers) were recently installed on the NUWC transformers. NETC plans to begin meter reads in October 1992 to determine NUWC's actual electric consumption.

A Landis & Gyr TG6800 Supervisory Control and Data Acquisition (SCADA) system was installed for Substation 1 in August 1991, with planned future expansion to include the boiler plant(s) and other key utility system elements. The SCADA is currently used only for monitoring of switch positions rather than for metering or energy management. Staff restrictions limit NETC's ability to make full use of the SCADA system's capabilities.

Table 2.1 shows the electric consumption used for billing by NETC for fiscal years (FY) 1989 through 1991. These figures are based on estimates rather than meter reads, and the accuracy is limited. The table shows that, over the past 3 years, NUWC's estimated consumption has accounted for 45%, and tenants (NUWC and others) have accounted for 86% of the Navy's total, with NETC consuming the remaining 14%.

NETC is currently opposing, through hearings before the Rhode Island Public Utilities Commission (PUC), a proposed rate increase by NE. The proposed rate increase would increase total costs to NETC by about 7.5% but, just as important, would shift the demand

Table 2.1 Electricity Consumption, MWh

Fiscal Year	Electricity Consumption by User			
	NETC	NUWC	Other Tenants	Total
1989	15,671	48,111	40,113	103,895
1990	13,929	49,171	45,488	108,588
1991	16,509	47,692	44,701	108,902

portion of the rate up to about 25% of the total cost. Currently, demand represents only about 7% of the total billing, providing a minimum incentive for the Navy to invest any significant amount on demand reduction. NETC hired Drazen-Brubaker & Associates, who analyzed the proposed rate schedule and recommended a Navy strategy. A decision is expected from the PUC by the end of the year.

Table 2.2 provides a breakdown of the tenant electric rate for FY92 based on information shown in Appendix A. The major expense, other than the purchase of electricity from NE, is line losses, which represent over 11% of the total tenant cost of electricity.

Table 2.2 Navy Tenant Activity Electricity Cost Breakdown, $/MWh

Cost Element	Cost, $/MWh
Energy purchased from Newport Electric	88.25
Line losses	12.60
Distribution system operation and maintenance	5.30
Contingencies	0.90
Total	107.05

2.2 Thermal

Steam is produced at two plants operated by NETC using fuel oil as the energy source. Because of maintenance problems with the steam end-use equipment (e.g., blown traps and condensate return pumps, faulty pressure reducing stations) throughout the Newport complex, the steam plants have high make-up feedwater rates.

Steam is used in the NUWC compound for space and domestic hot water heating only. There are no berthing or significant dining requirements. NUWC has adopted a policy of shutting down the steam system during the summer to reduce energy costs. Electric domestic hot water heaters were installed where required.

Steam meters (BIF model 20402) were recently installed at 33 of the buildings to measure steam consumption in 51 buildings. Many of the meters, however, are difficult to access for meter reading because of poor location (e.g., security zone, gas-free certificate requirement, above an acoustical tile ceiling), which may result in steam data being based on extrapolation of previous reads rather than actual meter reads.

Table 2.3 shows the steam consumption figures used for billing by NETC for FY 1989 through FY 1991. These figures are based on estimates rather than meter reads, and the accuracy is limited. The table shows that, over the past 3 years, NUWC's estimated consumption has accounted for 30%, and tenants (NUWC and others) have accounted for 70% of the Navy's total.

Table 2.3 Steam Delivered, MBtu[a]

	Steam Consumption by User			
Fiscal Year	NETC	NUWC	Other Tenants	Total
1989	128,839	147,700	161,795	438,334
1990	120,831	115,337	164,017	400,185
1991[b]	100,150	88,917	142,623	331,690

(a) Million British Thermal Units
(b) FY91 NETC and Other Tenants figures are estimates based on the values for the Total and NUWC.

Table 2.4 provides a breakdown of the tenant steam rate for FY92 based on information shown in Appendix A. In this case, distribution losses constitute the largest single element of the steam cost.

Table 2.4 Steam Cost Breakdown for Tenant Activities, $/MBtu

Cost Element	Cost, $/MBtu
Raw energy (oil) used in production of steam	5.22
Other utilities (electricity/water/sewage/gas) used in steam production	0.83
Labor/material/general expenses in steam production	2.18
Production losses	1.14
Distribution losses	6.55
Distribution system operation and maintenance	0.95
Contingencies	0.68
Total	17.55

3.0 Recommendations

Based on economic analyses[a] of the life-cycle cost to meter and/or provide utilities to the NUWC compound, the following recommendations are made:

- Meter the electric feeders to account for the consumption of steam and electricity by the NUWC compound (including both facility consumption and line/transformer losses). This majority of the NUWC compound can be metered at four points with remote reading meters either tied into the Naval Education and Training Center's (NETC) supervisory control and data acquisition system or reporting directly to NUWC via an automated meter reading or direct digital control network.

- Meter selected buildings to develop energy end-use information for a comprehensive energy resource management program.

- Initiate a comprehensive energy resource assessment, acquisition, and management program to minimize energy consumption and demand. A properly designed and applied program should be able to achieve significant cost reductions with minimal up-front capital investment on the part of NUWC.

- Work with NETC to reduce the electricity surcharge of 21% to a more reasonable level. The surcharge includes line losses of 11% (see Appendix A), which are high for a system the size of NETC's. These losses are probably an indication of failing to account for all consumption rather than actual distribution losses.

- Work with NETC to reduce the cost of thermal energy. As an alternative, assess the cost- effectiveness of installing either distributed hot water boilers or a central high-temperature hot water (HTHW) plant to supply the thermal loads of the NUWC compound.

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[a]All economic analyses are based on federal life cycle cost criteria as established in 10 CFR Part 436.

4.0 Issues

Several key issues must be considered. As a major customer, NUWC would like to be billed for its *actual* consumption and demand in lieu of using estimates. It should be recognized, however, that metering may actually show an increase in utilities consumed over that value based on estimates.

Additionally, NETC rates are quite high, reflecting a 21% surcharge for electricity over the cost of power from NE and a cost of $17.55/MBtu for steam. Reducing these rates will require improvements to the production, distribution, and end-use equipment.

Given the method used by the UCAR for setting rates based on total costs divided by total delivered energy, reducing the billable quantity of delivered energy through metering will simply raise the unit energy cost. The key is to reduce the cost of energy delivered, to accurately account for all energy, and then to apply an aggressive energy resource management program to reduce consumption and demand.

4.1 Consumption

Billing is currently based on consumption only, using the average cost of power provided. This gives the tenant little incentive to reduce his energy demand because the savings generated by an investment on his part are shared by everyone else. Given the low percentage of billing attributable to demand under the current rate scheme, consumption billing is probably the best option. If the new rate schedule is implemented, however, with the shift reflecting a greater emphasis on demand, large customers like NUWC may gain from a demand-based billing scheme. Demand-based billing for tenant activities is feasible only if NETC agrees to implement a coincident demand billing system. This is necessary if NUWC is to be charged for its portion of the NETC demand at the time the peak occurred.

The real question is, Why is the system being metered? If only for gross billing, then metering the feeders will provide adequate information. If for accurate billing of subtenants, then those subtenants must also be metered. If for energy management, then NUWC should extensively meter selected individual buildings to characterize loads and energy-use patterns. This should be followed with a comprehensive energy resource management program, coupled, if possible, with utility company demand-side management (DSM) programs.

4.2 Energy Resource Management

It should be recognized that metering the utilities and assessing the energy used does absolutely no good unless something is done with that information! Metering is a necessary and critical first step toward identifying an effective DSM program to reduce energy consumption and demand. Adjusting the utility bills to reflect actual consumption is also a good first step, but a comprehensive energy resource management program is necessary to take maximum advantage of the information to achieve the greatest possible reduction in the NUWC utility costs.

NUWC should make sure that it uses the demand-side management and rate structure incentives offered by its utility companies in this effort. Both the electric and gas/oil companies stand to gain from improvements made to the NUWC system. The electric company benefits from peak demand reduction and the procurement of additional generating capacity through conservation. The U.S. Navy represents roughly 20% of the NE gross sales, with minimal investment in billing and maintenance on the part of NE. It should be noted, however, that NE is predominantly a power broker, purchasing about 97% of its power from Montaup Electric in Massachusetts. NE has two diesel generator generating plants in Rhode Island and is part owner of an oil-fired steam turbine plant in Maine. These plants are used for peaking power as required. The gas/oil company will gain through the sale of a significant block of fuel to a single, stable customer. It is important to keep both the gas and oil companies as potential suppliers both for energy security and to maintain price competition.

4.3 Cost Reduction

Savings just as significant, if not more so, are to be gained from reducing the unit cost of the purchased utilities. Table 4.1 shows NETC's utility rates for FYs 1989 through 1992.

4.3.1 Electricity

As outlined in Table 2.2, more than 11% of the price of electricity charged to tenant

Table 4.1 Historical NETC Utility Rates

Fiscal Year	Steam, $/MBtu	Electricity - Purchased, $/MWh	Electricity - Tenants, $/MWh
1989	12.18	79.52	101.72
1990	14.02	79.97	97.12
1991	21.81	89.48	108.04
1992	17.55	88.25	107.05

activities in FY 1992 is for losses. Although there are some losses associated with the distribution lines and transformers, 11% appears to be high and is more likely an indication of unaccounted-for consumption. With the current state of the art in automatic meter reading (AMR), NETC should be able to accurately account for a much higher percentage of its consumption, holding tenants (or NETC) liable for its actual consumption rather than sharing the cost among all activities. NUWC should insist that NETC account for a much higher percentage of its consumption and reduce electric rates accordingly.

If NETC is unwilling to work toward more accurate billing, NUWC has the potential to purchase power directly from NE rather than through NETC. This would allow NUWC to avoid the added cost margin that NETC charges but would require additional NUWC maintenance effort for the distribution grid. This could be done by NETC at cost via a modification to the Intra-Service Support Agreement (ISSA) between NUWC and NETC, or by contracting with NE for maintenance services.

4.3.2 Thermal Power

Thermal energy (steam or high-temperature hot water) could be generated at a NUWC plant during the winter heating season for significantly less that the cost of purchased steam from NETC. Given the estimated size of the NUWC heating load, a packaged thermal plant could be used instead of the built-up plant required by NETC. Although not thoroughly analyzed, this would reduce the purchase, operating, and staffing requirements and costs. An alternative is to install packaged hot-water boilers in each building or group of buildings, to avoid the requirement for a distribution system. If steam is required for the pier (Facility 171), a packaged steam plant can be installed at the pier for use when required. This would also facilitate billing the fleet for the actual cost of providing utility services.

5.0 Metering Options

NUWC has multiple options, for both how to meter its electricity and steam and where to install those meters. This section will review those options and the advantages and disadvantages of each option.

5.1 Electricity Metering

Table 5.1 lists the options for electricity metering that will be reviewed. Table 5.2 summarizes the initial costs and life-cycle costs of the various electricity metering options. It does not give any allowance for energy savings realized as a result of the metering data. All costs shown are estimates and are for comparison of options only. More accurate costs can be estimated as part of the follow-on work.

5.1.1 Electricity Metering Locations

- *Meter the feeds only* - The majority of the NUWC compound can be metered with as few as four meters, one each at Substations 20 and 21 and at Buildings 1258 and 1259. This would allow total metering of the power entering and leaving the NUWC portion of the grid and would account for the bulk of direct power consumption and line/transformer losses beyond the main substation. The use of AMR meters with demand recording would allow recording of the demand profile and determination of the

Table 5.1 Options for Electricity Metering

	Use existing meters	Modify existing meters	Install AMR meters	Tie into SCADA	Install DDC [a] network
Meter the feeders			●	●	●
Meter the transformers	●	●	●	●	●
Meter the buildings			●		●

(a) Direct digital control

Table 5.2 Economic Analysis of Electricity Metering Options

Option	Initial Cost, Thousand $	Life-Cycle Cost, Thousand $
Meter the feeders - install AMR meters	58-74	306-383
Meter the feeders - tie into SCADA	47-59	295-369
Meter the feeders - tie into DDC network	59-73	306-383
Meter the transformers - existing meters (minimal data analysis)	0	1080-1350
Meter the transformers - modify existing meters	158-198	443-554
Meter the transformers - install AMR meters	580-724	2305-2500
Meter the transformers - tie into SCADA	327-409	1707-2134
Meter the transformers - tie into DDC network	339-424	1719-2149
Meter the buildings - install AMR meters (11 buildings)	206-258	454-567
Meter the buildings - tie into DDC network (11 buildings)	230-288	467-573

coincident demand to reflect the NUWC portion of the total NETC demand bill. Data can be collected and analyzed remotely, eliminating the requirement for on-site meter reading.

- *Meter the transformers* - This would allow further breakdown of the energy consumption and demand for improved energy management, assuming that the staff is available to perform that function. These meters currently exist at most of the transformers (some of the meters have been removed by the contractor replacing transformers) and are capable of providing valuable information but not coincident demand data. Demand reduction is difficult to implement accurately without the ability to analyze the demand data profile. Under the current billing scheme, however, these meters are sufficient. The problem is reading the meters, which requires staff for meter reading and the time and energy of a qualified engineer to evaluate the data. Initial indications are that data analysis beyond billing may not be viable because of staff limitations.

- *Meter the buildings* - This option would provide the ultimate in energy end-use characterization. By installing meters capable of recording a number of data channels, the energy consumption can be broken down to determine what portion is being used for various functions, such as chillers, air handlers, or lighting. In addition, these meters could be connected to the steam meters that have been installed in the buildings for data collection and analysis of questions such as, Does the steam flow profile match the expected profile, given the building's operating schedule? Given the number of buildings, however, this option would require the installation of AMR meters to allow remote data collection and automated analysis. Attempting to collect the information by hand would be prohibitively expensive in terms of staff. In any event, the information is of limited value unless someone has the expertise and time to analyze it and take action on the findings for energy management.

  Many of the buildings at NUWC are sheds, warehouses, garages, or other facilities with low energy consumption. The preferred option is to select a few key buildings with large energy use to be metered extensively. This would allow NUWC to accurately select and implement energy management strategies to reduce its energy bills.

A mix of these options represents the best solution. The feeders should be metered to determine the gross consumption and demand for billing purposes, with selected buildings extensively metered for an energy management program. Depending on the level of effort desired and funding available, as few as five buildings or as many as 25 buildings could be metered. The transformer meters provide easy access and make sense to meter if meter reading would be performed manually, but this is not the best solution, given the available technology and staff limitations.

5.1.2 Electricity Metering Implementation

As with any military installation, staff requirements must be kept to a minimum. System automation both reduces the labor requirement and, assuming that reliable equipment is installed, reduces the chance of meter reading and transcribing errors. Options for implementing metering include the following:

- *Install new automated meter reading meters* - Although it may seem wasteful to install new meters immediately after installing meters at each of the transformers in the NUWC compound, the installation of a reasonable number of AMR meters would allow for measurement of gross energy demand and consumption for billing purposes, with the more complete analysis of selected buildings for energy-use profiles. Remote reading meters can be highly automated, including meter reading, checks for obvious data errors, and data manipulation for billing and energy management, while keeping the staff requirement to a minimum and providing accurate utility consumption information. The meters can be connected via a hardwired network, radio, or telephone, depending on the availability of telephone lines. At least one telephone line is required for remote data collection.

- *More frequent reads of existing meters* - The existing meters can be read frequently (daily or weekly) to collect trend information. This option eliminates the initial capital investment in additional metering but at greatly increased long-term staff requirements. In addition, it does not allow the collection of a true demand profile to accurately evaluate demand reduction strategies.

- *Modify existing metering to allow remote reads* - The existing meters can be modified for remote querying, and software can be used to analyze the resulting data. This would allow the analysis of the demand profiles of the greatest spectrum of building types but not the detailed breakdown of consumption by energy end-use (e.g., chiller, air handlers).

- *Tie metering into a DDC network* - Although not designed for meter reading, a good DDC network is fully capable of performing that task. The installation of field interface devices at the feeders and buildings to be metered would lay the initial groundwork for a basewide DDC network. The advantages are twofold. First, it would establish the DDC network to which all other installations would need to conform. Until a true industry standard is implemented, a basewide DDC network needs to conform to a single manufacturer's control language. The second advantage is minimal staff requirements. Although there is some effort involved in maintaining and analyzing the metering system/data, the same people who maintain the DDC network can manage the metering system. The metering system would provide them valuable information on the performance of buildings, which can be tied to mechanical system performance.

- *Tie metering into the SCADA system* - The existing SCADA system is fully capable of handling the meter reading task with the addition of the necessary hardware and software. A remote terminal unit (RTU) would be installed at each of the metering points, with communication to the SCADA via telephone line, hardwired network, or radio. The necessary software would be added at the central terminal to automatically query the RTUs and analyze the data. The advantage of this option is that it could be easily expanded to the rest of the NETC distribution network, automating the entire meter reading process. In addition, NETC would be responsible for the maintenance and operation of the system. The disadvantage is that the SCADA is controlled by NETC, which limits the access that NUWC has to the information.

5.2 Steam Metering

Table 5.3 lists the options for steam metering that will be reviewed. Table 5.4 summarizes the initial costs and life-cycle costs of the various steam metering options. The analysis does not make any allowance for energy savings realized as a result of the metering data. The options for installing AMR meters, and for tying into a DDC network are made assuming that the electricity metering options have not been installed. Installing both steam and electricity metering would cost less than the apparent cost shown by adding the costs shown in Tables 5.2 and 5.4 because common infrastructure such as the AMR device or the

Table 5.3 Options for Steam Metering

	Use existing meters	Install new AMR meter	Adapt existing meters to AMR meters	Adapt existing meters to DDC network
Meter the main		●		
Meter the buildings	●		●	●

Table 5.4 Economic Analysis of Steam Metering Options

Option	Initial Cost, Thousand $	Life-Cycle Cost, Thousand $
Meter the main - install AMR meter	16-21	707-883
Meter the buildings - use existing meters	0	1080-1350
Meter the buildings - adapt existing meters to AMR meters (11 buildings)	104-130	1484-1855
Meter the buildings - tie into DDC network (11 buildings)	189-236	1569-1961

DDC field interface device would be common to both systems. All costs shown are estimates and are for comparison of options only. More accurate costs can be estimated as part of any follow-on work.

5.2.1 Steam Metering Locations

- *Meter the main* - Metering the steam main where it enters the NUWC compound would allow for measurement of total steam consumed by NUWC, while requiring only a single metering point. This is the only information required for billing and accounts for both the energy consumed by the buildings and the line losses within the NUWC compound. It is assumed that the existing CABCO meters have not been given routine preventive maintenance and that their accuracy has degraded over time. The CABCO meters should be replaced with a new meter of known accuracy, tied into a remote reading network to allow collection of the steam data at the same time as the electricity data.

- *Meter the buildings* - Metering the buildings would allow monitoring of the steam consumed by individual buildings. This option can be used to identify maintenance or operation problems with the end-use equipment by comparing the use profile to that expected, given the building's occupancy schedule. Higher than expected steam consumption can be used to identify failed pressure-reducing valves, steam traps, or heat exchangers. This information can be used for billing in lieu of metering the main and accounts for building consumption without the line losses within the NUWC compound.

5.2.2 Steam Metering Implementation

Although all meters require routine maintenance to retain their accuracy, it is important that the proper meter(s) be installed to minimize the staff requirement for maintenance and to provide the best accuracy.

- *Use the existing meters* - The existing meters, if properly maintained, will provide steam consumption data as frequently as they are read. The problem, however, is the location of the existing meters. They can be modified to allow reading at a more convenient location by installing a remote readout at the exterior of each building (at least for those that are difficult to read).

- *Install new AMR meters* - New state-of-the-art meters can be installed, allowing completely automatic meter reading and collection of an energy end-use profile.

- *Adapt existing meters to AMR meters* - The existing BIF meters can be modified by adding a pulse initiator to be tied in to AMR meters installed at select buildings for collection of energy end-use data. This makes use of both the existing BIF meters and the capability of AMR meters, assuming that NUWC selects the option of installing AMR meters.

- *Adapt existing meters to DDC network* - The existing BIF meters could also be modified by adding a pulse initiator to be tied in to a DDC device for remote metering. The benefits here are the same as for using a DDC network for electricity metering.

6.0 Cost Reduction

As outlined before, reducing the unit cost of utilities presents a major opportunity for reducing the utility budget. There are at least two possible approaches for cost reduction: 1) work with NETC to reduce the tenant rates or 2) install a separate electrical feeder and natural gas line and purchase energy directly from NE and the gas company (various options exist for supplying thermal energy for heating).

In either case (electricity or thermal), it is preferable, from the total Navy point of view, to improve the NETC utility system to reduce the cost of providing service rather than duplicating it. This would be a major undertaking, requiring NETC to more accurately account for energy consumed, and a complete overhaul, or even redesign, of the NETC thermal loop. It would require convincing NETC that it stands to lose a significant portion of its customer base if it does not improve its level of customer service, including providing utilities at a reasonable cost. If NETC is unwilling to make a firm commitment to reducing costs to a target level that is competitive given the options, NUWC should proceed with developing independent utility sources.

The first step in reducing costs, however, is to reduce the total energy consumed through a cost-effective energy resource management program. This will provide payback not only through direct conservation, but also by potentially reducing the cost of plant improvements by reducing the size of the generation, distribution, and end-use equipment needed.

Table 6.1 summarizes the initial costs and life-cycle costs of the various utility unit cost reduction options. All costs shown are estimates and are for comparison of options only. More accurate costs can be estimated as part of any follow-on work.

6.1 Electricity

Providing a separate NE feeder can be accomplished by installing a 69/13.8-kV transformer at Substation 21 and bringing in the new feeder at that location. This would involve an expansion of the existing substation. This does NOT entail a complete disconnection from the existing NETC grid and, in fact, improves the energy security by providing an alternate feeder for the entire base grid. The NUWC compound can be disconnected from the NETC grid by manipulating switches at Substations 1, 20, and 21, and knife switches in the vicinity of Buildings 11 and 80. An additional knife switch would be required to isolate Building 11 from NETC. By manipulating switches rather than permanently disconnecting from the NETC grid, additional security is provided for both NUWC and NETC.

As explained previously, under the current rate schedule NETC purchases an initial block of power and energy at a higher rate, with all additional power and energy at reduced rate.

Table 6.1 Economic Analysis of Utility Cost Reduction Options

Option	Initial Cost, Thousand $	Life-Cycle Cost, Million $
Electricity Unit Cost		
Status quo	0	171
Reduce unit costs by accounting for all consumption (assume that NUWC absorbs 45% of unaccounted-for consumption)	483-604	167
Install separate NE feeder (assume NUWC consumption increases by amount equal to 45% of unaccounted-for consumption)	500	164
Thermal Power Unit Cost		
Status quo	0	52
Reduce unit rates by improving central plant, distribution system, and end-use equipment (NUWC pays for improvements to its end-use equipment only)	525-656	36-45
Install NUWC steam plant (includes improvement to end-use equipment)	952-1191	31-39
Install NUWC HTHW plant (includes modifications to end-use equipment)	2101-2636	24-30
Install boilers in each NUWC building	1139-1424	23-29

The new schedule proposed by NE would almost eliminate the block structure (the new schedule includes a $0.24/kVA-reactive charge of reactive power in excess of 17.5% of the total power), shifting to a demand and time-of-use structure. Under the current schedule, there is a penalty to the Navy for NUWC to establish a separate billing contract, because the initial block of higher cost power must be purchased twice, first by NETC and then by NUWC. The penalty would almost disappear under the new schedule, but there would still be an additional cost of having separate demand meters, assuming that the NUWC and NETC peaks are not coincident. Except in the case of coincident demands (of which there is an extremely low probability), the demand cost would be higher with two meters and bills than with the single NETC bill and meter.

6.2 Thermal Power

If NETC is willing to work toward reduced utility rates, many options are worth investigating, including improvements to the existing steam systems (productions, distribution, and end use), conversion to HTHW, and cogeneration of electrical and thermal power. This would require a complete investigation of the technical and economic feasibility of the options to identify which one has the greatest payback to the Navy.

If NETC is unwilling, however, to pursue cost reductions, options for disconnecting from the NETC steam system include installation of a central steam or HTHW plant, or the installation of boilers at each building. The final recommendation may include a combination of these options. The absence of residential or large dining facilities makes the implementation of a distributed or alternative thermal supply system easier (these facilities have large peaks not normally seen in office, laboratory, or warehouse buildings).

NUWC is on a branch of the NETC steam network and does not pass steam on to other tenants. This makes it easier to disconnect from the NETC system and adopt a separate thermal system strategy. The existing steam piping and heating equipment could be used if a steam system were installed. Given the higher thermal losses associated with steam, the poor condition of many of the critical existing components (e.g., traps, condensate pumps, pressure-reducing valves), and the high maintenance associated with steam, this is not recommended. The existing steam and condensate lines would have to be evaluated to see if they could be reused, although it is most likely that a new HTHW distribution system would be required.

A new thermal plant utilizing natural gas (with oil as a backup for both energy security and to avoid having a sole source of fuel) could be installed in the NUWC compound and staffed either by NUWC maintenance personnel or by a service contractor. The installation of package boilers would simplify the cost of installing and operating the boilers. Use of multiple boilers providing incremental capacity would allow closer matching of the plant load to the NUWC compound load. Options such as automatic burner control and thermal plant output (temperature and flow rate) modulated with weather conditions can be used to provide peak efficiency.

An alternative to a central plant is installing hot water boilers at each building (or group of buildings). This would eliminate the requirements for a HTHW distribution loop and staff for the central plant. It would increase the cost of facility maintenance because the individual boilers would require maintenance, although they are generally reliable if given proper preventive maintenance.

An additional problem (although probably a minor one) is that with distributed boilers, it would be more difficult to store and use dual fuels to maintain fuel backup and price competition between the gas and oil suppliers. It is much easier with a central plant to switch between fuels than using multiple fuels in multiple boilers installed around the NUWC compound. This would have to be traded-off against the differences in system efficiencies between a central plant and distributed plants, and the distribution system losses associated with a central plant.

Appendix A

Utility Cost Analysis

Appendix A

Utility Cost Analysis

	Steam		Electricity	
Quantity purchased	697,859	MBtu	119,998	MWh
Production losses	85,211		0	
Distribution losses	251,773		13,313	
Transfers	0		1,685	
Net delivered	360,875	MBtu	105,000	MWh
Losses	48	%	11	%
Production/purchase				
Labor	775,000	$	0	$
Material	305,252		0	
Contracts	400,395		0	
General expenses	43,538		0	
Fuel oil	3,643,506		0	
Steam	0		0	
Electricity	113,056		10,589,824	
Water	240,000		0	
Sewage	176,250		0	
Natural Gas	46,575	$	0	$
Distribution				
Labor	110,000	$	340,000	$
Material	60,000		123,000	
Contracts	166,000		249,000	
General expenses	7,124	$	24,540	$
Total delivered cost	6,086,695	$	11,146,027	$
Activity rate (to tenants)	17.55	$/MBtu	107.05	$/MWh
			31.37	$/MBtu
Unit purchased cost (by NETC)	6.05	$/MBtu	88.25	$/MWh
			25.86	$/MBtu
Surcharge	190	%	21	%

Note: Unit purchased cost includes cost of fuel oil, steam, electricity, water, sewage, and natural gas used in production. Unit delivered cost includes purchased cost and production/distribution costs.

Data taken from FY92-UCAR-E7 dated 7/20/92 11:26 AM

Appendix B

Newport Electric Rate Schedule Summary (Current)

Appendix B

Newport Electric Rate Schedule Summary (Current)

Demand charge:	
First 5,000 kW of billing demand or less per month	$21,515
All additional kW of billing demand	$2.81 per kW
Credit for transformer ownership by customer	$0.138 per kW
Energy charge:	
First 340 hours use of billing demand per month	$0.0592 per kWh
All additional kWh used per month	$0.0554 per kWh
Primary metering:	
Credit for metering at line voltage (not less than 23 kV)	2.5 %

The billing demand in kilowatts for each month shall be the greater of (a) the maximum demand adjusted for power factor each month, (b) 75% of the maximum billing demand established by customer during any of the immediately preceding eleven month, (c) 50% of the maximum billing demand established by customer during the life of the contract, or (d) 5,000 kilowatts.

Cost Adjustment Factors ($/kWh)

	Purchased Power	Fuel Adjustment	Uniform Conservation	Total
1991				
Jan-Feb	0.02589	-0.00160	0.00012	0.02441
Mar-Jun	0.03922	-0.00810	0.00012	0.03124
Jul-Oct	0.04182	-0.01500	0.00012	0.02694
Nov-Dec	0.04228	-0.01800	0.00012	0.02440
1992				
Jan-Feb	0.04228	-0.01800	0.00010	0.02438
Mar-Jun	0.05071	-0.02200	0.00010	0.02881

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