

FINAL SUBMITTAL

ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)

LIMITED ENERGY STUDY

WATERVLIET ARSENAL

WATERVLIET, NEW YORK

VOLUME II

APPENDICES

19971016 261

CONTRACT NO. DACA65-91-C-0072

PREPARED FOR:

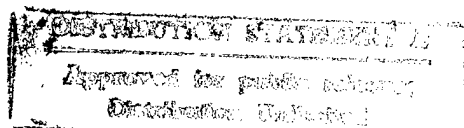
U.S. ARMY CORPS OF ENGINEERS
NORFOLK, VIRGINIA

PREPARED BY:

ENERGY AND ENVIRONMENTAL SERVICES DEPARTMENT
REYNOLDS, SMITH AND HILLS, INC.
P.O. BOX 4850
JACKSONVILLE, FLORIDA 32201

RS&H PROJECT NO. 2900379002

AUGUST 1992



8/92

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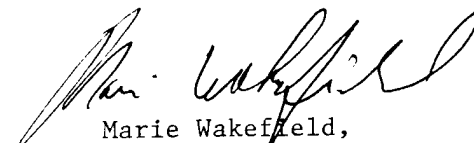


DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
P.O. BOX 9005
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Marie Wakefield,
Librarian Engineering

VOLUME II
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- Appendix B - Backup Data, Calculations and Cost Estimates

APPENDIX A

**PRENEGOTIATION MINUTES
AND
SCOPE OF WORK**

18 December 1990

MEMORANDUM THRU Chiefs, Special Projects Sec
Military Programs Br

FOR Contract File

SUBJECT: Record of Preliminary Negotiations with Reynolds, Smith & Hills, Inc., Jacksonville, FL for A-E Services in Connection with Preparation of the Limited Energy Study (LES) for Energy Engineering Analysis Program (EEAP), Watervliet Arsenal, NY; DACA-65-91-C-004212

1. Authority to perform subject work is contained in CESAM-EN-CC memo dated 15 Aug 1990, Subject: Energy Engineering Analysis Program (EEAP), FY91 Program for Norfolk District, which authorizes an EEAP LES at Watervliet Arsenal.

2. The scope of work consists of reviewing the previously completed Energy Engineering Analysis Program (EEAP) study which applies to the specific building, system, or energy conservation opportunity (ECOS) covered by this study; performing a limited site survey of specific buildings or areas to collect all data required to evaluate the specific ECOS included in this study; reevaluating the specific project or ECO from the previous study to determine its economic feasibility based on revised criteria, current site conditions, and technical applicability; evaluating specific ECOS to determine their energy savings potential and economic feasibility; providing project documentation for recommended ECOS; and preparing a comprehensive report to document all work performed, the results, and the recommendations. The scope of work and services to be performed are further described in enclosed Scope of Work for an LES at Watervliet Arsenal.

3. The project scope of work and proposed A-E services were discussed in detail at a preliminary negotiations meeting and site visit held at Watervliet Arsenal in Building 120 on 6 December 1990 at 0830 among the following:

Participant
Paul Hutchins
Bill Face
Frank Mercurio
Timpy Uppal
Bryant Wilkins

Representing
RSH
SMCWV-EHE
SMCWV-EHE
SMSWV-ODP-IO
CENAO-EN-MS

4. The following schedule for the project was agreed to, subject to timely receipt of additional Government furnished information which is essential to the performance of the A-E contract. The periods of time for A-E services are obligatory. Deviations in the schedule by the Government will in no way abrogate the time periods for the A-E:

Start effort immediately after award of of the contract such that effort will be Complete & Approved not later than 365 days after award of the contract.

5. The quantities of documents required at the various submissions are as shown in enclosed detailed scope of work.

6. The A-E was requested to expedite preparation of the proposal.

Enclosure



BRYANT WILKINS
Project Manager
Special Projects Section

James N. Thomasson, P.E.
Chief, Engineering Division

The preceding Record of Preliminary Negotiations adequately describes my understanding of the scope of the proposed A-E contract and the work to be performed by our firm. I am familiar with Clause (Responsibilities of the Architect-Engineer).



Authorized Representative of
Reynolds, Smith & Hills, Inc.

PRENEGOTIATION MEETING--WATERVLIET ARSENAL LIMITED ENERGY STUDY
ADDITIONAL NOTES

- o Power factor correction is desired.
- o Architectural modifications are difficult on many buildings due to historical value.
- o Project has been designed for heat exchanger on Building 125 exhaust system. WVA is looking at a completely new system with make-up air.
- o Exhaust heat recovery is possible in Building 25.
- o Reduce OSA intake in Building 44.
- o Cogeneration is popular.
- o Niagra Mohawk is the utility.
- o Evaluating switch from No. 6 fuel oil to natural gas.
- o Five boilers, 135 psia, two 50 k#/hr, two 100 k#/hr, one 25 k#/hr.
- o Natural gas used in donkey boiler, Selas Furnace and some heat treat.
- o Steam used for space heating in all buildings except Building 10, where it is converted to hot water.
- o Largest energy users--Tocco induction furnace, rotary forge.
- o Air compressors have cooling towers; others for heat treat, Selas furnace and Tocco furnace.
- o Only significant space cooling is in Building 40, Benet Labs, two 750-ton chillers.
- o Donkey boiler is used only for process steam in Building 35 during the summer--25 k#/hr.
- o Weatherization; none except Building 22, Building 4 (second floor) and Building 10 (unit 4/5).
- o Metering ~30 electric, five natural gas and a few steam.
- o Condensate is not returned from chrome plating in Building 35. Could be used to preheat boiler make-up water.

CESAM-EN-CC

May 1991
Revision 2

GENERAL SCOPE OF WORK

FOR A

LIMITED ENERGY STUDY

WATERVLIET ARSENAL

WATERVLIET, NY

DACA-65-91-C-0072

Performed as part of the

ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)

BASIC CONTRACT - INDUSTRIAL FACILITIES AT WVAD

OPTION - ANCILLARY FACILITIES AT WVAD

**SCOPE OF WORK
FOR A
LIMITED ENERGY STUDY
WATERVLIET ARSENAL**

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ANNEXES

- A - DETAILED SCOPE OF WORK
- B - EXECUTIVE SUMMARY GUIDELINE

1. BRIEF DESCRIPTION OF WORK: The Architect-Engineer (AE) shall:

1.1 Review the previously completed Energy Engineering Analysis Program (EEAP) study which applies to the specific building, system, or energy conservation opportunity (ECO) covered by this study.

1.2 Perform a limited site survey of specific buildings or areas to collect all data required to evaluate the specific ECOs included in this study.

1.3 Reevaluate the specific project or ECO from the previous study to determine its economic feasibility based on revised criteria, current site conditions and technical applicability.

1.4 Evaluate specific ECOs to determine their energy savings potential and economic feasibility.

1.5 Provide project documentation for recommended ECOs as detailed herein.

1.6 Prepare a comprehensive report to document all work performed, the results and all recommendations.

2. GENERAL

2.1 This study is limited to the evaluation of the specific buildings, systems, or ECOs listed in Annex A, DETAILED SCOPE OF WORK.

2.2 The information and analysis outlined herein are considered to be minimum requirements for adequate performance of this study.

2.3 For the buildings, systems or ECOs listed in Annex A, all methods of energy conservation which are reasonable and practical shall be considered, including improvements of operational methods and procedures as well as the physical facilities. All energy conservation opportunities which produce energy or dollar savings shall be documented in this report. Any energy conservation opportunity considered infeasible shall also be documented in the report with reasons for elimination.

2.4 The study shall consider the use of all energy sources applicable to each building, system, or ECO.

2.5 The "Energy Conservation Investment Program (ECIP) Guidance", described in letter from CEHSC-FU, dated 25 April 1988 and the latest revision from CEHSC-FU establishes criteria for ECIP projects and shall be used for performing the economic analyses of all ECOs and projects. The program, Life Cycle Cost In Design (LCCID), has been developed for performing life cycle cost calculations in accordance with ECIP guidelines and is referenced

in the ECIP Guidance. If any program other than LCCID is proposed for life cycle cost analysis, it must use the mode of calculation specified in the ECIP Guidance. The output must be in the format of the ECIP LCCA summary sheet, and it must be submitted for approval to the Contracting Officer.

2.6 Computer modeling will be used to determine the energy savings of ECOs which would replace or significantly change an existing heating, ventilating, and air-conditioning (HVAC) system. The requirement to use computer modeling applies only to heated and air-conditioned or air-conditioned-only buildings which exceed 8,000 square feet or heated-only buildings in excess of 20,000 square feet. Modeling will be done using a professionally recognized and proven computer program or programs that integrate architectural features with air-conditioning, heating, lighting and other energy-producing or consuming systems. These programs will be capable of simulating the features, systems, and thermal loads of the building under study. The program will use established weather data files and may perform calculations on a true hour-by-hour basis or may condense the weather files and the number of calculations into several "typical" days per month. The Detailed Scope of Work, Annex A, will list programs that are acceptable to the Contracting Officer. If the AE desires to use a different program, it must be submitted for approval with a sample run, an explanation of all input and output data, and a summary of program methodology and energy evaluation capabilities.

2.7 Energy conservation opportunities determined to be technically and economically feasible shall be developed into projects acceptable to the installation personnel. This may involve combining similar ECOs into larger packages which will qualify for ECIP, MCA, or PCIP funding. However, preparation of programming documents such as DD Forms 1391, Project Development Brochures, or DA Forms 5108-R will not be required.

2.7.1 Projects which qualify for ECIP funding shall be identified, separately listed, and prioritized by the Savings to Investment Ratio (SIR).

2.7.2 All feasible non-ECIP projects shall be ranked in order of highest to lowest SIR.

2.7.3 At some installations Energy Conservation and Management (ECAM) funding will be used instead of ECIP funding. The criteria for each program is the same. The Director of Engineering and Housing will indicate which program is used at this installation. This Scope of Work mentions only ECIP, however, ECAM is also meant.

3. PROJECT MANAGEMENT

3.1 Project Managers. The AE shall designate a project manager to serve as a point of contact and liaison for work required under this contract. Upon award of this contract, the

individual shall be immediately designated in writing. The AE's designated project manager shall be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for coordination of work required under this contract. The Contracting Officer will designate a project manager to serve as the Government's point of contact and liaison for all work required under this contract. This individual will be the Government's representative.

3.2 Installation Assistance. The Commanding Officer or authorized representative at the installation will designate an individual to assist the AE in obtaining information and establishing contacts necessary to accomplish the work required under this contract. This individual will be the installation representative.

3.3 Public Disclosures. The AE shall make no public announcements or disclosures relative to information contained or developed in this contract, except as authorized by the Contracting Officer.

3.4 Meetings. Meetings will be scheduled whenever requested by the AE or the Contracting Officer for the resolution of questions or problems encountered in the performance of the work. The AE's project manager and the Government's representative shall be required to attend and participate in all meetings pertinent to the work required under this contract as directed by the Contracting Officer. These meetings, if necessary, are in addition to the presentation and review conferences.

3.5 Site Visits, Inspections, and Investigations. The AE shall visit and inspect/investigate the site of the project as necessary and required during the preparation and accomplishment of the work.

3.6 Records

3.6.1 The AE shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with Government representative(s) relative to this contract in which the AE and/or designated representative(s) thereof participated. These records shall be dated and shall identify the contract number, and modification number if applicable, participating personnel, subject discussed and conclusions reached. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the records.

3.6.2 The AE shall provide a record of requests for and/or receipt of Government-furnished material, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of the work under this contract. The records shall be dated and shall identify the contract number and modification number, if applicable. The AE shall

forward to the Contracting Officer within ten calendar days, a reproducible copy of the record of request or receipt of material.

3.7 Interviews. The AE and the Government's representative shall conduct entry and exit interviews with the Director of Engineering and Housing before starting work at the installation and after completion of the field work. The Government's representative shall schedule the interviews at least one week in advance.

3.7.1 Entry. The entry interview shall describe the intended procedures for the survey and shall be conducted prior to commencing work at the facility. As a minimum, the interview shall cover the following points:

- a. Schedules.
- b. Names of energy analysts who will be conducting the site survey.
- c. Proposed working hours.
- d. Support requirements from the Director of Engineering and Housing.

3.7.2 Exit. The exit interview shall briefly describe the items surveyed and probable areas of energy conservation. The interview shall also solicit input and advice from the Director of Engineering and Housing.

4. SERVICES AND MATERIALS. All services, materials (except those specifically enumerated to be furnished by the Government), plant, labor, supervision and travel necessary to perform the work and render the data required under this contract are included in the lump sum price of the contract.

5. PROJECT DOCUMENTATION. All energy conservation opportunities which the AE has considered shall be included in one of the following categories and presented in the report as such:

5.1 ECIP Projects. To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than \$200,000, a Savings to Investment Ratio greater than one and a simple payback period of less than four years. For ECAM projects, the \$200,000 limitation may not apply; in such cases, the AE shall check with the installation for guidance. The overall project and each discrete part of the project shall have an SIR greater than one. All projects meeting the above criteria shall be arranged as specified in paragraph 2.7.1 and provided with the following documentation: life cycle cost analysis (LCCA) summary sheet, description of the work to be accomplished, backup data for the LCCA, ie, energy savings calculations and cost estimate(s), and the simple payback period. The energy savings for projects consisting of multiple ECOs must

take into account the synergistic effects of the individual ECOs. [For projects and ECOs reevaluated from previous studies, the backup data shall consist of copies of the original calculations and analysis, with new pages revising the original calculations and analysis. In addition, the backup data shall include as much of the following as is available: the increment of work under which the project or ECO was developed in the previous study, title(s) of the project(s), the energy to cost (E/C) ratio, the benefit to cost (B/C) ratio, the current working estimate (CWE), and the payback period. The purpose of this information is to provide a means to prevent duplication of projects in any future reports.]

5.2 Non-ECIP Projects. Projects which do not meet ECIP criteria with regard to cost estimate, payback period, or nonenergy (75%) qualification test, but which have an SIR greater than one shall be documented. Projects or ECOs in this category shall be arranged as specified in paragraph 2.7.2 and provided with the following documentation: the life cycle cost analysis (LCCA) summary sheet completely filled out, a description of the work to be accomplished, backup data for the LCCA, ie, energy savings calculations and cost estimate(s), and the simple payback period. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs. In addition, these projects shall be grouped as required by the Government's representative, for one of the following categories:

a. Quick Return on Investment Program (QRIP). This program is for projects which have a total cost not over \$100,000 and a simple payback period of two years or less.

b. OSD Productivity Investment Funding (OSD PIF). This program is for projects which have a total cost of more than \$100,000 and a simple payback period of four years or less.

c. Productivity Enhancing Capital Investment Program (PECIP). This program is for projects which have a total cost of more than \$3,000 and a simple payback period of four years or less.

The above programs are all described in detail in AR 5-4, Change No. 1.

d. Regular Military Construction Army (MCA) Program. This program is for projects which have a total cost greater than \$200,000 and a simple payback period of four to twenty-five years.

e. Low Cost/No Cost Projects. These are projects which the Director of Engineering and Housing can perform using his resources.

5.3 Nonfeasible ECOs. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with reasons and justifications showing why they were rejected.

6. DETAILED SCOPE OF WORK. The Detailed Scope of Work is contained in Annex A.

7. WORK TO BE ACCOMPLISHED.

7.1 Review Previous Studies. Review the previous EEAP study which applies to the specific building, system, or ECO covered by this study. This review should acquaint the AE with the work that has been performed previously. Much of the information the AE may need to develop the ECOs in this study may be contained in the previous study.

7.2 Perform a Limited Site Survey. The AE shall obtain all necessary data to evaluate the ECOs or projects by conducting a site survey. However, the AE is encouraged to use any data that may have been documented in a previous study. The AE shall document his site survey on forms developed for the survey, or standard forms, and submit these completed forms as part of the report. All test and/or measurement equipment shall be properly calibrated prior to its use.

7.3 Reevaluate Selected Projects. The AE shall reevaluate the projects and ECOs listed in Annex A. These are projects and ECOs that the previous study has identified but that have not been accomplished or only parts have been accomplished. If the project or ECO is acceptable as is, that is, there are no changes to the basic project or ECO, the energy savings shown in the previous project may be accepted as accurate but the energy cost and construction cost estimates shall be updated based on the most current data available. With the above information the project shall then be analyzed based on current ECIP criteria. If the project or ECO is basically acceptable but some of the buildings in the original project have been deleted or new buildings can be added, the necessary changes shall be made to the energy savings, the energy costs and construction costs shall be updated, and the revised project or ECO shall then be analyzed using current ECIP guidance. If the original project or ECO has had numerous changes made to it so that all of the numbers are suspected of being inaccurate, but the project or ECO is still considered feasible, the AE shall develop the project from the beginning and analyze it with the current ECIP guidance. These projects shall be separately listed in the report.

7.4 Evaluate Selected ECOs. The AE shall analyze the ECOs listed in Annex A. These ECOs shall be analyzed in detail to determine their feasibility. Savings to Investment Ratios (SIRs) shall be determined using current ECIP guidance. The AE shall provide all data and calculations needed to support the recommended ECO. All assumptions shall be clearly stated. Calculations shall be prepared showing how all numbers in the ECO were figured. Calculations shall be an orderly step-by-step progression from the first assumption to the final number. Descriptions of the products, manufacturers catalog cuts, pertinent drawings and sketches shall also be included. A life cycle cost analysis summary sheet shall

be prepared for each ECO and included as part of the supporting data.

7.5 Combine ECOs Into Recommended Projects. During the Interim Review Conference, as outlined in paragraph [7.6.1], the AE will be advised of the DEH's preferred packaging of recommended ECOs into projects for implementation. Some projects may be a combination of several ECOs, and others may contain only one. These projects will be evaluated and arranged as outlined in paragraphs 5.1, 5.2, and 5.3. Energy savings calculations shall take into account the synergistic effects of multiple ECOs within a project and the effects of one project upon another. The results of this effort will be reported in the Final Submittal per par [7.6.2].

7.6 Submittals, Presentations and Reviews. The work accomplished shall be fully documented by a comprehensive report. The report shall have a table of contents and shall be indexed. Tabs and dividers shall clearly and distinctly divide sections, subsections, and appendices. All pages shall be numbered. Names of the persons primarily responsible for the project shall be included. The AE shall give a formal presentation of the interim submittal to installation, command, and other Government personnel. Slides or view graphs showing the results of the study to date shall be used during the presentation. During the presentation, the personnel in attendance shall be given ample opportunity to ask questions and discuss any changes deemed necessary to the study. A review conference will be conducted the same day, following the presentation. Each comment presented at the review conference will be discussed and resolved or action items assigned. It is anticipated that the presentation and review conference will require approximately one working day. The presentation and review conference will be at the installation on the date agreeable to the Director of Engineering and Housing, the AE and the Government's representative. The Contracting Officer may require a resubmittal of any document(s), if such document(s) are not approved because they are determined by the Contracting Officer to be inadequate for the intended purpose.

7.6.1 Interim Submittal. An interim report shall be submitted for review after the field survey has been completed and an analysis has been performed on all of the ECOs. The report shall indicate the work which has been accomplished to date, illustrate the methods and justifications of the approaches taken and contain a plan of the work remaining to complete the study. Calculations showing energy and dollar savings, SIR, and simple payback period of all the ECOs shall be included. The results of the ECO analyses shall be summarized by lists as follows:

a. All ECOs eliminated from consideration shall be grouped into one listing with reasons for their elimination as discussed in par 5.3.

b. All ECOs which were analyzed shall be grouped into two listings, recommended and non-recommended, each arranged in order

of descending SIR. These lists may be subdivided by building or area as appropriate for the study.

The AE shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing the work and results to date shall be a part of this submittal. At the Interim Submittal and Review Conference, the Government's and AE's representatives shall coordinate with the Director of Engineering and Housing to provide the AE with direction for packaging or combining ECOs for programming purposes and also indicate the fiscal year for which the programming or implementation documentation shall be prepared. The survey forms completed during this audit shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they are to be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within.

7.6.2 Final Submittal. The AE shall prepare and submit the final report when all sections of the report are 100% complete and all comments from the interim submittal have been resolved. The AE shall submit the Scope of Work for the study and any modifications to the Scope of Work as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The recommended projects, as determined in accordance with paragraph 5, shall be presented in order of priority by SIR. The lists of ECOs specified in paragraph [7.6.1] shall also be included for continuity. The final report and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The final report shall be arranged to include:

a. An Executive Summary to give a brief overview of what was accomplished and the results of this study using graphs, tables and charts as much as possible (See Annex B for minimum requirements).

b. The narrative report describing the problem to be studied, the approach to be used, and the results of this study.

c. Documentation for the recommended projects (includes LCCA Summary Sheets).

d. Appendices to include as a minimum:

- 1) Energy cost development and backup data
- 2) Detailed calculations
- 3) Cost estimates
- 4) Computer printouts (where applicable)
- 5) Scope of Work

ANNEX A

**DETAIL SCOPE OF WORK
LIMITED ENERGY STUDY
WATERVLIET ARSENAL**

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BUILDINGS TO BE AUDITED AND GENERAL ECOs

Building No. BASIC INDUSTRIAL FACILITIES
Description

35	Med. Caliber Tube Bldg.
110 (South end)	Heavy Caliber Tube Bldg.
125	Breech Comp. & Weld Shop Bldg.
135	Heavy Caliber Tube Shop

General ECOs

- Waste heat recovery from industrial processes
- Industrial process ventilation and exhaust systems
- Industrial process controls
- Energy-efficient motors and variable frequency drives

OPTION 1 - ANCILLARY FACILITIES

Number	Building Number	Description
1	10	Campbell Hall
2	15	Garage (Motor Pool)
3	20	Major Component Building
4	21	O'Keefe Hall
5	22	Fire Station
6	23	Operations Office
7	24	Operations Office
8	25	Minor Comp. Bldg. & Op. Offices
9	38	Storehouse and Museum
10	40	Benet Labs & Others
11	44	Dalliba Hall/Product Assurance
12	110	(Remainder) Heavy Caliber Tube Bldg.
13	115	Maggs Research Center
14	120	Facilities Offices and Shops
15	130	Storehouse/Processing Bldg.
16	136	Boiler Plant
17	145	Warehouse & Property Disposal

GENERAL ECOs

- Steam distribution and condensate return systems
- Building ventilation and exhaust systems
- Radiant heating
- Space heating controls
- Energy-efficient lighting
- Energy-efficient ballasts
- Lighting controls (including occupancy sensors, photocells, separate switching)
- Fluorescent fixture reflectors

SPECIFIC ECOs

- Power factor correction for electrical system
- Fuel switch from FSR to Natural Gas (Building #136)
- Cogeneration
- Reduce heat loss in dip tank operation (Building #35)
- Electrical demand peak reduction
- Improve steam distribution and condensate return system.

ECOs TO BE UPDATED

- None -

SCHEDULE OF ACTIVITIES

<u>Activity</u>	<u>Calendar Days (NTP Plus)</u>
NTP	0
Interim Submittal	145
Interim Review Conference	195
Prefinal Submittal	235
Prefinal Review Conference	270
Prefinal (Corrected)/Final Submittal	305

SUBMITTAL DISTRIBUTION LIST

Address	Interim 60%	Final 100%
Commander U.S. Army Engineer Division, North Atlantic ATTN: CENAD-EN-MM 90 Church Street New York, NY 10007	2 cys	2 cys
Commander Office of Chief of Engineerg ATTN: CEEC-EE (McCarty) Pulaski Building Washington, DC 20314	Executive Summary Only 1 cy	1 cy
Commander U.S. Army Engineer District, Norfolk Attn: CENAO-EN-MP (Wilkins) 803 Front Street Norfolk, VA 23510	2 cys	2 cys
Army Energy Office ATTN: DALO-LEP (Keath) New Cumberland Army Depot New Cumberland, PA 17070	Executive Summary Only 1 cy	1 cy
Commander Watervliet Arsenal ATTN: SMCWV-FE (Bill Face) Building 120 Watervliet, NY 12189	2 cys	2 cys
Commander USAMC Installations & Services Activity ATTN: AMXEN B (G. Badtram) Building 60, 2nd Floor Rock Island, IL 61299-7190	1 cy	1 cy
	9	9

GOVERNMENT FURNISHED CRITERIA

1. Building information schedule (manual).
2. Production equipment schedule.
3. Utility procurement records (including reimburseable).
4. Facilities engineering technical data support.
5. Equipment modernization/acquisition plan.
6. Basic utility systems information maps.
7. Equipment layout and utilization records.
8. Final reports of previously completed studies performed under the Energy Engineering Analysis Program (EEAP). Only portions pertaining to the industrial facilities, if any, need to be made available.
9. Latest copies of any other energy studies performed since the previous EEAP study. Only portions pertaining to the industrial facilities, if any, need to be made available.
10. Energy Resources Management Plan.
11. ETLs 1110-3-282, Energy Conservation; 1110-3-318, Procedures for Programming Energy Monitoring and Control Systems (EMCS) Funded Through the MCA Program; 1110-3-332, Economic Studies; and 1110-3-354, Direct Digital Control of Heating, Ventilation and Air Conditioning (HVAC) Systems.
12. Architectural and engineering instructions.
13. Energy Conservation Investment Program (ECIP) Guidance, dated 25 April 1988 and revision dated 15 June 1989.
14. Information on Existing EMCS Studies, Designs, Construction Contracts, or Operating Systems.
15. TM 5-785, Engineering Weather Data; TM 5-800-2, General Criteria Preparation of Cost Estimation; TM 5-800-3, Project Development Brochure; and TM 5-815-2, Energy Monitoring and Control Systems (EMCS).
16. AR 415-15, Military Construction Army (MCA) Program Development; AR 415-17, Cost Estimating for Military Programming; AR 415-20, Construction, Project Development and Design Approval; AR 415-28, Department of the Army Facility Classes and Construction Categories; AR 415-35, Construction, Minor

Construction; AR 420-10, General Provisions, Organization, Functions and Personnel; AR 11-27, Army Energy Program; and AR 5-4, Change Number 1, Department of the Army Productivity Improvement Program.

17. HNDSP-84-076-ED-ME, Preliminary Survey and Feasibility Study for Energy Monitoring and Control Systems.

18. NCEL CR 82.030, Standardized EMCS Energy Savings Calculations. (Only if needed for this study.)

19. HNDSP88-207-ED-ME, HNDSP88-208-ED-ME, HNDSP88-209-ED-ME and HNDSP88-210-ED-ME, EMCS Cost Estimating Guides.

20. The latest applicable Engineer Improvement Recommendation System (EIRS) bulletin.

21. An example of a correctly completed programming document for an ECIP/ECAM project.

22. Production data.

23. EEAP PRC (11/84)

24. Energy Management Proposal, Niagra-Mohawk (10/90)

SPECIAL REQUIREMENTS AND INFORMATION

1. Point of contact at Watervliet Arsenal and liaison for all work required under this contract is:

Bill Face
Watervliet Arsenal
ATTN: SMCWV-FE
Building 120
Watervliet, NY
Phone: (518) 266-4225

2. The fiscal year to which all ECIP projects should be estimated to and programming or implementation documents prepared for is FY TBD. Depending on project packaging, the Installation Commander may determine different program years for the final report. Remaining projects shall be escalated to a FY TBD.

3. A computer program titled Life Cycle Costing in Design (LCCID) is available from the BLAST Support Office in Urbana, Illinois for a nominal fee. The computer program can be used for performing the economic calculations for ECIP and non-ECIP ECOs. The AE is encouraged to obtain this computer program. The BLAST Support Office can be contacted at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana, Illinois 61801. The telephone number is (217) 333-3977. AE shall indicate in writing what program will be used.

4. Consolidated review comments will be provided to AE by Project Manager about 14 days prior to review conferences. AE will review each comment and provide consolidated proposed responses to Project Manager 48 hours prior to conference.

5. AE will provide cover letter with all submittals noting a review is required and that a Review Conference is scheduled approximately 45 days hence. Letter will also inform recipients of letter to follow from Norfolk District COE setting exact conference date.

6. Acceptable programs for computer modeling of building energy systems are:

- a. BLAST*
- b. DOE 2.1B*
- c. Carrier E20 or HAP**
- d. TRACE**

*Very accurate, but requires a lot of time for input; therefore, rather expensive for straightforward projects.

**Adequate for load determination, equipment selection, and energy performance for most projects.

ANNEX B

EXECUTIVE SUMMARY GUIDELINE

1. Introduction.
2. Building Data (types, number of similar buildings, sizes, etc.)
3. Present Energy Consumption of Buildings or Systems Studied.
 - o Total Annual Energy Used.
 - o Source Energy Consumption.
 - Electricity - KWH, Dollars, BTU
 - Fuel Oil - GALS, Dollars, BTU
 - Natural Gas - THERMS, Dollars, BTU
 - Propane - GALS, Dollars, BTU
 - Other - QTY, Dollars, BTU
4. Reevaluated Projects Results.
5. Energy Conservation Analysis.
 - o ECOs Investigated.
 - o ECOs Recommended.
 - o ECOs Rejected. (Provide economics or reasons)
 - o ECIP Projects Developed. (Provide list)*
 - o Non-ECIP Projects Developed. (Provide list)*
 - o Operational or Policy Change Recommendations.

* Include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date.
6. Energy and Cost Savings.
 - o Total Potential Energy and Cost Savings.
 - o Percentage of Energy Conserved.
 - o Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented.

APPENDIX B

BACKUP DATA AND CALCULATIONS

APPENDIX B
BACKUP DATA, CALCULATIONS AND COST ESTIMATES

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ENERGY PRICES, DATA, BASIC ASSUMPTIONS, ECONOMIC PARAMETERS

WATERVLIET ARSENAL
ENERGY PRICES AND ECONOMIC PARAMETERS

ENERGY PRICES:

Electricity: 3,413 Btu/kwh, \$0.06945/kwh or \$20.35/MBtu (average)

Customer Charge: \$305.17 per month

On-Peak Energy Charge: \$0.0605/kwh, \$17.73/MBtu

(0800-2200 hrs M-F)

Off-Peak Energy Charge: \$0.045 kwh, \$13.18/MBtu

Demand Charge: \$5.77/kw/month (on-peak)

Power Factor Charge: \$0.873/kva of lagging reactive demand (KVAR)

Source: Niagara Mohawk Electric Bill (July 1991)

Natural Gas: 100,000 Btu/therm,

Firm: \$0.416/therm or \$4.16/MBtu (average)

Spot and Transportation = \$2.99 + \$0.44 = \$3.43/MBtu

Source: Watervliet Arsenal Engineering

Fuel Oil No. 2: 138,690 Btu/gallon, \$0.69/gallon, \$5.00/MBtu

Source: Watervliet Arsenal Engineering (FY 92 rates)

Fuel Oil No. 6: 149,690 Btu/gallon, \$0.66/gallon, \$4.40/MBtu

Source: Watervliet Arsenal Engineering (FY 92 rates)

BASIS FOR COST ESTIMATES:

<u>Adjustment</u>	<u>Labor</u>	<u>Material</u>	<u>Comments</u>
Sales Tax	N.A.	N.A.	WVA is tax exempt
FICA/Insurance	20.0%	N.A.	
Overhead	15.0%		
Profit	10.0%		
Performance Bond	1.0%		
Contingency	10.0%		
SIOH	6.0%		Input by LCCID Program
Design Fees	6.0%		Input by LCCID Program

ADDS REPORT: PROD - AEO MACOMDB REPORT

RUN ON : 06/28/91 08:56:18

FOR : W16H1F WATERVLIET ARSENAL

UTILITIES CONSUMPTION -- TOTAL FACILITY

PRODUCT/PRODUCT GROUP

	FY90 COST (\$000)	FY85 CONSUMPTION (MBTUS)	FY88 CONSUMPTION (MBTUS)	FY89 CONSUMPTION (MBTUS)	FY90 CONSUMPTION (MBTUS)	90 VS 85 PER CENT CHANGE	\$/MBTU
UTILITY							
ELC	3,300	167,869	176,704	171,257	172,574	-2.80	19.12
NA6	310	58,318	84,136	200,697	65,675	-12.1b	4.72
* SUBTOTAL *	3,610	226,187	260,840	371,954	238,249	-5.33	15.15
PETROLEUM							
FSD	50	6,570	8,079	7,613	12,320	-87.52	4.04
FSR	983	318,306	301,751	275,371	277,616	12.78	3.54
* SUBTOTAL *	1,033	324,876	309,830	282,984	289,936	10.75	3.56
* * TOTAL * *	4,643	551,063	570,670	654,938	528,185	4.15	8.79

ADDS REPORT: PROQUE - DEIS-II PRODUCT QUERY
 INCLUDES : FROM OCT89 THRU SEP90
 RUN ON : 06/28/91 08:48:24
 FOR : WIGHIF WATERVLIET ARSENAL
 UNITS ARE : MBTUS

PROD CODE	FY	MONTH	BUILDING CONSUMED	PROCESS CONSUMED	F. HOUSING CONSUMED	MSE CONSUMED	TOTAL CONSUMED
ELC	90	OCT 89	13642	0	201	0	13843
		NOV 89	14365	0	253	0	14618
		DEC 89	13823	0	235	0	14058
		JAN 90	14212	0	270	0	14482
		FEB 90	13495	0	246	0	13741
		MAR 90	15341	0	239	0	15580
		APR 90	13928	0	218	0	14146
		MAY 90	13867	0	225	0	14092
		JUN 90	15058	0	218	0	15276
		JUL 90	14273	0	215	0	14488
		AUG 90	12700	0	229	0	12929
		SEP 90	15099	0	222	0	15321
			-----	-----	-----	-----	-----
			169803	0	2771	0	172574

ADDS REPORT: PROQUE - DEIS-II PRODUCT QUERY
 INCLUDES : FROM SEP89 THRU SEP90
 RUN ON : 06/28/91 08:51:12
 FOR : WIGHIF WATERVLIET ARSENAL
 UNITS ARE : MBTUS

PROD CODE	FY	MONTH	BUILDING CONSUMED	PROCESS CONSUMED	F. HOUSING CONSUMED	MSE CONSUMED	TOTAL CONSUMED
NAG	90	OCT 89	5477	0	0	0	5477
		NOV 89	4262	0	5	0	4267
		DEC 89	5645	0	5	0	5650
		JAN 90	6183	0	22	0	6205
		FEB 90	4037	0	22	0	4059
		MAR 90	5175	0	14	0	5189
		APR 90	5508	0	14	0	5522
		MAY 90	9006	0	13	0	9019
		JUN 90	8117	0	0	0	8117
		JUL 90	4024	0	3	0	4027
		AUG 90	3196	0	0	0	3196
		SEP 90	4945	0	2	0	4947
			-----	-----	-----	-----	-----
			65575	0	100	0	65675

ADDS REPORT: PROQUE - DEIS-II PRODUCT QUERY

INCLUDES : FROM OCT89 THRU SEP90

RUN ON : 06/28/91 08:52:40

FOR : W16H1F WATERVLIET ARSENAL

UNITS ARE : MBTUS

PROD CODE	FY	MONTH	BUILDING CONSUMED	PROCESS CONSUMED	F. HOUSING CONSUMED	MSE CONSUMED	TOTAL CONSUMED
FSR	90	OCT 89	22262	0	692	0	22954
		NOV 89	38558	0	1088	0	39646
		DEC 89	54024	0	1855	0	55879
		JAN 90	42066	0	2207	0	44273
		FEB 90	52830	0	1685	0	54515
		MAR 90	36012	0	0	0	36012
		APR 90	14209	0	666	0	14875
		MAY 90	9462	0	0	0	9462
			-----	-----	-----	-----	-----
			269423	0	8193	0	277616

ADDS REPORT: PROQUE - DEIS-II PRODUCT QUERY

INCLUDES : FROM OCT89 THRU SEP90

RUN ON : 06/28/91 08:53:41

FOR : W16H1F WATERVLIET ARSENAL

UNITS ARE : MBTUS

PROD CODE	FY	MONTH	BUILDING CONSUMED	PROCESS CONSUMED	F. HOUSING CONSUMED	MSE CONSUMED	TOTAL CONSUMED
FSD	90	OCT 89	70	0	367	0	437
		NOV 89	635	0	0	0	635
		DEC 89	431	0	0	0	431
		JAN 90	2149	0	0	0	2149
		FEB 90	967	0	0	0	967
		MAR 90	239	0	0	0	239
		APR 90	3926	0	0	0	3926
		MAY 90	2674	0	0	0	2674
		JUN 90	47	0	0	0	47
		JUL 90	58	0	0	0	58
		AUG 90	87	0	414	0	501
		SEP 90	256	0	0	0	256
			-----	-----	-----	-----	-----
			11539	0	781	0	12320

PAGE 1
 ADDS REPORT: PROD - AEO MACOMDB REPORT
 RUN ON : 02/06/92 10:31:53
 FOR : W16H1F WATERVLIET ARSENAL
 UTILITIES CONSUMPTION -- TOTAL FACILITY

PRODUCT/PRODUCT GROUP

	FY91 COST (\$000)	FY85 CONSUMPTION (MBTUS)	FY89 CONSUMPTION (MBTUS)	FY90 CONSUMPTION (MBTUS)	FY91 CONSUMPTION (MBTUS)	91 VS 85 PER CENT CHANGE	\$/MBTU
UTILITY							
ELC	3,671	167,869	171,257	172,574	~~104,997~~ 182,203	~~37.45~~ 8.54	~~34.96~~ 20.15
NAG	355	58,318	~~200,697~~ 87,410	65,675	~~69,731~~ 84,527	~~-19.57~~ 44.94	5.10
* SUBTOTAL *	4,026	226,187	~~371,954~~	238,249	~~174,728~~ 266,730	~~-22.75~~ 17.72	23.04
PETROLEUM			258,667				
FSD	58	6,570	~~7,613~~ 6743	~~12,320~~ 1393	~~7,853~~ 2002	~~-19.53~~ -69.53	7.43
FSR	1,939	318,306	275,371	~~277,616~~ 286,335	~~293,237~~ 302,279	~~-7.00~~ -5.04	6.61
FSX	0	N/A	N/A	N/A	~~500~~ 0	N/A	0.00
* SUBTOTAL *	1,998	324,876	~~282,984~~ 282,114	~~289,936~~ 293,728	~~301,590~~ 304,281	~~-7.17~~ -6.34	6.62
** TOTAL **	6,024	551,063	~~654,938~~ 540,781	~~528,185~~ 531,977	~~476,318~~ 571,011	~~-13.56~~ 3.62	12.65

* Obvious errors in DEIS data were corrected for FY89, 90 & 91 using information supplied by WVA engineering.

PAGE 1
 ADDS REPORT: PROQUE - DEIS-II PRODUCT QUERY
 INCLUDES : FROM OCT90 THRU SEP91
 RUN ON : 02/06/92 10:36:24
 FOR : W16H1F WATERVLIET ARSENAL
 UNITS ARE : MBTUS

PROD CODE	FY	MONTH	BUILDING CONSUMED	PROCESS CONSUMED	F. HOUSING CONSUMED	MSE CONSUMED	TOTAL CONSUMED
ELC	91	OCT 90	15096	0	198	0	~~15294~~ 14,163
		NOV 90	15782	0	253	0	~~16035~~ 15,893
		DEC 90	14604	0	249	0	~~14853~~ 14,727
		JAN 91	14492	0	242	0	~~14734~~ 14,628
		FEB 91	5976	0	253	0	~~6229~~ 16,178
		MAR 91	5341	0	253	0	~~5594~~ 15,450
		APR 91	6655	0	259	0	~~6914~~ 14,359
		MAY 91	6498	0	232	0	~~6730~~ 14,129
		JUN 91	6935	0	205	0	~~7140~~ 16,184
		JUL 91	4031	0	229	0	~~4260~~ 16,107
		AUG 91	2904	0	184	0	~~3088~~ 14,671
		SEP 91	3887	0	239	0	~~4126~~ 14,688
	*		102201	0	2796	0	104997 181,177
FSD	91	OCT 90	76	0	553	0	629
		NOV 90	64	0	0	0	64
		DEC 90	431	0	1549	0	1980
		JAN 91	361	0	548	0	909
		FEB 91	501	0	845	0	1346
		MAR 91	408	0	431	0	839
		APR 91	285	0	670	0	955
		MAY 91	204	0	705	0	909
		JUN 91	82	0	0	0	82
		JUL 91	47	0	0	0	47
		SEP 91	93	0	0	0	93
	*		2552	0	5301	0	7853
FSR	91	OCT 90	15032	0	654	0	15686
		NOV 90	33604	0	1320	0	34924
		DEC 90	55074	0	1798	0	56872
		JAN 91	46216	0	2075	0	~~48291~~ 57,300
		FEB 91	49466	0	1855	0	51321
		MAR 91	40275	0	1364	0	41639
		APR 91	33931	0	754	0	34685
		MAY 91	6375	0	704	0	7079
		JUN 91	1930	0	0	0	1930
		AUG 91	163	0	0	0	163
		SEP 91	648	0	0	0	648
	*		282714	0	10524	0	~~293238~~ 302,247
FSX	91	JAN 91	128	0	0	0	128
		FEB 91	124	0	0	0	124
		MAR 91	112	0	0	0	112
		APR 91	136	0	0	0	136

PAGE 2

ADDS REPORT: PROQUE - DEIS-II PRODUCT QUERY

INCLUDES : FROM OCT90 THRU SEP91

RUN ON : 02/06/92 10:37:13

FOR : W16H1F WATERVLIET ARSENAL

UNITS ARE : MBTUS

PROD CODE	FY	MONTH	BUILDING CONSUMED	PROCESS CONSUMED	F. HOUSING CONSUMED	MSE CONSUMED	TOTAL CONSUMED	
*			500	0	0	0	500	
NAG	91	OCT 90	~~9549~~ 9600	0	0	0	9549	
		NOV 90	~~4995~~ 4900	0	11	0	4906	
		DEC 90	~~4751~~ 4700	0	0	0	4751	
		JAN 91	~~4211~~ 4000	0	32	0	4243	
		FEB 91	~~5529~~ 5300	0	0	0	5529	
		MAR 91	~~5579~~ 6100	0	0	0	5579	
		APR 91	~~6186~~ 5000	0	0	0	6186	
		MAY 91	~~6289~~ 6800	0	12	0	6301	
		JUN 91	~~6186~~ 10,900	0	0	0	6186	
		JUL 91	~~5155~~ 7300	0	2	0	5157	
		AUG 91	~~6186~~ 7200	0	0	0	6186	
		SEP 91	~~5155~~ 10,700	0	2	0	5157	
*			69671	84,500	0	59	0	69730

Note: Obvious errors in DEIS data were corrected for FY 89, 90 & 91 using information supplied by WVA engineering.

WEATHER DATA

STATE	WINTER DESIGN DATA HEATING				DEGREE DAYS	SUMMER DESIGN DATA AIR CONDITIONING										SUMMER CRITERIA DATA AIR CONDITIONING				
	LOCATION					Dry Bulb					Wet Bulb					Dry Bulb		Wet Bulb		
						Mean Daily Range					5% MCWB					≥ 93°F		≥ 73°F		
						Pdg Wind Speed					Pdg Wind					≥ 93°F		≥ 73°F		
						Lat	Long	Elev	feet	annual	1% MCWB	2.5% MCWB	Pdg Wind	5% MCWB	1% MCWB	2.5% 5%	hrs	hrs	hrs	hrs
NEW MEXICO (CONT)																				
	32 47	105 49	9240	W	7968	81 54	79 54	21	SW	76 54	59 58	57	0	59	0	0	0			
	33 14	107 16	4858		3392	97 63	95 62	28	S	93 62	67 66	66	185	1374	0	65	65			
	35 11	103 36	4039		4047	99 66	97 66	30	SW	95 65	70 69	68	248	1232	1	418	418			
	33 18	104 32	3676		3697	100 66	98 66	29	SSE	96 66	71 70	69	350	1560	5	583	583			
	32 23	106 29	4330		2526	99 64	97 64	24	SE	95 64	69 68	67	278	1781	10	198	198			
	35 31	108 35	6680		5915	89 59	88 58	34	WSW	85 57	64 62	61	4	512	0	1	1			
	35 06	108 47	6440		5815	90 59	89 58	34	WSW	86 58	64 62	61	8	616	0	1	1			
NEW YORK																				
	42 45	73 48	275	W	6888	91 73	88 72	25	S	85 70	75 74	72	16	417	132	775	775			
	40 45	74 00	40		4909	92 74	89 73	18	SW	87 72	76 75	74	25	602	309	1243	1243			
	42 13	75 59	1590		7285	86 71	83 69	21	WSW	81 68	73 72	70	2	205	41	518	518			
	40 42	73 58	15		4909	92 74	89 73	18	SW	87 72	76 75	74	25	602	309	1243	1243			
	42 56	78 44	705		6927	88 71	85 70	21	SW	83 69	74 73	72	2	346	92	731	731			
	44 02	75 46	655		7601	86 71	83 70	26	W	80 69	75 73	71	2	168	77	552	552			
	42 29	79 16	692		6851	88 73	85 72	20	WSW	83 71	75 74	72	2	317	141	814	814			
	40 36	74 02	21		5184	90 73	87 72	17	SSW	84 71	76 75	74	8	383	275	1222	1222			
	40 34	73 54	10		5184	90 73	87 72	17	SSW	84 71	76 75	74	8	383	275	1222	1222			
	40 48	73 47	35		4812	92 74	89 73	18	SW	87 72	76 75	74	25	602	309	1243	1243			
	40 36	74 03	135		5184	90 73	87 72	17	SSW	84 71	76 75	74	8	383	275	1222	1222			
	40 38	73 35	15		5184	90 73	87 72	17	SSW	84 71	76 75	74	8	383	275	1222	1222			
	43 20	73 37	328		7270	88 72	85 71	25	S	82 69	74 73	71	6	277	80	591	591			
	43 14	75 25	514		7331	88 71	85 70	26	W	83 69	75 73	71	3	306	84	611	611			
	40 52	73 24	100		5084	91 74	88 73	19	SSW	85 72	77 76	74	21	476	331	1284	1284			
	42 29	76 28	1099		7052	88 71	85 71	31	SW	82 70	74 73	71	5	252	73	625	625			
	42 09	79 15	1723		6849	88 70	86 70	29	WSW	83 69	74 72	71	1	305	50	627	627			
	43 07	76 13	400		6678	90 73	87 71	24	NNW	84 70	75 73	72	8	412	107	745	745			
	43 08	78 50	638		6724	89 74	86 72	23	SW	84 71	76 74	73	4	350	162	814	814			
	41 04	71 52	110		5771	82 70	79 70	14	SW	77 69	74 73	72	0	52	93	873	873			
	40 50	73 47	70		5161	92 74	89 73	18	SW	87 72	76 75	74	25	602	309	1243	1243			
	40 39	73 47	13		5184	90 73	87 72	17	SSW	84 71	76 75	74	8	383	275	1222	1222			
	40 46	73 54	11		4909	92 74	89 73	18	SW	87 72	76 75	74	25	602	309	1243	1243			
	40 45	74 00	40		4909	92 74	89 73	18	SW	87 72	76 75	74	25	602	309	1243	1243			
	41 30	74 06	471		6336	90 73	88 72	23	W	85 70	76 74	73	14	460	175	886	886			

ALBANY NEW YORK

Temperature Range	NOVEMBER				DECEMBER				JANUARY				FEBRUARY				MARCH				APRIL				ANNUAL TOTAL			
	Obsn		Total		Obsn		Total		Obsn		Total		Obsn		Total		Obsn		Total		Obsn		Total		Obsn		Total	
	Hour Gp		M		Hour Gp		M		Hour Gp		M		Hour Gp		M		Hour Gp		M		Hour Gp		M		Hour Gp		M	
	01	09	17	24	01	09	17	24	01	09	17	24	01	09	17	24	01	09	17	24	01	09	17	24	01	09	17	24
95/99	08	16	24		08	16	24		08	16	24		08	16	24		08	16	24		08	16	24		08	16	24	
90/94																												
85/89																												
80/84																												
75/79																												
70/74																												
65/69																												
60/64																												
55/59																												
50/54																												
45/49																												
40/44																												
35/39																												
30/34																												
25/29																												
20/24																												
15/19																												
10/14																												
5/9																												
0/4																												
-5/-1																												
-10/-6																												
-15/-11																												
-20/-16																												
-25/-21																												

LAT 42 45N LONG 73 48W ELEV 275 FT

MEAN FREQUENCY OF OCCURRENCE OF DRY BULB TEMPERATURE (DEGREES F) WITH MEAN COINCIDENT WET BULB TEMPERATURE (DEGREES F) FOR EACH DRY BULB TEMPERATURE RANGE

Temperature Range	MAY										JUNE										JULY										AUGUST										SEPTEMBER										OCTOBER									
	Obsn					Total Obsn	M	C	W	B	Obsn					Total Obsn	M	C	W	B	Obsn					Total Obsn	M	C	W	B	Obsn					Total Obsn	M	C	W	B																				
	Hour Gp										Hour Gp										Hour Gp										Hour Gp										Hour Gp																			
	01 to 08	09 to 16	17 to 24	25 to 31	32 to 36						01 to 08	09 to 16	17 to 24	25 to 31	32 to 36						01 to 08	09 to 16	17 to 24	25 to 31	32 to 36						01 to 08	09 to 16	17 to 24	25 to 31	32 to 36						01 to 08	09 to 16	17 to 24	25 to 31	32 to 36	01 to 08	09 to 16	17 to 24	25 to 31	32 to 36	01 to 08	09 to 16	17 to 24	25 to 31	32 to 36					
95/99	1	0	1	70	1	0	1	76	4	0	4	74	1	0	1	75	1	0	1	76	2	55	27	84	68	1	48	18	67	59	0	18	5	23	71	0	0	0	62																					
90/94	4	1	5	67	6	1	7	73	14	4	18	73	6	1	7	73	6	1	7	73	21	5	26	71	21	5	26	71	9	2	11	73	9	2	11	73	0	0	0	62																				
85/89	13	5	18	65	1	39	17	57	2	55	27	84	68	1	48	18	67	59	0	18	5	23	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62																					
80/84	1	25	10	36	63	6	49	31	86	12	64	44	120	67	6	64	38	108	66	2	30	14	46	67	11	1	12	64	11	1	12	64	11	1	12	64	11	1	12	64																				
75/79	3	35	21	59	60	23	45	42	110	63	44	47	62	153	65	29	60	57	146	55	15	40	28	83	64	1	18	7	26	62	1	18	7	26	62	1	18	7	26	62																				
70/74	12	45	37	94	57	49	39	52	140	61	80	21	59	160	63	62	32	63	157	63	24	48	34	106	60	4	28	13	45	58	4	28	13	45	58	4	28	13	45	58																				
65/69	29	42	42	113	54	56	24	45	125	57	58	4	28	90	59	65	12	42	119	59	37	47	47	131	57	11	44	27	82	55	11	44	27	82	55	11	44	27	82	55																				
60/64	44	38	46	128	51	53	12	30	95	53	32	1	10	43	55	47	3	18	68	55	46	28	46	120	53	30	47	43	120	52	30	47	43	120	52	30	47	43	120	52																				
55/59	52	26	37	115	47	36	3	12	51	49	16	2	18	51	27	6	33	51	45	13	34	92	49	38	43	48	129	47	38	43	48	129	47	38	43	48	129	47	38	43	48	129	47																	
50/54	52	14	32	98	43	12	2	14	45	3	3	46	11	0	11	47	38	4	20	62	45	50	33	47	130	44	50	33	47	130	44	50	33	47	130	44	50	33	47	130	44																			
45/49	34	5	14	53	39	4	0	4	41	0	0	41	1	1	43	19	0	7	26	41	43	14	34	91	39	43	14	34	91	39	43	14	34	91	39	43	14	34	91	39	43	14	34	91	39															
40/44	14	0	3	17	35	1	1	37	1	1	0	0	0	0	0	0	10	2	12	36	35	4	4	0	4	32	31	7	17	60	35	7	17	60	35	7	17	60	35	7	17	60	35																	
35/39	7	0	7	31	31	3	3	31	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3															
30/34	1	1	1	28	1	1	1	28	1	1	1	28	1	1	1	28	1	1	1	28	1	1	1	28	1	1	1	28	1	1	1	28	1	1	1	28	1	1	1	28	1	1	1	28	1	1	1	28												
25/29																																																												
20/24																																																												

ALBANY NEW YORK

OUTSIDE AIR HEATING REQUIREMENTS

WATERVLIET ARSENAL LIMITED ENERGY STUDY

Operation Hrs/Day = 8

Room or Supply Air Conditions - Winter 68
Air Quantity (cfm) 1

Hour Fractions 1 AM - 9 AM 0.25
9 AM - 5 PM 0.75
5 PM - 1 AM 0

Operation Days Per Week 5

	Temp. Range	Hours of Occurrence			Total Hours	Delta H or T	Const.	CFM	BTU/HR	Total BTU
		2-9	10-17	18-1						
70	74	115	257	222	222	-4	1.08	1	0	0
65	69	234	235	271	235	1	1.08	1	1	254
60	64	263	212	252	225	6	1.08	1	6	1,456
55	59	274	190	236	211	11	1.08	1	12	2,507
50	54	263	183	214	203	16	1.08	1	17	3,508
45	49	242	183	205	198	21	1.08	1	23	4,485
40	44	229	202	205	209	26	1.08	1	28	5,862
35	39	261	241	251	246	31	1.08	1	33	8,236
30	34	295	220	262	239	36	1.08	1	39	9,283
25	29	216	156	191	171	41	1.08	1	44	7,572
20	24	163	112	130	125	46	1.08	1	50	6,198
15	19	110	79	96	87	51	1.08	1	55	4,776
10	14	84	43	65	53	56	1.08	1	60	3,221
5	9	60	27	38	35	61	1.08	1	66	2,322
0	4	37	16	22	21	66	1.08	1	71	1,515
-5	-1	27	3	9	9	71	1.08	1	77	690
-10	-6	10	0	4	3	76	1.08	1	82	205
-15	-11	5	0	0	1	81	1.08	1	87	109
-20	-16	3	0	0	1	86	1.08	1	93	70
=====										
Totals		2891	2359	2673	2492					62,269

Total Operation Hours While Heating
(and corrected for working days/week) 1621 44,478

Avg outdoor temp while heating (F) 42.3

WATERVLIET ARSENAL LIMITED ENERGY STUDY

Operation Hrs/Day = 16

Room or Supply Air Conditions - Winter 68
Air Quantity (cfm) 1

Hour Fractions 1 AM - 9 AM 0.375
9 AM - 5 PM 1
5 PM - 1 AM 0.625

Operation Days Per Week 5

Temp. Range	Hours of Occurrence			Total Hours	Delta H or T	Const.	CFM	BTU/HR	Total BTU
	2-9	10-17	18-1						
70	74	115	257	222	439	-4	1.08	1	0
65	69	234	235	271	492	1	1.08	1	531
60	64	263	212	252	468	6	1.08	1	3,033
55	59	274	190	236	440	11	1.08	1	5,230
50	54	263	183	214	415	16	1.08	1	7,178
45	49	242	183	205	402	21	1.08	1	9,115
40	44	229	202	205	416	26	1.08	1	11,681
35	39	261	241	251	496	31	1.08	1	16,598
30	34	295	220	262	494	36	1.08	1	19,221
25	29	216	156	191	356	41	1.08	1	15,780
20	24	163	112	130	254	46	1.08	1	12,637
15	19	110	79	96	180	51	1.08	1	9,928
10	14	84	43	65	115	56	1.08	1	6,963
5	9	60	27	38	73	61	1.08	1	4,826
0	4	37	16	22	44	66	1.08	1	3,110
-5	-1	27	3	9	19	71	1.08	1	1,438
-10	-6	10	0	4	6	76	1.08	1	513
-15	-11	5	0	0	2	81	1.08	1	164
-20	-16	3	0	0	1	86	1.08	1	104
=====									
Totals	2891	2359	2673	5114					128,051

Total Operation Hours While Heating
(and corrected for working days/week) 3338 91,465

Avg outdoor temp while heating (F) 42.3

WATERVLIET ARSENAL LIMITED ENERGY STUDY

Operation Hrs/Day = 24

Room or Supply Air Conditions - Winter 68
Air Quantity (cfm) 1

Hour Fractions 1 AM - 9 AM 1
9 AM - 5 PM 1
5 PM - 1 AM 1

Operation Days Per Week 5

Temp. Range	Hours of Occurrence			Total Hours	Delta H or T	Const.	CFM	BTU/HR	Total BTU
	2-9	10-17	18-1						
70	74	115	257	222	594	-4	1.08	1	0
65	69	234	235	271	740	1	1.08	1	799
60	64	263	212	252	727	6	1.08	1	4,711
55	59	274	190	236	700	11	1.08	1	8,316
50	54	263	183	214	660	16	1.08	1	11,405
45	49	242	183	205	630	21	1.08	1	14,288
40	44	229	202	205	636	26	1.08	1	17,859
35	39	261	241	251	753	31	1.08	1	25,210
30	34	295	220	262	777	36	1.08	1	30,210
25	29	216	156	191	563	41	1.08	1	24,930
20	24	163	112	130	405	46	1.08	1	20,120
15	19	110	79	96	285	51	1.08	1	15,698
10	14	84	43	65	192	56	1.08	1	11,612
5	9	60	27	38	125	61	1.08	1	8,235
0	4	37	16	22	75	66	1.08	1	5,346
-5	-1	27	3	9	39	71	1.08	1	2,991
-10	-6	10	0	4	14	76	1.08	1	1,149
-15	-11	5	0	0	5	81	1.08	1	437
-20	-16	3	0	0	3	86	1.08	1	279
=====									
Totals	2891	2359	2673	7923					203,595

Total Operation Hours While Heating
(and corrected for working days/week) 5233 145,425

Avg outdoor temp while heating (F) 42.3

WATERVLIET ARSENAL LIMITED ENERGY STUDY

Operation Hrs/Day = 24

Room or Supply Air Conditions - Winter 68
Air Quantity (cfm) 1

Hour Fractions 1 AM - 9 AM 1
9 AM - 5 PM 1
5 PM - 1 AM 1

Operation Days Per Week 7

Temp. Range	Hours of Occurrence			Total Hours	Delta H or T	Const.	CFM	BTU/HR	Total BTU
	2-9	10-17	18-1						
70	74	115	257	222	594	-4	1.08	1	0
65	69	234	235	271	740	1	1.08	1	799
60	64	263	212	252	727	6	1.08	1	4,711
55	59	274	190	236	700	11	1.08	1	8,316
50	54	263	183	214	660	16	1.08	1	11,405
45	49	242	183	205	630	21	1.08	1	14,288
40	44	229	202	205	636	26	1.08	1	17,859
35	39	261	241	251	753	31	1.08	1	25,210
30	34	295	220	262	777	36	1.08	1	30,210
25	29	216	156	191	563	41	1.08	1	24,930
20	24	163	112	130	405	46	1.08	1	20,120
15	19	110	79	96	285	51	1.08	1	15,698
10	14	84	43	65	192	56	1.08	1	11,612
5	9	60	27	38	125	61	1.08	1	8,235
0	4	37	16	22	75	66	1.08	1	5,346
-5	-1	27	3	9	39	71	1.08	1	2,991
-10	-6	10	0	4	14	76	1.08	1	1,149
-15	-11	5	0	0	5	81	1.08	1	437
-20	-16	3	0	0	3	86	1.08	1	279
=====									
Totals	2891	2359	2673	7923					203,595

Total Operation Hours While Heating
(corrected for working days/week) 7326 203,595

Avg outdoor temp while heating (F) 42.3



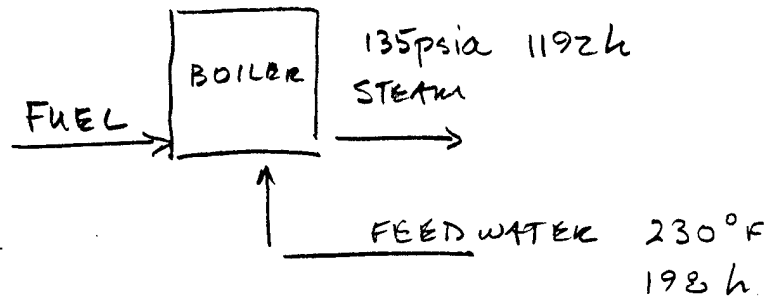
SUBJECT _____
DESIGNER P. H. H. H. H.
CHECKER B. Todd

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

BOILER PLANT EFFICIENCIES

- Calculate Average Boiler Plant Efficiency

Bldg 136



$$EFF = \frac{\text{STEAM PRODUCED}}{\text{FUEL}}$$

Data from March and April '90 were used since Boiler #3, the primary boiler, was utilized extensively.

$$EFF = \frac{(38,739,000 + 25,616,000) \# * (1192 - 198) \text{ Btu} / \#}{(309,436 + 205,867) \text{ gal} * 150,000 \frac{\text{Btu}}{\text{gal}}} = \underline{\underline{0.83}}$$

Bldg 35

Using data from August 90

$$EFF = \frac{(3,676,600) \# * (1192 - 198) \text{ Btu} / \#}{46,329 \text{ ccf} * 1031 \text{ Btu} / \text{ccf} * 100 \text{ ccf} / \text{ccf}} = \underline{\underline{0.77}}$$

ECO CALCULATION AND COST ESTIMATES

ECO CALCULATIONS AND COST ESTIMATES

TABLE OF CONTENTS

ECO #	Description	Page Nos.
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3	Cogeneration	3-1
4	Dip tank covers and variable-speed drives	4-1
5	Electrical demand peak reduction	5-1
6	Plating area condensate return system	6-1
7	Cooling tower variable speed drives	7-1
8	High-efficiency fluorescent lighting	8-1
9	Not used	
10	High-efficiency electric motors	10-1
11	Boiler O ₂ trim controls	11-1
12	Natural gas boilers	12-1
13	Air flow reduction	13-1
14	High-efficiency chiller	14-1
15	EMCS	15-1
16	Return air system	16-1
17	Double-pane windows	17-1
18	Storm windows	18-1
19	Occupancy sensors	19-1

ECO 1

Power Factor Improvement

Assumptions:

1. Motors selected for power factor improvement are operated on a regular basis.
2. The capacitors will be installed ahead of each piece of motor driven equipment.
3. Reactive Electric demand charge is \$0.865/KVAR.

Calculations:

Annual Cost Savings :

Motors for buildings 20, 110 and 135 were tabulated by horsepower. (details are located on pages 1-17 → 1-27.

Capacitor size recommendations were obtained from Consulting / Specifying Engineer, July 1988, Page 97, Table 3. (copy is located on page 1-14 of this appendix.

$$\text{Savings} = \text{Capacitor KVAR} \times \$0.865 / \text{KVAR} \cdot \text{mo.} \times 12 \text{ mo./yr.}$$

$$\text{Savings} = \text{Capacitor KVAR} \times \$10.38 / \text{KVAR} \cdot \text{Year}$$

Savings for the motors in each building were calculated on computer spreadsheets. These calculations are located on pages 1-8 through 1-10

ECO 1 - Continued

The total savings for each building are:

Bldg. 20 : \$3,724

Bldg. 110 : \$11,325

Bldg. 135 : \$15,829

\$30,878 = Total Annual Savings

Construction Cost:

A regression analysis was performed to calculate a cost curve for the capacitors. Cost data was obtained from Means Electrical Cost Data, 1991. The regression analysis is located on page 1-7 of this appendix.

The bare material and labor costs are tabulated on pages 1-4 through 1-6.

Total Construction Cost = \$130,930 (see page 1-3 for details)

Simple Payback

$$\frac{\text{Cost}}{\text{Savings}} = \frac{\$130,930}{\$30,878/\text{yr}} = \underline{\underline{4.2 \text{ years}}}$$

. 02/05/92

ECO Construction Cost Estimate
Calculations

ECO Name: POWER FACTOR IMPROVEMENT

ECO #: 1

1991 ECO "bare" costs (from cost estimate sheet)

Material	\$70,131
Labor	\$19,192

Subtotal bare costs	\$89,323

FICA Insurance (20% of Labor)	\$3,838

Sales Tax (Not Applicable For GOGO)	\$0

Subtotal	\$93,161

Overhead (15%)	\$13,974

Subtotal	\$107,135

Profit (10%)	\$10,714

Subtotal	\$117,849

Bond (1%)	\$1,178

Subtotal	\$119,027

Contingency (10%)	\$11,903

Subtotal (Construction Cost Input For LCCID *)	\$130,930

SIOH (6% of Construction Cost)	\$7,856

Subtotal	\$138,786

Design (6% of Construction Cost)	\$7,856

Total Project Cost	\$146,642

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

CONSTRUCTION COST ESTIMATE

DATE PREPARED

Aug. 8, 1991

SHEET

OF

PROJECT

ENERGY ENGINEERING ANALYSIS

LOCATION

Watervliet Arsenal Bldg. 110

ARCHITECT ENGINEER

REYNOLDS, SMITH AND HILLS A.E.P., INC.

DRAWING NO.

NA

ESTIMATOR

W.T. Todd

CHECKED BY

BASIS FOR ESTIMATE

- ☒ CODE A (No design completed)
☐ CODE B (Preliminary design)
☐ CODE C (Final design)
☐ OTHER (Specify)

CAPACITORS SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Capacitors, 480 V, 3 ϕ							
4 KVAR	0	Ea.	90	-0-	266	-0-	
5 KVAR	0	Ea.	92	-0-	277	-0-	
6 KVAR	1	Ea.	94	94	289	94	
7.5 KVAR	9	Ea.	97	873	307	2763	
8 KVAR	3	Ea.	98	294	313	939	
15 KVAR	4	Ea.	112	448	395	1580	
17.5 KVAR	18	Ea.	117	2106	424	7632	
20 KVAR	0	Ea.	122	-0-	454	-0-	
25 KVAR	12	Ea.	133	1596	513	6156	
30 KVAR	3	Ea.	143	429	571	1713	
40 KVAR	1	Ea.	163	163	689	689	
50 KVAR	4	Ea.	184	736	806	3224	
180 KVAR	0	Ea.	450	-0-	2334	-0-	
Subtotals	55			\$6,739		\$24,790	\$31,529
Costs From equation derived From Means 1991 Electrical Cost Data							

CONSTRUCTION COST ESTIMATE

DATE PREPARED

Aug. 8, 1991

SHEET

OF

PROJECT

ENERGY ENGINEERING ANALYSIS

LOCATION

Watervliet Arsenal Bldg. 135.

ARCHITECT ENGINEER

REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE

- ☒ CODE A (No design completed)
☐ CODE B (Preliminary design)
☐ CODE C (Final design)
☐ OTHER (Specify) _____

DRAWING NO.

NA

ESTIMATOR

W. T. Todd

CHECKED BY

CAPACITORS

SUMMARY

QUANTITY

NO.
UNITS

UNIT
MEAS.

PER
UNIT

LABOR

TOTAL

MATERIAL

PER
UNIT

TOTAL

TOTAL
COST

Capacitors, 480 V, 3 ϕ

4 KVAR

0

Ea.

90

-0-

266

-0-

5 KVAR

0

Ea.

92

-0-

277

-0-

6 KVAR

17

Ea.

94

1598

289

4913

7.5 KVAR

14

Ea.

97

1358

307

4298

8 KVAR

8

Ea.

98

784

313

2504

15 KVAR

10

Ea.

112

1120

395

3950

17.5 KVAR

6

Ea.

117

702

424

2544

20 KVAR

10

Ea.

122

1220

454

4540

25 KVAR

9

Ea.

133

1197

513

4617

30 KVAR

5

Ea.

143

715

571

2855

40 KVAR

2

Ea.

163

326

689

1378

50 KVAR

0

Ea.

184

-0-

806

-0-

180 KVAR

2

Ea.

450

900

2334

4668

Sub-totals

83

\$9,920

\$36,267

\$46,187

Costs From equation derived from Means 1991 Electrical Cost Data

Power Factor Improvement
For Electric Motor Driven Equipment
Filename: CAP-COST

08/08/91

Regression Analysis Data

Capacitor KVAR	Bare Labor Cost From 1991 Means	Bare Matl. Cost From 1991 Means	Total Cost
5.0	\$100	\$276	\$376
7.5	\$100	\$295	\$395
10.0	\$100	\$345	\$445
15.0	\$100	\$405	\$505
20.0	\$125	\$450	\$575
30.0	\$135	\$560	\$695
40.0	\$170	\$710	\$880
50.0	\$185	\$795	\$980

Regression Analysis Output

	Labor	Material
Constant	81.4	218.7
X Coefficient	2.050	11.754
Standard Error of Coefficient	0.176	0.304
Standard Error of Y Estimate	7.6	13.2
R Squared	0.958	0.996
Number of Observations	8	8
Degrees of Freedom	6	6

Capacitor Cost Equations:

$$\text{Labor Cost} = \$81.4 + \$2.050/\text{KVAR} \times \text{Capacitor KVAR}$$

$$\text{Material Cost} = \$218.7 + \$11.754/\text{KVAR} \times \text{Capacitor KVAR}$$

Power Factor Improvement - Building 20
 For Electric Motor Driven Equipment
 Filename: CAP-20R

08/08/91

Motor HP	Number Motors	Recommended KVAR (1)	Labor Cost (2)	Material Cost (2)	Annual Cost Savings (3)
800	0	180	0	0	0
700	0	170	0	0	0
600	0	150	0	0	0
500	0	120	0	0	0
450	0	90	0	0	0
400	0	80	0	0	0
350	0	75	0	0	0
300	0	70	0	0	0
250	0	60	0	0	0
200	0	50	0	0	0
150	2	40	327	1378	822
125	0	35	0	0	0
100	0	30	0	0	0
75	2	25	265	1025	514
60	2	20	245	908	411
50	2	17.5	235	849	360
40	7	15	785	2765	1079
30	3	8	293	938	247
25	3	7.5	290	921	231
20	1	6	94	289	62
Totals	22		2534	9072	3724

$$\text{Simple payback} = \frac{11,606 \$}{3,724 \$/\text{yr}} = 3.12 \text{ Year(s)}$$

- (1) Consulting/Specifying Engineer, July 1988, page 97, Table 3 for 1800 rpm, 4 pole motors.
- (2) Cost curve derived from Means Electrical Cost Data, 1991 Refer to regression analysis in this section.
- (3) For a reactive electric demand charge of \$0.865 per KVAR.

Power Factor Improvement - Building 110
 For Electric Motor Driven Equipment
 Filename: CAP-110R

08/08/91

Motor HP	Number Motors	Recommended KVAR (1)	Labor Cost (2)	Material Cost (2)	Annual Cost Savings (3)
800	0	180	0	0	0
700	0	170	0	0	0
600	0	150	0	0	0
500	0	120	0	0	0
450	0	90	0	0	0
400	0	80	0	0	0
350	0	75	0	0	0
300	0	70	0	0	0
250	0	60	0	0	0
200	4	50	736	3226	2054
150	1	40	163	689	411
125	0	35	0	0	0
100	3	30	429	1714	924
75	12	25	1592	6151	3082
60	0	20	0	0	0
50	18	17.5	2111	7639	3236
40	4	15	449	1580	616
30	3	8	293	938	247
25	9	7.5	871	2762	693
20	1	6	94	289	62
Totals	55		6737	24987	11325

$$\text{Simple payback} = \frac{31,724 \$}{11,325 \$/\text{yr}} = 2.80 \text{ Year(s)}$$

(1) Consulting/Specifying Engineer, July 1988, page 97, Table 3
 for 1800 rpm, 4 pole motors.

(2) Cost curve derived from Means Electrical Cost Data, 1991
 Refer to regression analysis in this section.

(3) For a reactive electric demand charge of \$0.865 per KVAR.

Power Factor Improvement - Building 135
 For Electric Motor Driven Equipment
 Filename: CAP-135R

08/08/91

Motor HP	Number Motors	Recommended KVAR (1)	Labor Cost (2)	Material Cost (2)	Annual Cost Savings (3)
800	2	180	901	4669	3698
700	0	170	0	0	0
600	0	150	0	0	0
500	0	120	0	0	0
450	0	90	0	0	0
400	0	80	0	0	0
350	0	75	0	0	0
300	0	70	0	0	0
250	0	60	0	0	0
200	0	50	0	0	0
150	2	40	327	1378	822
125	0	35	0	0	0
100	5	30	715	2857	1541
75	9	25	1194	4613	2311
60	10	20	1224	4538	2054
50	6	17.5	704	2546	1079
40	10	15	1122	3950	1541
30	8	8	782	2502	657
25	14	7.5	1355	4296	1079
20	17	6	1593	4917	1048
Totals	83		9915	36265	15829

$$\text{Simple payback} = \frac{46,180 \$}{15,829 \$/\text{yr}} = 2.92 \text{ Year(s)}$$

- (1) Consulting/Specifying Engineer, July 1988, page 97, Table 3 for 1800 rpm, 4 pole motors.
- (2) Cost curve derived from Means Electrical Cost Data, 1991 Refer to regression analysis in this section.
- (3) For a reactive electric demand charge of \$0.865 per KVAR.

Power Factor Calculation

Filename: PFCALC

Data For: Feb-91

INPUTS

Metered On Peak KW	10432.3 KW
Metered KVAR	8448.0 KVAR
Billed KVAR	4992.0 KVAR
Cost Per KVAR	0.85551 \$/KVAR

OUTPUTS

Current KVA	13423.9 KVA
Current PF	0.777
Allowable KVA	10989.9 KVA
Allowable PF	0.949
Allowable KVAR	3456.0 KVAR
Billed KVAR	4992.0 KVAR
Billed Amount	\$4,270.71

$$KVA = (KW^2 + KVAR^2)^{0.5}$$

$$PF = KW/KVA$$

Source: WVA February 1991 Electric Bill

Power Factor Calculation

Filename: PFCALC

Data For: Aug-90

INPUTS

Metered On Peak KW	11011.9 KW
Metered KVAR	9120.0 KVAR
Billed KVAR	5472.0 KVAR
Cost Per KVAR	0.80851 \$/KVAR

OUTPUTS

Current KVA	14298.1 KVA
Current PF	0.770
Allowable KVA	11600.4 KVA
Allowable PF	0.949
Allowable KVAR	3648.0 KVAR
Billed KVAR	5472.0 KVAR
Billed Amount	\$4,424.17

$$KVA = (KW^2 + KVAR^2)^{0.5}$$

$$PF = KW/KVA$$

Source: WVA August 1990 Electric Bill

Power Factor Calculation

Filename: PFCALC

Data For: Sep-90

INPUTS

Metered On Peak KW	11205.0 KW
Metered KVAR	8832.0 KVAR
Billed KVAR	5120.0 KVAR
Cost Per KVAR	0.80851 \$/KVAR

OUTPUTS

Current KVA	14267.3 KVA
Current PF	0.785
Allowable KVA	11803.9 KVA
Allowable PF	0.949
Allowable KVAR	3712.0 KVAR
Billed KVAR	5120.0 KVAR
Billed Amount	\$4,139.57

$$KVA = (KW^2 + KVAR^2)^{0.5}$$

$$PF = KW/KVA$$

Source: WVA September 1990 Electric Bill

TO: ODP-I
MIKE MIZENKO

SMCWV-EHE

28 January 1986

MEMORANDUM FOR RECORD

SUBJECT: Strip Chart Readings

1. Strip Chart Readings taken during the weeks of 23 and 30 Dec 1985 indicate that some equipment is running significantly below the previously assumed load values.

<u>BLDG NO.</u>	<u>EQUIPMENT</u>	<u>ASSUMED HP</u>	<u>READING HP</u>	<u>%</u>
25	OMNI 20	40	20	50
35	WOHLENBERG	125	32	25
135	RD&D H.S. LATHE, B, NORTH	200	60 (77AMPS)	30
135	RD&D LATHE, C. NORTH	200	42 (55AMPS)	21
135	HONE, B. SOUTH	100	35 (46AMPS)	35
135	SWAGE	$\frac{100}{765}$	$\frac{100}{289} (124AMPS)$	$\frac{100}{387}$ 38% Average

2. Five of these machine readings indicate that additional testing under maximum load conditions is warranted.

Bill
BILL FACE
Engineering Division

MIKE,

THESE VALUES DO NOT REDUCE THE
MFG. CONNECTION RATINGS, BUT WILL ALLOW
MORE EQUIPMENT CONNECTIONS PER BUS
DUCT THAN PREVIOUSLY CALCULATED.

Bill

TABLE 2
SUGGESTED MAXIMUM CAPACITOR RATINGS—"T-FRAME" NEMA "DESIGN B" MOTORS*

Motor full load horse- power rating	Number of poles and nominal motor speed in rpm											
	2 3,600 rpm		4 3,000 rpm		6 2,400 rpm		8 1,800 rpm		10 1,440 rpm		12 1,200 rpm	
	Capacitor kvar	Current reduction percent	Capacitor kvar	Current reduction percent	Capacitor kvar	Current reduction percent	Capacitor kvar	Current reduction percent	Capacitor kvar	Current reduction percent	Capacitor kvar	Current reduction percent
2	1	14	1	24	1.5	30	2	42	2	40	3	50
3	1.5	14	1.5	23	2	28	3	38	3	40	4	49
5	2	14	2.5	22	3	26	4	31	4	40	5	49
7½	2.5	14	3	20	4	21	5	28	5	38	6	45
10	4	14	4	18	5	21	6	27	7.5	36	8	38
15	5	12	5	18	6	20	7.5	24	8	32	10	34
20	6	12	6	17	7.5	19	9	23	10	29	12.5	30
25	7.5	12	7.5	17	8	19	10	23	12.5	25	17.5	30
30	8	11	8	16	10	19	15	22	15	24	20	30
40	12.5	12	15	16	15	19	17.5	21	20	24	25	30
50	15	12	17.5	15	20	19	22.5	21	22.5	24	30	30
60	17.5	12	20	15	22.5	17	25	20	30	22	35	28
75	20	12	25	14	25	15	30	17	35	21	40	19
100	22.5	11	30	14	30	12	35	16	40	15	45	17
125	25	10	35	12	35	12	40	14	45	15	50	17
150	30	10	40	12	40	12	50	14	50	13	60	17
200	35	10	50	11	50	11	70	14	70	13	90	17
250	40	11	60	10	60	10	80	13	90	13	100	17
300	45	11	70	10	75	12	100	14	100	13	120	17
350	50	12	75	8	90	12	120	13	120	13	135	15
400	75	10	80	8	100	12	130	13	140	13	150	15
450	80	8	90	8	120	10	140	12	160	14	160	15
500	100	8	120	9	150	12	160	12	180	13	180	15

For use with 3-phase, 60 hertz NEMA Classification B Motors to raise full load power factor to approximately 95%.

Courtesy of Commonwealth Sprague Capacitor Inc.

TABLE 3
**MULTIPLIERS TO DETERMINE CAPACITOR KILOVARs REQUIRED
 FOR POWER-FACTOR CORRECTION**

Original power factor	Corrected power factor																			
	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1.00	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.98
0.50	0.982	1.008	1.034	1.060	1.086	1.112	1.139	1.165	1.192	1.220	1.248	1.276	1.306	1.337	1.369	1.403	1.440	1.481	1.529	1.589
0.51	0.937	0.962	0.989	1.015	1.041	1.067	1.094	1.120	1.147	1.175	1.203	1.231	1.261	1.292	1.324	1.358	1.395	1.436	1.484	1.544
0.52	0.893	0.919	0.945	0.971	0.997	1.023	1.050	1.076	1.103	1.131	1.159	1.187	1.217	1.248	1.280	1.314	1.351	1.392	1.440	1.500
0.53	0.850	0.876	0.902	0.928	0.954	0.980	1.007	1.033	1.060	1.088	1.116	1.144	1.174	1.205	1.237	1.271	1.308	1.349	1.397	1.457
0.54	0.809	0.835	0.861	0.887	0.913	0.939	0.966	0.992	1.019	1.047	1.075	1.103	1.133	1.164	1.196	1.230	1.267	1.308	1.356	1.416
0.79	0.026	0.052	0.078	0.104	0.130	0.156	0.183	0.209	0.236	0.264	0.292	0.320	0.350	0.381	0.413	0.447	0.484	0.525	0.573	0.633
0.80	0.000	0.026	0.052	0.078	0.104	0.130	0.157	0.183	0.210	0.238	0.266	0.294	0.324	0.355	0.387	0.421	0.458	0.499	0.547	0.609
0.81		0.000	0.026	0.052	0.078	0.104	0.131	0.157	0.184	0.212	0.240	0.268	0.298	0.329	0.361	0.395	0.432	0.473	0.521	0.581
0.82			0.000	0.026	0.052	0.078	0.105	0.131	0.158	0.186	0.214	0.242	0.272	0.303	0.335	0.369	0.406	0.447	0.495	0.555
0.83				0.000	0.026	0.052	0.079	0.105	0.132	0.160	0.188	0.216	0.246	0.277	0.309	0.343	0.380	0.421	0.469	0.529
0.84					0.000	0.026	0.053	0.079	0.106	0.134	0.162	0.190	0.220	0.251	0.283	0.317	0.354	0.395	0.443	0.503
0.85						0.000	0.027	0.053	0.080	0.108	0.136	0.164	0.194	0.225	0.257	0.291	0.328	0.369	0.417	0.477
0.86							0.000	0.026	0.053	0.081	0.109	0.137	0.167	0.198	0.230	0.264	0.301	0.342	0.390	0.450
0.87								0.000	0.027	0.055	0.083	0.111	0.141	0.172	0.204	0.238	0.275	0.316	0.364	0.424
0.88									0.000	0.028	0.056	0.084	0.114	0.145	0.177	0.211	0.248	0.289	0.337	0.397
0.89										0.000	0.028	0.056	0.086	0.117	0.149	0.183	0.220	0.261	0.309	0.369
0.90											0.000	0.028	0.058	0.089	0.121	0.155	0.192	0.233	0.281	0.341
0.91												0.000	0.030	0.061	0.093	0.127	0.164	0.205	0.253	0.313
0.92													0.000	0.031	0.063	0.097	0.134	0.175	0.223	0.283
0.93														0.000	0.032	0.066	0.103	0.144	0.192	0.252

Courtesy of Commonwealth Sprague Capacitor Inc.

Power Factor Improvement
For Electric Motor Driven Equipment
Filename: CAPTABL2

08/08/91

Motor HP	Number Motors	Recommended KVAR (1)	Capacitor Cost (2)	Annual Cost Savings (3)	Simple Payback
800	1	180	4077	1849	2.2
700	1	170	3875	1746	2.2
600	1	150	3471	1541	2.3
500	1	120	2864	1233	2.3
450	1	90	2258	924	2.4
400	1	80	2056	822	2.5
350	1	75	1955	770	2.5
300	1	70	1854	719	2.6
250	1	60	1652	616	2.7
200	1	50	1450	514	2.8
150	1	40	1248	411	3.0
125	1	35	1147	360	3.2
100	1	30	1046	308	3.4
75	1	25	945	257	3.7
60	1	20	844	205	4.1
50	1	17.5	793	180	4.4
40	1	15	742	154	4.8
30	1	8	601	82	7.3
25	1	7.5	591	77	7.7
20	1	6	561	62	9.1
15	1	5	540	51	10.5
10	1	4	520	41	12.7
7.5	1	3	500	31	16.2
5	1	2.5	490	26	19.1
3	1	1.5	470	15	30.5
2	1	1	460	10	44.7
Totals	26		37008	13004	2.8

- (1) Consulting/Specifying Engineer, July 1988, page 97, Table 3 for 1800 rpm, 4 pole motors.
- (2) Cost curve derived from Means Electrical Cost Data, 1991 Refer to regression analysis below. 46.4 % markup added.
- (3) For a reactive electric demand charge of \$0.865 per KVAR.

Regression Data

Capact. Cost From KVAR	Means
5	376
7.5	395
10	445
15	505
20	575
30	695
40	880
50	980

Regression Output

Constant	300.1
Std Error of Y Estimate	15.4
R Squared	0.996
No. of Observations	8
Degrees of Freedom	6
X Coefficient	13.80
Std Err of Coefficient	0.356

Industrial Applications

Application and Benefits

A low power factor means higher costs and reduced efficiency
Chances are that power factor in your plant is low

Approximately one-half of all plants have a power factor below 85 percent. Low power factor wastes money directly in higher electric bills, and indirectly by reducing the efficiency of plant distribution systems and the productive equipment they serve.

ABB capacitors can benefit your power system in four major ways:

1. Raise power factor . . . you avoid premium charges and power-factor penalties on your electric bill.

- Dry dielectric system – no free fluid
- Environmentally safe
- Reduced fire risk
- Reduced losses
- Self healing
- Sequential protection

In addition to improving power factor capacitors also:

- Improve voltage @ transformer due to capacitor addition:

$$\% \text{ voltage rise} = \frac{\text{kVAR of capacitors} \times \% \text{ reactance of transformer}}{\text{kVA of transformer}}$$

Note: system reactance should be added to the transformer reactance if available.

- Reduce power losses in the distribution system due to capacitor addition:

$$\% \text{ reduction of losses} = 100 - 100 \left(\frac{\text{original power factor}}{\text{improved power factor}} \right)^2$$

Derating Capacitors

- Reduce kVAR when operating 60 Hz unit @ 50 Hz

$$\text{Actual kVAR} = \text{rated kVAR} \left(\frac{50}{60} \right) = .83 \text{ rated kVAR}$$

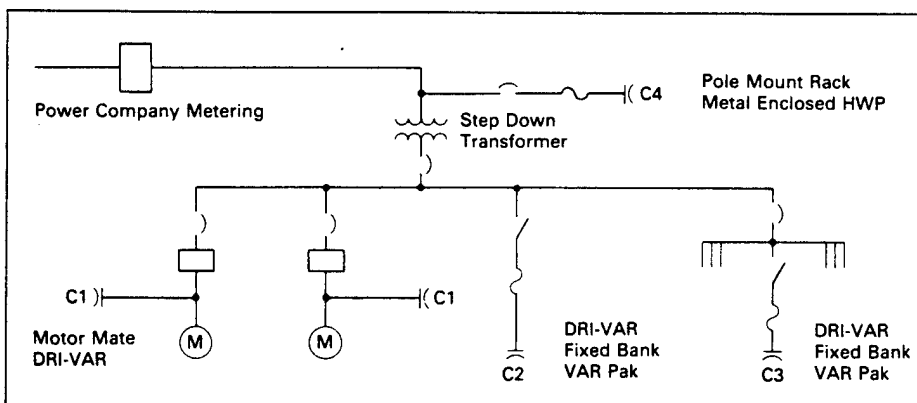
- Reduce kVAR when operating @ below rated voltage

$$\text{Actual kVAR} = \text{rated kVAR} \left(\frac{\text{operating voltage}}{\text{rated voltage}} \right)^2$$

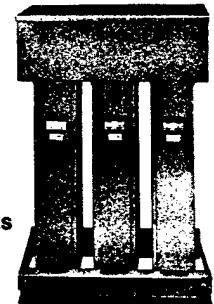
i.e.

$$240\text{V} @ 208 = .751 \text{ rated kVAR}$$

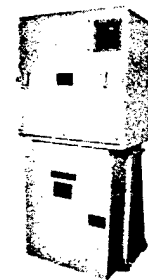
Typical One-Line Diagram Showing Capacitor Locations



DRI-VAR
Power Capacitor
 240, 480, 600 Volts



DRI-VAR
Fixed Bank
 240, 480, 600 Volts



VAR-PAK
Var-Controlled
Automatic Switched
Capacitor Bank
 240, 480, 600 Volts



HWP With CLC Fuses
 2400 and 4160 Volts
 25-800 kVAR



Two-Unit HWP
 2400 and 4160 Volts
 25-800 kVAR

HWP
 2400 and 4160 Volts
 25-800 kVAR

Waternliet Arsenal
 Building 135 Motor List
 Filename: MOTORLST

WVA # ->	11760	11700	12441	11770	12270	12111	12260	12177	11640	10277	12006	9390	11190	12289
No.Ea.->	1	1	1	1	3	5	8	6	4	3	2	1	2	4
No.Op.->	1	1	1	1	3	3	3	3	3	1	1	1	2	3

Motor HP	# Motors													TOTALS
800		2												2
250														0
200														0
150		2												2
125														0
100				1						4				5
75					1		1	1						3
60		8											1	9
50						1								2
40	1	6						1						8
30		2		2					1			1		6
25		4		2					2				1	9
20	1	6		1				2	1					11
15														0
10	2			1									1	4
7.5		4					4	1	1	1				11
5		5					1	1				1	1	9
3	3	1		2	1		4	1	1				2	15
2					2	2			1					6
1.5						1	2	2	1					7
1	6	3					1		1			1	1	17
0.75	2				1			1				2		8
0.5					4	1	1	2			7	4	1	24
0.33					1			1	1					3
0.25					1	1	4	1					2	10
0.125						1	4							6
TOTALS	15	43	0	9	11	7	22	14	10	5	7	9	10	177
	15	43	0	9	33	21	66	42	30	5	7	9	20	345

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Equipment List

By Process		By WV Number	
Equipment	WV Number	Equipment	WV Number
Indu. Furnace	11760	Press	9390
Rotary Forge	11700	Swage	10277
Abrasive Saw	12441	Lathe	11190
Selas Furnace	11770	Hone	11640
Press	12270	Hone	11640
Lathe	12111	Rotary Forge	11700
Lathe	12260	Indu. Furnace	11760
Lathe	12177	Selas Furnace	11770
Hone	11640	Pit Furnace	12006
Swage	10277	Lathe	12111
Pit Furnace	12006	Lathe	12177
Press	9390	Lathe	12260
Lathe	11190	Press	12270
Hone	11640	Lathe	12289
Lathe	12289	Abrasive Saw	12441

Equipment List

By Process		By WV Number	
Equipment	WV Number	Equipment	WV Number
Indu. Furnace	11760	Press	9390
Rotary Forge	11700	Swage	10277
Abrasive Saw	12441	Lathe	11190
Selas Furnace	11770	Hone	11640
Press	12270	Hone	11640
Lathe	12111	Rotary Forge	11700
Lathe	12260	Indu. Furnace	11760
Lathe	12177	Selas Furnace	11770
Hone	11640	Pit Furnace	12006
Swage	10277	Lathe	12111
Pit Furnace	12006	Lathe	12177
Press	9390	Lathe	12260
Lathe	11190	Press	12270
Hone	11640	Lathe	12289
Lathe	12289	Abrasive Saw	12441

11/15/84

SECTION 2 B1-A

480 V.A.C.

ITEM	LOAD (HP)	FLA	DEMAND @ .8
P.C. GRINDER	62 HP	75	60.0 A
P.C. GRINDER	62 ↓	75	60.0
ENGINE LATHE	50	65	52.0
BORING LATHE	66 1/3	80	64.0
CONV. BORE	53 1/6	67	53.6
SPOTTING LATHE	75	96	76.8
ENGINE LATHE	75	96	76.8
PRESS	36 3/4	46	36.8
HORIZ. HONES	182 1/2	230	184.0
SWAGE	200	240	192.0
RIFLER	57 1/2	58	46.4
CONV. BORE	52	66	52.8
GUIDED BORE	303	365	292.0
GUIDED BORE	303	365	292.0

Large MACHINE SUB-TOTAL $1538.8 \times \frac{480V}{700V} = 1277 \text{ KW}$
 + 3 SMALL MACHINES @ 10 HP ea $(14 \times \frac{480V}{700V}) = 35 \text{ KW}$
 + BLDG. 121 390.0 → 390 KW
 + FRENCH LATHE (125 HP ASSUME) 150.0 → 150 KW
 + LTG., OUTLETS & MISC. 100.0 → 100 KW

Sub-TOTAL ----- 1952 KW

Diversity @ .8 ----- 1562 KW
 + 30% Future Capacity ----- 469 KW

TOTAL ----- 2031 KW

@ .8 P.F. = 2539 KVA.

G+C Report

Waterliet - Bldg. 110 - Substation Loading
Assume Peak PRODUCTION

11/15/84

480 V.A.C.

SECTION 2B1

ITEM	LOAD (HP)	FLA	DEMAND @ .8
OPEN	-	-	-
HORIZ. HONE	25 HP	34	27.2 A.
CONV BORE	7 3/4	11	8.8
HELLER MILLING	(200 AMPS)	200	160.0
RIFLER	27 1/2	37	29.6
RADIAL DRILL	17 1/6	30	24.0
RIFLER	27 1/2	37	29.6
↓	-	-	-
PLANE MILL	31 1/2	40	32.0
↓	-	-	-
DRILL PRESS RIVETER	4 3/4, 2	10	8.0

Large MACHINE SUB-TOTAL $319.2 A \times \frac{480V}{1000} = 265 \text{ KW}$
 + 55 SMALL MACHINES @ 10 HP $(14 FLA \times 55 = 770) \times \frac{480V}{1000} = 639 \text{ KW}$
 + LTH., OUTLETS, & MISC. 100.0 KW → 100 KW
 + PIT FURNACE 600.0 KW → 600 KW

SUB-TOTAL 1604 KW

SMALL MACH.
↓
55

+ 30% Future CAPACITY → DIVERSITY @ .8 1283 KW
 385 KW
 TOTAL 1668 KW

@ .8 P.F.

2085 KVA

G+G report

Water V. List - Bldg. 110 - Substation Loading
Assume PEAK PRODUCTION

11/15/84

SECTION 2A2

480V A.C.

ITEM	LOAD (HP)	FLA	DEMAND @ .8
PLANNER MILL	27 HP	36	28.8 A.
PLANNER MILL	41 1/2 ↓	52	41.6
GRINDER	62	77	61.6
BELT GRINDER	57	75	60.0
ENGINE LATHE	75	96	76.8
GRINDER	20	27	21.6
RIFLER	55	57	45.6
Grinder	57	58	46.4
HONE, RIFLER	55 1/2, 77 3/4	154	123.2
BORE	303	365	292.0
BORE	303	365	292.0
ENGINE LATHE	75	96	76.8
GRINDER	26	35	28.0
HONE	50	65	52.0
ENGINE LATHE	75	96	76.8
P.C. LATHE	57 1/4	58	46.4

Large Machine Subtotal - $1369.6 \times \frac{1700}{1000} = 1137.0$ KW

+ 66 Small Machine @ 10 HP ea. (144 FLA ea) 767.0 KW

LTG., OUTLETS, MISC. → 100.0 KW

Bldg 108 100.0 KW (assumed)

QUANTERS 1-6 100.0 KW (")

QUANTERS #8 50.0 KW (")

Bldg 410 (2 Floors) 300.0 KW (")

Sub-total 2554 KW

Diversity x .8 2043 KW

+ 30% Future Capacity 613 KW

Total 2656 KW

@ .8 P.F. = 3320 KVA.

SMALL MACH.
↓
66

Recommendation: Replace 2A2 with double ended sub-station rated at 2000 KVA ea. Transformer.

480V.A.C.

Bldg 110

Motor Data From G+G Rpt.

	<u>HP</u>	<u>Assumed Sizes</u>
Spindle	57.25	50, 12, 2
PC lathe	53.17	50, 10, 2
Engine lathe	75	75
" "	75	75
PC Grinder	62	50, 12, 2
" "	62	50, 10, 2
Press	36.75	30, 5, 1, 3/4
PC lathe	57.25	50, 5, 2
PC lathe	57.25	50, 5, 2, 1/4
Grinder	57	50, 5, 2
14 Small Mach	~10 hp (each)	< 10 x 14
Planer Mill	27	25, 2
" "	41.5	40, 1, 1/2
Grinder	62	50, 10, 2
"	20	20
"	26	25, 1
Belt Grinder	57	50, 5, 2
Engine lathe	75	75
" "	75	75
" "	75	75
Rifler	55	50, 5
Grinder	57	50, 5, 2
Hone	55.5	50, 5, 1/2
Rifler	77.75	75, 7.5, 4
Bore	303	200, 75, 25, 5
"	303	200, 75, 25, 4

Bldg 110 continued

Hone 50

P.C. lathe 57.25

66 Small Mach. ~10 hp (each)

Horiz. Hone 25

Conv. Bore 7.75

Heller Milling ~150 hp

Rifler 27.5

" 27.5

X

Radial Drill 17

Planer Mill 31.5

Drillpress 4.75

Riveter 2

55 sm mach 10 hp (each)

PC Grinder 62

" " 62

Engine lathe 50

Boring lathe 66.33

Conv. Bore 53.17

Spotting Lathe 75

Engine Lathe 75

Press 36.75

Horiz. Hone 182.5

Swage 200

Rifler 57.5

Conv. Bore 52

Guided Bore 303

" "

1-23

303

+ 3 sm mach @ 10hp ea

5, 5, 5, 5

10x66

25

5, 5, 5

100, 2, 5, 5, 5

25, 2, 5

25, 2, 5

15, 2

30, 1, 5

4, 3/4

X

10x55

50, 10, 5

50, 10, 5

50

50, 10, 5, 1, 5

40, 2, 5, 1/2

75

75

50, 5, 1, 2, 5

150, 25, 5, 2, 5

100, 100

50, 5, 2, 1/2

50, 2

200, 75, 25, 3

Bldg 110 Motor Totals

<u>HP</u>	<u># motors</u>
200	4
150	1
100	3
75	12
60	-0-
50	18
40	4
30	3
25	9
20	1
15	1
10	143

(2) MACHINING RUNNING AT 80% OF NAMEPLATE RATING
AND A DEMAND FACTOR OF 80% FOR 64% DEDUCTING FROM
CONNECTED LOAD TO MAXIMUM LOAD

(1) SEE J, SEC II

WATERLUT WO. 7/18/20

Equipment Load Density Calculation

1/30/85

D. Becking

Calculation based on Plant layout of equipment
in area bordered by columns D and F - 5 and 9.
Equipment loads provided by Plant layout, consider
no diversity and 80% demand factor.

ITEM	HP.	FLA	Load @ 80%
Horizontal Mill	20	27	22
Radial Arm Drill	3	5	4
Vertical Mill	15	21	17
Vertical Turret Lathe	30	40	32
Horizontal Gun Drill	30	40	32
Surface Grinder	40	52	42
Horizontal Broach	42	52	42
Thread Mill	25	34	27
Thread Mill	25	34	27
Vertical Turret Lathe	45	60	48
Thread Mill	25	34	27
Vertical Turret Lathe	30	40	32
Duplex Mill	7.5	11	9
Vertical Turret Lathe	40	52	42
Surface Grinder	15	21	17
Heavy Vertical Lathe		320	256
Machining Center	15	21	17
Broach Colonial		320	256
Rotary Grinder	40	52	42
Rotary Grinder	60	77	62
NC Profile Mill	50	65	52
Vertical Turret Lathe	60	77	62
NC Profile Lathe	50	65	52
Horizontal Broach	40	52	42
Profile Mill	45	62	50

LOAD WITH-OUT TWO LARGEST = 800/

665 X .8 X .8 = 426 KVA

PER 19,200 S.F. = 22.2 VA/S.F.

VS.

45.3 W/S.F.

New Equip. now being installed 4000 DISC

400 A. DISC, 175

From
G+G Report

TOTAL

1311 Amps. X $\frac{480\sqrt{3}}{1000}$ X .8 DIVERSITY = 870 KW

Area: 120' x 160' = 19,200 sq

Density = $\frac{870KW}{19,200sq}$ = 45.3 w/sq for Equipment

1-25

Motor Data
Bldg. 20 From G & G Report

Assumed Sizes

Horizontal Mill	20	20
Radial Arm Drill	3	3
Vertical Mill	15	15
Vertical Turret Lathe	30	30
Horiz. Gun Drill	30	30
Surf. Grinder	40	40
Horiz. Broach	42	40, 5
Thread Mill	25	25
" "	25	25
Vertical Turret Lathe	45	40, 5
" " "	30	30
" " "	40	40
" " "	60	60
Thread Mill	25	25
Duplex Mill	7.5	7.5
Surface Grinder	15	15
Hessap Vert. Lathe	~ 240	150, 75, 10, 5
Machining Center	15	15
Rotary Grinder	40	40
" "	60	60
NC Profile Mill	30	50
" " Lathe	50	50
Horiz. Broach	40	40
Profile Mill	45	40, 5
Broach Colonial	~ 240	150, 75, 10, 5

Bldg 20 Motor totals

<u>HP</u>	<u># Motors</u>
150	2
75	2
60	2
50	2
40	7
30	3
25	3
20	1
15	3
10	2
Total	27

31
- 7
27



SUBJECT ECO# 2
NGAS Fuel Switch
DESIGNER P. Hutchins
CHECKER B. Todd

AEP NO 290-0379-002
SHEET OF
DATE 8/8/91
DATE 9/16/91

- Calculate dollar savings

	FY90 <u>Use (MBtu)</u>	FY91 <u>Avg. Rate \$/MBtu</u>	Est. FY91 <u>Cost \$</u>
#6 Fuel Oil	278,000	\$6.61	\$1,837,580
Nat. Gas	278,000	\$4.66	\$1,295,480
Annual Savings			<u>\$542,100</u>



SUBJECT Natural Gas Pipeline
ECO #2
DESIGNER P. Hutchins
CHECKER _____

AEP NO 290-0379-002
SHEET _____ OF _____
DATE 7/11/91
DATE _____

Natural Gas Pipeline

- Determine pipe line size
- Calculate the natural gas peak flow:

Peak steam demand is ~ 120,000 #/hr 120 psig
(based on conversations with WVA personnel)

$$\frac{120,000 \text{ \#/hr} \cdot (1192 - 118) \text{ Btu/lb}}{0.80} = 161 \text{ MBtu/hr}$$

- Convert to MCF (thousands of cf)

$$\frac{161 \times 10^6 \text{ Btu/hr}}{1030 \text{ Btu/cf}} \times \frac{1 \text{ Mcf}}{1000 \text{ cf}} = 156 \frac{\text{Mcf}}{\text{hr}}$$

- Add 16 MBtu/hr for cogeneration

$$\frac{16 \times 10^6}{1030} \times \frac{1}{1000} = 16 \frac{\text{Mcf}}{\text{hr}}$$

- Plus contingency (10%)

$$(156 + 16) \times 1.1 = 190 \frac{\text{Mcf}}{\text{hr}}, \text{ say } 200 \frac{\text{Mcf}}{\text{hr}}$$



SUBJECT Nat Gas Line
DESIGNER P. Hutchins
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE 11/11/91
DATE _____

- Calculate required pipe diameter

Inlet pressure minimum is 50 psig
Exit pressure minimum is 10 psig

Maximum ΔP = 40 psig

Calculate ΔP through various pipe sizes

Use nomographs from Crane's, Flow of Fluids

Given :

Natural gas specific gravity = 0.75

Flow rate = 200,000 cfh

Pressure = 50 psig

Temp. = 60°F

Density (nat gas) = 0.23 lbs/cf

Flow = 46,000 lb/hr

Density (air) = 0.335 lbs/cf

S_g = 0.69

Flow rate =

- Convert to standard conditions:

$$P_1 V_1 = P_2 V_2$$

$$P_1 = 0.23 \text{ \#/cf} \quad P_2 = 0.053 \text{ \#/cf}$$

$$V_1 = 200,000 \text{ cfh}$$

$$V_2 = \frac{P_1 V_1}{P_2} = \frac{0.23 (200,000)}{0.053} = 867,924 \text{ scfh}$$

(2-2)



SUBJECT Nat. Gas Line

AEP NO _____

DESIGNER

Hutchins

SHEET _____

OF _____

CHECKER _____

DATE 11/11/91

DATE _____

$$q_h' = 114.2 \sqrt{\frac{P_1'^2 - P_2'^2}{f L_m T S_g}} d^5$$

Simplified Compressible
Flow-Gas Pipe Line
Formula from
Crane p. 1-8
Egn 1-7a

$$\left(\frac{q_h'}{114.2}\right)^2 = \frac{(P_1'^2 - P_2'^2) d^5}{f L_m T S_g}$$

$$d^5 = \frac{\left(\frac{q_h'}{114.2}\right)^2 f L_m T S_g}{P_1'^2 - P_2'^2}$$

- Find f

μ (viscosity, centipoise) = 0.011 p. A-5 (Crane's)

$Re = \frac{0.482 q_h' S_g}{d \mu}$	f	$d(\text{in})$	Pipe Size	Re
	0.015	6.065	6	4.3E6
	0.0141	7.981	8	3.3E6
	0.0139	10.02	10	2.6E6

Solving for d for various ΔP 's for

ΔP	$d(\text{in})$
10	9.3
20	8.2
30	7.7
40	7.4

$q_h' = 870,000 \text{ ct/hr}$
 $f = 0.014$
 $L_m = 1500 \text{ ft} / 5280 \text{ ft} = 0.28 \text{ mi.}$
 $T = 520^\circ \text{ R}$
 $S_g = 0.69$
 $P_1' = 65 \text{ psia}$
 $P_2' = 25 - 55 \text{ psia}$



SUBJECT Nat. Gas Line
DESIGNER P. Hatcher
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE 11/11/91
DATE _____

$$P_1'^2 - P_2'^2 = \frac{\left(\frac{q_h'}{114.2}\right)^2 f L_m \bar{\tau} S_g}{d^5}$$

$$P_2' = \sqrt{P_1'^2 - \frac{\left(\frac{q_h'}{114.2}\right)^2 f L_m \bar{\tau} S_g}{d^5}}$$

d (") ΔP

6	750
8	23.2
10	7.6
12	3.6

← 8" is selected

CONSTRUCTION COST ESTIMATE

DATE PREPARED

11/11/91

SHEET

OF

PROJECT

ENERGY ENGINEERING ANALYSIS

BASIS FOR ESTIMATE

☐ CODE A (No design completed)☒ CODE B (Preliminary design)☐ CODE C (Final design)☐ OTHER (Specify) _____

LOCATION

WATERVILLE ARSENAL - Albany, NY

ARCHITECT ENGINEER

REYNOLDS, SMITH AND HILLS A.E.P., INC.

DRAWING NO.

ESTIMATOR

P. Hutchins

CHECKED BY

Natural Gas Line

SUMMARY

QUANTITY

LABOR

MATERIAL

TOTAL
COSTNO.
UNITSUNIT
MEAS.PER
UNIT

TOTAL

PER
UNIT

TOTAL

Steel pipe, SCH 40, 8" d.

tared & wrapped

1500

LF

10.84

\$16,260

26.00

\$39,000

\$55,260

Excavation - 16" x 5'

1500

LF

0.47

705

-

-

705

Horizontal boring

Railroad work 24" d.

360

LF

320.00

115,200

40.00

14,400

129,600

Backfill, dozer

compacting

300

CY

1.76

528

-

-

528

Bedding, crushed

stone

300

CY

4.28

1248

12.90

3870

5118

133,941

57,270

191,211

Boiler Plant interconnect

1

ea

5000

5000

5000

5000

10,000

Metering Station

1

ea

5000

5000

5000

5000

10,000

143,941

67,270

211,211

'Includes equipment costs

Ref: 1991 Means, Mechanical p. 18-22

02/05/92

ECO Construction Cost Estimate Calculations

ECO Name: NATURAL GAS FUEL SWITCH

ECO #: 2

1991 ECO "bare" costs (from cost estimate sheet)

Material	\$67,270
Labor	\$143,941

Subtotal bare costs	\$211,211

FICA Insurance (20% of Labor)	\$28,788

Sales Tax (6.5% of Material)	\$4,373

Subtotal	\$244,372

Overhead (15%)	\$36,656

Subtotal	\$281,028

Profit (10%)	\$28,103

Subtotal	\$309,131

Bond (1%)	\$3,091

Subtotal	\$312,222

Contingency (10%)	\$31,222

Subtotal (Construction Cost Input For LCCID *)	\$343,444

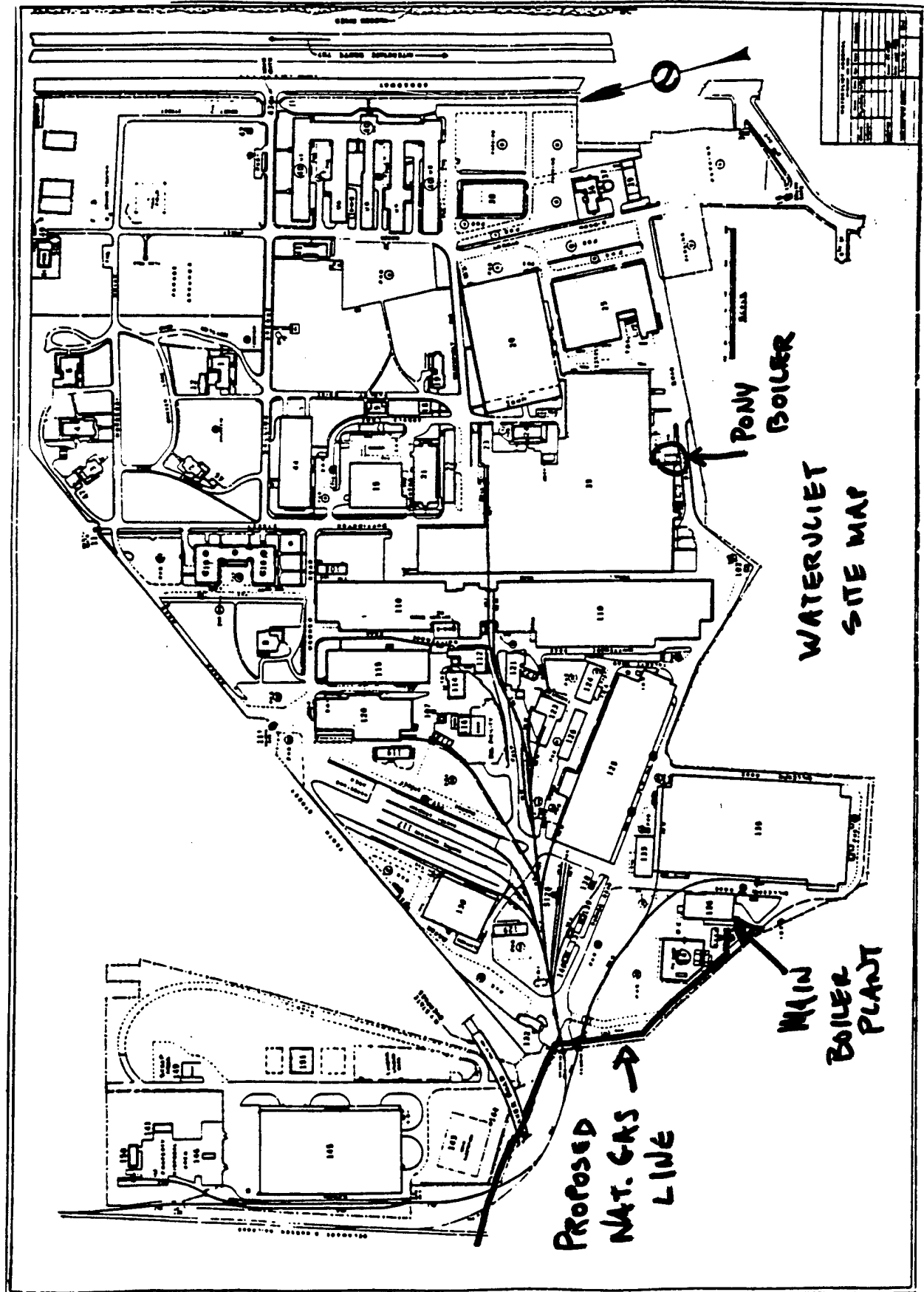
SIOH (6% of Construction Cost)	\$20,607

Subtotal	\$364,051

Design (6% of Construction Cost)	\$20,607

Total Project Cost	\$384,658

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.





SUBJECT ECO # 3
Cogeneration
DESIGNER P. Hutchins
CHECKER B. Todd

AEP NO 290 0379-002
SHEET OF
DATE 6/28/91
DATE 9/16/91

- Current fuel use - FY 90

MBTU

ELC	173,000
FSD	12,000
FSR	278,000
NGAS	65,000

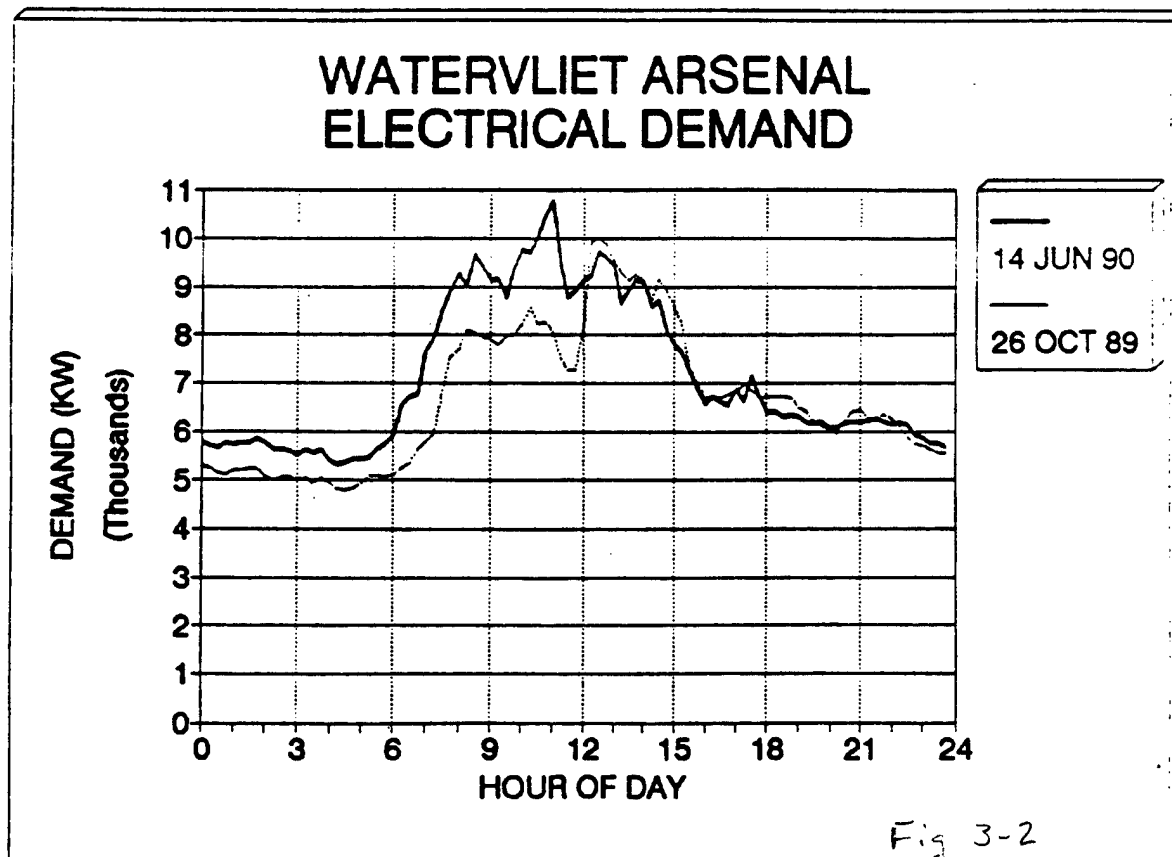
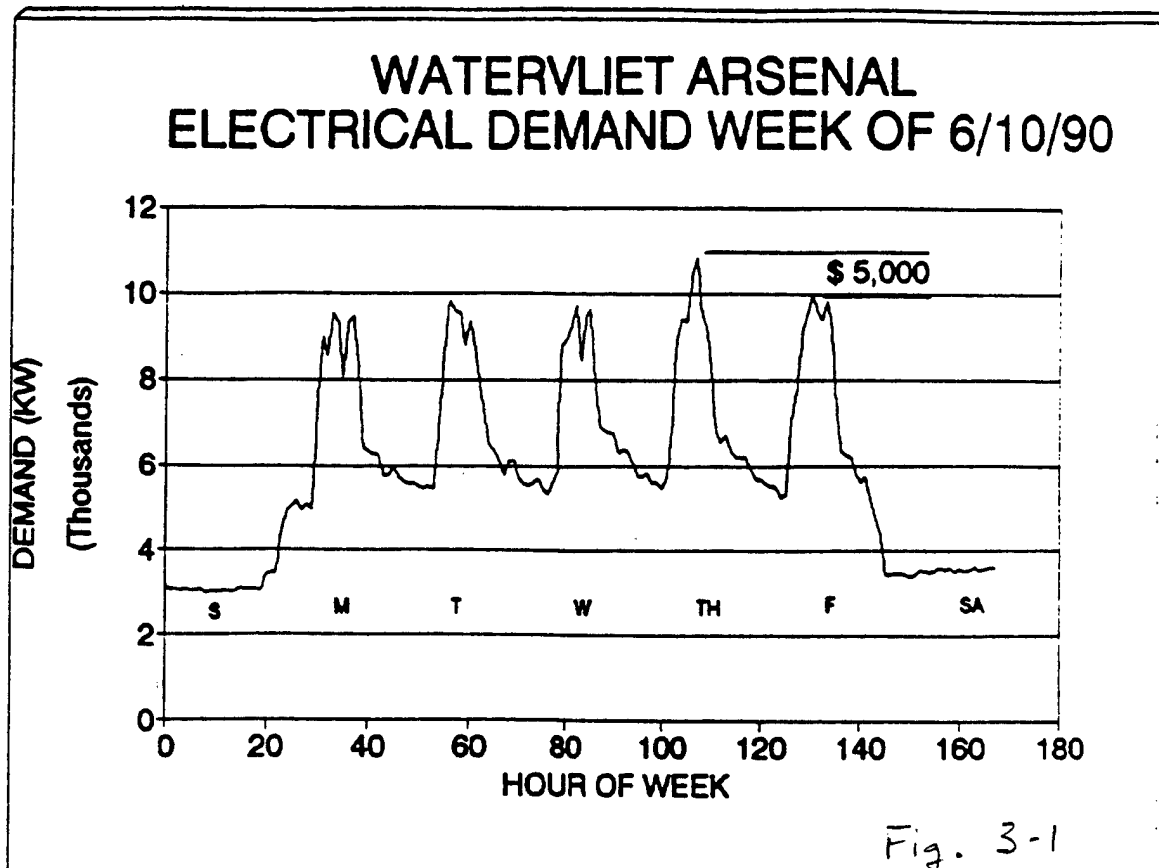
- Calculate energy savings

- Size and type of cogen equipment

Demand data from WVA (Figures 3-1 and 3-2) show a constant load of about 3 MW at all times, a 9 MW load 0800 - 1500 hrs Monday through Friday and about 5 MW for 1500 - 0800, M-F.

Steam use is shown on a monthly basis in Figure 3-3. It shows a minimum average steam production of 6000 #/hr during non-space heating periods (this represents metal plating heat loads in Bldg 35) and varying loads up to 65,000 #/hr dependent upon the weather for space heating.

Figure 3-4 shows the steam production during the summer by day of week. It demonstrates a 1000 #/hr load Monday through Thursday.



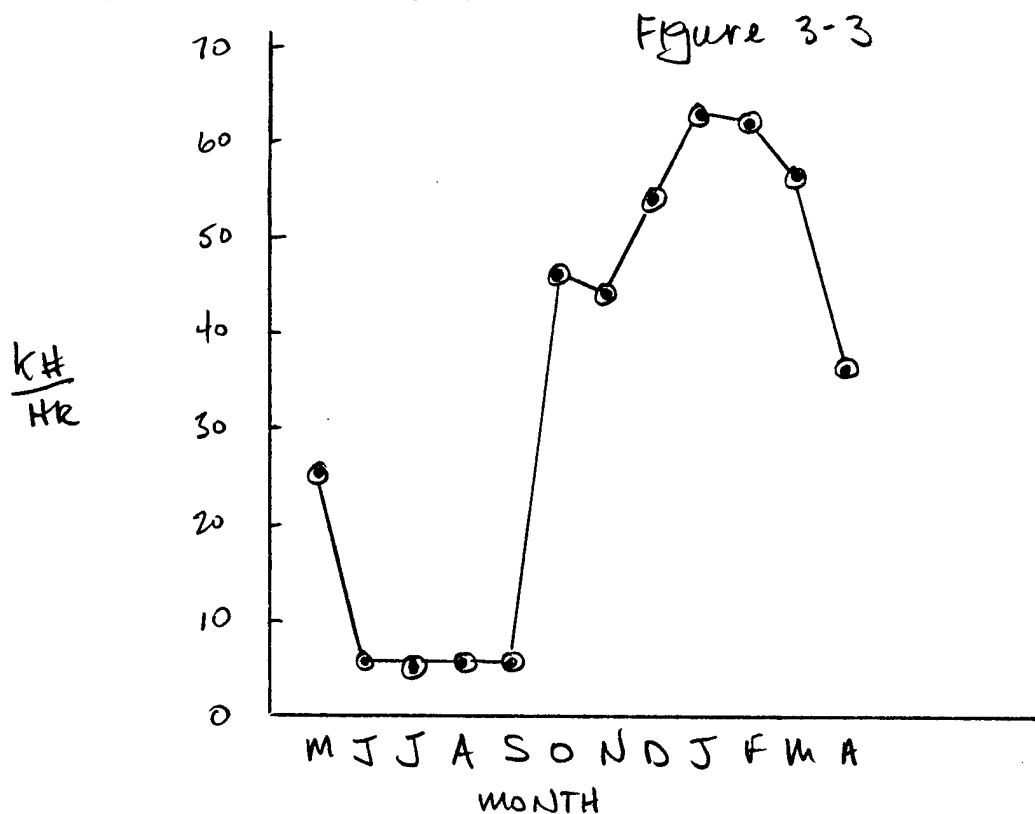


SUBJECT ECO #3 - Cogeneration
DESIGNER P. Hutchins
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE 7/8/91
DATE _____

Monthly Steam Use - Bldg 136 + 35

		AUG	
		DLY	HRLY
'90	M	612	25.5
	J	152	6.3
	J	135	5.6
	A	147	6.1
	S	142	5.9
	O	1142	47.6
	N	1059	44.1
	D	1295	54.0
'91	J	1502	62.6
	F	1492	62.2
	M	1250	52.1
	A	854	35.6



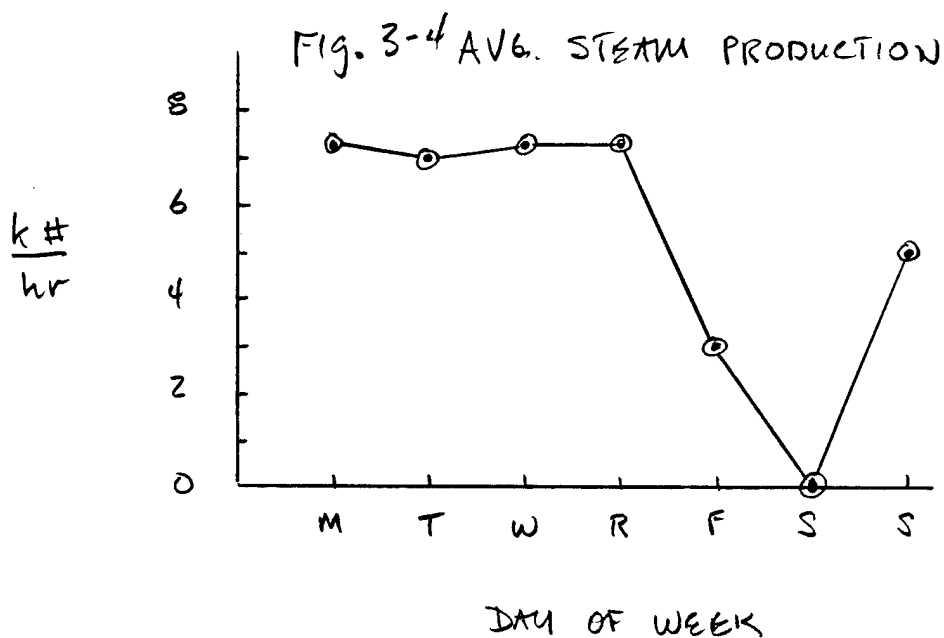


SUBJECT ECO # 3 - Cogeneration
 DESIGNER P. Hutchins
 CHECKER _____

AEP NO _____
 SHEET _____ OF _____
 DATE 7/8/91
 DATE _____

Building 35 Boiler Steam Production

	<u>JUNE</u>			<u>AUG</u>			<u>AUG</u>	
	<u>4-10</u>	<u>11-17</u>	<u>18-24</u>	<u>6-12</u>	<u>13-19</u>	<u>20-26</u>	<u>DL4</u>	<u>HCL</u>
M	224	179	167	140	161	176	175	7.3
T	205	169	169	140	117	206	168	7.0
W	194	169	171	157	164	188	174	7.3
R	156	190	189	167	167	160	172	7.3
F	41	86	71	53	76	98	71	3.0
S	-	-	-	-	-	-	0	0
S	75	92	140	109	107	191	119	5.0





SUBJECT _____
_____ *Cogen* _____
DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE *6/28/91*
DATE _____

The ratio of the heat-to-electricity requirements determines which type of cogeneration equipment is preferred. This is shown in Figure 3-5. In general this figure shows the following preferences:

<u>Heat/Electrical Output</u>	<u>Recommended Equipment</u>
< 4	Reciprocating Engine
$> 4, < 10$	Gas Turbine
> 10	Steam Turbine

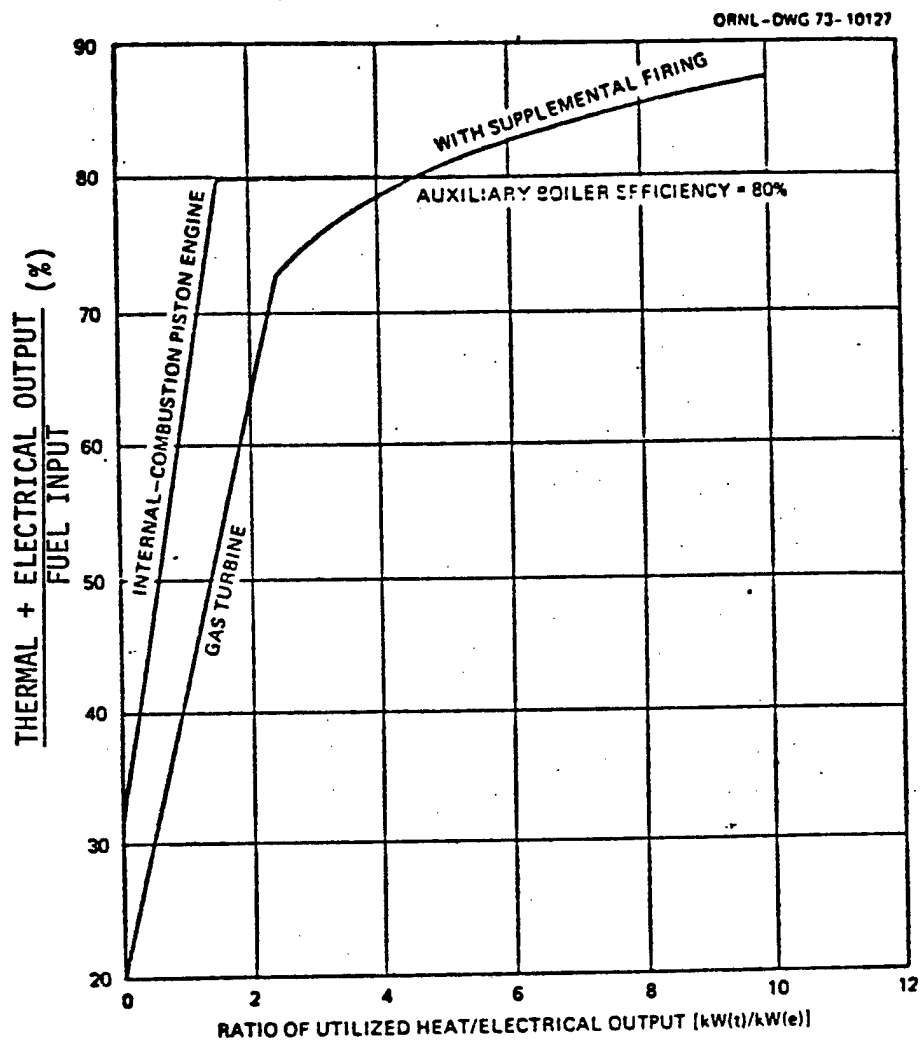
To obtain maximum utilization of the cogen equipment and, therefore, maximum benefit calculate H/E based on 3 MW and 7000#/hr.

$$\frac{H}{E} = \frac{3000 \text{ kw}}{7000 \text{ \#/hr}} \cdot \frac{3413 \text{ Btu/kw}}{1000 \text{ Btu/\#}} = \underline{1.46}$$

This indicates that a reciprocating engine is the best match. The exception to this is a steam-injected gas turbine that utilizes some or all of the steam produced to power a steam turbine mounted on the gas turbine shaft. This system will also be evaluated.

Fig. 3-5

PRIME MOVER PERFORMANCE COMPARISON



REF: TECHNOLOGY ASSESSMENT OF
MODULAR INTEGRATED UTILITY SYSTEMS,
OAK RIDGE NAT'L LAB



SUBJECT ECO#3

DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

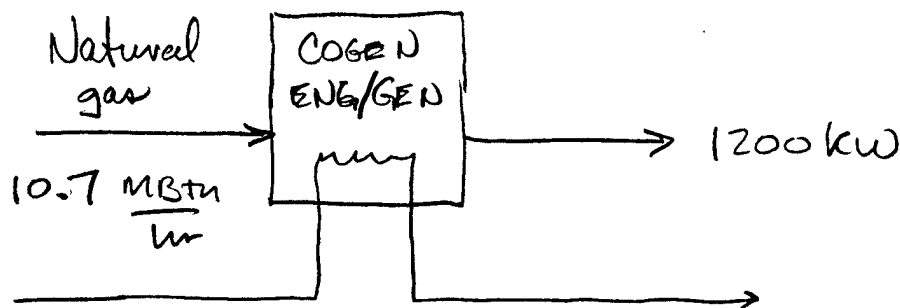
- Calculate reciprocating engine energy use

Assumptions:

Steam requirement - ~ 7000 #/hr 150 psig
Elec. requirement - none, NIMO must buy
all cogenerated

Because of the 150 psig requirement, heat cannot be recovered from the engine jacket cooling water. The engine exhaust gas is the only source.

Using the Caterpillar Model 3608 with Vapor phase heat recovery silencers and economizers:



200 F FEEDWATER

2.6 MBtu/hr 120 psig steam

To maximize the use of the cogeneration unit, two engines should be used.

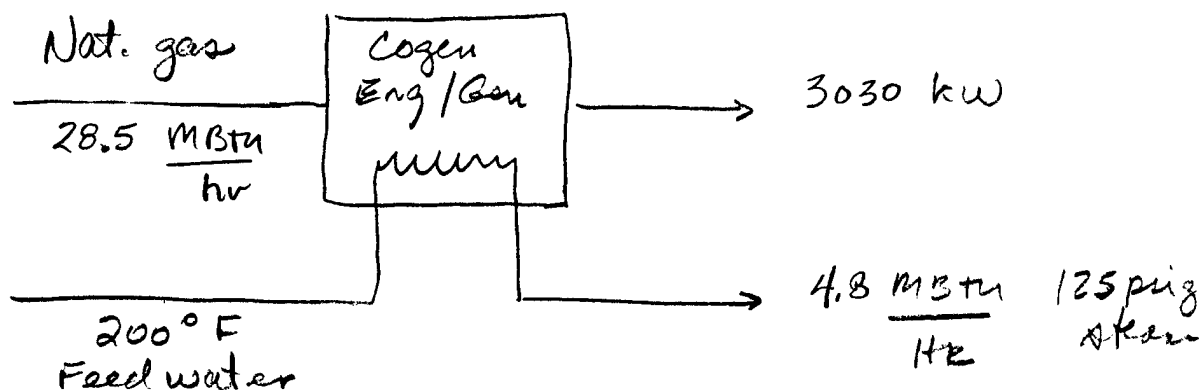


SUBJECT ECO #3

 DESIGNER _____
 CHECKER _____

AEP NO _____
 SHEET _____ OF _____
 DATE _____
 DATE _____

The overall performance for two
 MODEL 3608 engine/generators
 (based on data located on pages 3-11:3-13) is:



Annual energy use: $50 \frac{\text{wks}}{\text{yr}} \cdot 5 \frac{\text{da}}{\text{wk}} \cdot 24 \frac{\text{hr}}{\text{da}} = 6000 \frac{\text{hrs}}{\text{yr}}$

Nat. Gas: $28.5 \frac{\text{MBtu}}{\text{hr}} \cdot 6000 \frac{\text{hrs}}{\text{yr}} = \underline{\underline{171,000 \frac{\text{MBtu}}{\text{yr}}}}$

Annual energy savings:

Nat. Gas: $4.8 \frac{\text{MBtu}}{\text{hr}} \cdot 6000 \frac{\text{hr}}{\text{yr}} \cdot \frac{4}{12} \text{ yr (Summer)}$
 $\div 0.77 \text{ Blr eff (p.I-12) } = \underline{\underline{12,500 \frac{\text{MBtu}}{\text{yr}}}}$
App B

Fuel Oil: $4.8 \frac{\text{MBtu}}{\text{hr}} \cdot 6000 \cdot \frac{8}{12} \div 0.83 \text{ (p.I-12) } = \underline{\underline{23,100 \frac{\text{MBtu}}{\text{yr}}}}$
App B

Annual dollar savings due to electricity purchase
 by NIMO @ 6¢/kwh:

$3030 \text{ kW} \cdot 6000 \frac{\text{hrs}}{\text{yr}} \cdot \$ \frac{0.06}{\text{kwh}} = \underline{\underline{\$ 1,090,800 \text{ yr}}}$
 3-8

SUBJECT ECO #3

AEP NO _____

SHEET _____ OF _____

DESIGNER _____

DATE _____

CHECKER _____

DATE _____

Other annual costMaintenance $\approx$ 1.5¢/kwh

$$\frac{\$0.015}{\text{kwh}} \cdot 3030 \text{ kw} \cdot \frac{6000 \text{ hrs}}{\text{yr}} = \frac{\$273,000}{\text{yr}}$$

Summary of energy use changes for total installation

	<u>Annual Use (MBtu)</u>		
	<u>Current</u>	<u>w/ Cogen</u>	<u>Savings</u>
ELC	173,000	173,000	0
FSR	278,000	254,900	23,100
NGAS	65,000	223,500	(158,500)

Annual dollar savings due to sales of
electricity to NIKO =

$$\underline{\$1,090,800/\text{yr.}}$$

Estimated payback = 10.5 yrs

$$\frac{\$800/\text{kw} \cdot 3030 \text{ kw}}{\$1,090,800 - 273,000 + 23,100 - 158,500} = \frac{\$2,421,000}{\$661,400/\text{MBtu}} = \underline{\underline{4.66 \text{ MBtu}}}$$

CONSTRUCTION COST ESTIMATE

DATE PREPARED

8/6/91

SHEET

OF

PROJECT

ENERGY ENGINEERING ANALYSIS

LOCATION

WATERVLIET ARSENAL

ARCHITECT ENGINEER

REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE

☐ CODE A (No design completed)☒ CODE B (Preliminary design)☐ CODE C (Final design)☐ OTHER (Specify)

DRAWING NO.

ESTIMATOR

Paul Hutchins

CHECKED BY

ECO#3-Cogen.

SUMMARY

QUANTITY

LABOR

MATERIAL

TOTAL
COSTNO.
UNITSUNIT
MEAS.PER
UNIT

TOTAL

PER
UNIT

TOTAL

CATERPILLAR SPARK-
Ignited Engine Generators
Model 3608-1515kw
(includes switchgear,
utility breaker, main
breaker)

2

EA

875k

1,750,000

1,750,000

Exhaust heat recovery
system and valving
Economizers

2

EA

77.5k

155,000

155,000

2

EA

27.5k

55,000

55,000

Substation switchgear

100K

100,000

100,000

INSTALLATION COSTS
(@ \$250/kw)

850,000

850,000

TOTALS

850,000

2,060,000

2,910,000

Project No. 290-0379-002
 Local _____ L.D. ✓ Placed ✓ Rec'd. ✓ Date 7/10/91
 Of P. HUTCHINS Conversed With DAVID WOOD
CATERPILLAR - RINGPOWER Regarding Cozen - WVA

		MATERIAL
Three alternatives:	output (125psia)	COST
- One Model 3616	- 3MW ~ 5000 #/hr	\$ 2.25 mill.
- Two Model 3608	- 3MW ~ 5000 #/hr	1.75 mill.
- Four Model 3516	- 3.2MW ~ 4800 #/hr	1.5 mill.

O & M cost - 1.5¢/kwh

Installation cost - \$200-\$300/kw

Includes: Engine, switchgear, utility breaker, main breaker

If I change the ^{steam} pressure how does that affect output

DW is faxing performance sheets

^{Milton}
 Southworth ~~Harshbarger~~ (518) 465-5255
 Cat. Dealer in New York

CATERPILLAR, INC.
SPARK IGNITED ENGINE DIVISION

3608 SI
PERFORMANCE DATA

ENGINE POWER		Heat Exch Cooled	Radiator Cooled
Electric Kilowatts	Ekv	1515	1430
Brake Horsepower	Bhp	2120	2000
BMEP	Psi	180	170
Speed	Rpm	900	900

FUEL CONSUMPTION

BSFC	Btu/Bhp-Hr	6715	6715
Thermal Efficiency	%	37.9	37.9

EMISSIONS

BSNOx	G/Bhp-Hr	1.0	1.0
BSCO	G/Bhp-Hr	1.7	1.7
BSTHC	G/Bhp-Hr	5.0	5.0
BSNMHC	G/Bhp-Hr	0.6	0.6

FUEL TOLERANCE

Fuel Range, LHV	Btu/CuFt	900-1200	900-1200
Methane Number Range		50-100	50-100

GENERAL

AC/OC Water Temp	Deg F	90	130
Jacket Water Temp	Deg F	185	185
Air/Fuel Ratio	Vol/Vol	20	20
Timing	Deg BTDC	20	20
Air Flow	Lb/Hr	24050	22750
Exhaust Flow	Acfm	13250	12550
Stack Temp	Deg F	800	800

GENERATOR

Stability	ISO Class	II	II
Response	ISO Class	II	II

NOTES

1. Ratings are based on SAE J1349 standard ambient conditions of 29.61 in Hg and 77 deg F. Variations in altitude, temperature and gas composition may require engine rating and performance adjustment. For these special applications, consult your Caterpillar Power Systems Distributor.

2. Electrical rating based on 0.8 power factor and 95.5% generator efficiency.

3-11a

**VAPORPHASE**
ENGINEERING CONTROLS, INC.

July 12, 1991

Ring Power Company
8050 Phillips Highway
Jacksonville, FL 32216

Attn: Mr. David Wood

Subject: RS & H
Our Proposal #7286

Dear Dave:

We offer the following equipment for (4) G-3516SITA-90 gas engines at 800 KW and 1200 RPM or for (2) G-3608SITA-90 gas engines at 1515 KW and 900 RPM.

(4) Caterpillar G-3516SITA-90 Rated 800 KW at 1200 RPM

- (4) Model ECXSV-4410 Bare fire tube exhaust only waste heat recovery silencers, ASME Code stamped for 150 PSIG to produce 125 PSIG steam with full steam trim, insulated.
Anticipated recovery at full load, clean per engine: 1,025,994 BTU/HR or 974 #/HR of 125 PSIG steam with 200 Deg. F feed water.
Unit weight: 7,843#

- (4) Model EDVP-14 Pneumatic internal exhaust diversion valves with pilots.
Unit weight: 145#

- (1) Model BPB-2 Pneumatic back pressure valve and pilot.
Unit weight: 110#

(2) Caterpillar G-3608SITA-90 Rated 1515 KW at 900 RPM

- (2) Model ECXSV-5410 Bare fire tube exhaust only waste heat recovery silencers, ASME Code stamped for 150 PSIG to produce 125 PSIG steam with full steam trim, insulated.
Anticipated recovery at full load, clean per engine: 2,393,243 BTU/HR or 2,272#/HR of 125 PSIG steam with 200 Deg. F feed water.
Unit weight: 10,316#

ENGINEERING CONTROLS

Ring Power Company
July 12, 1991
Page #2. . .

- (2) Model EDVP-20 Pneumatic internal exhaust diversion valves with pilots.

Unit weight: 175#

- (1) Model BPB-2 Pneumatic back pressure valve and pilot.

Unit weight: 110#

Should an economizer be added to either unit, performance would be improved by 10%.

The cost for the economizer on the ECXSV-4410 would be
Each per unit.

The cost for the economizer on the ECXSV-5410 would be
Each per unit.

Delivery is 14-16 weeks after receipt of approved submittal package.

We trust this gives you the information you require for now.
Please feel free to contact us if we can be of any further assistance.

Very truly yours,



Peter Englin

PCE/rb

Enclosure

Pricing - 4,3516's \$240,000

2,3608's 155,000

Economizer - 4,3516's 65,000

- 2,3608's 55,000

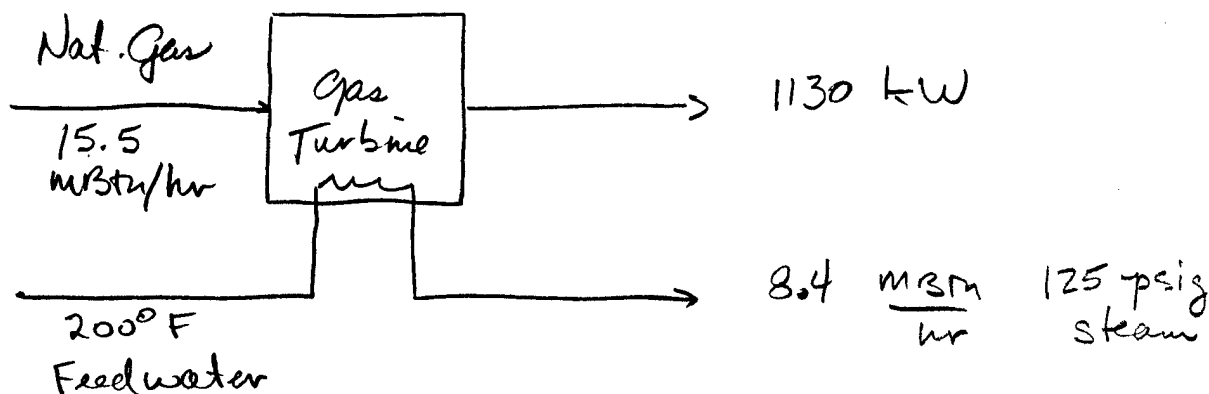


SUBJECT ECO#3
Gas Turbine Option
DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

- Calculate gas turbine energy use

The block diagram below demonstrates the gas turbine engine/generator performance for the SOLAR T 1500 (1130 kw) turbine (based on data located on p. 3-18 : 3-19)



Annual energy use

$$\text{Nat Gas: } 15.5 \frac{\text{MBtu}}{\text{hr}} \times 6000 \text{ hrs} = \underline{\underline{93,000 \frac{\text{MBtu}}{\text{yr}}}}$$

Annual energy savings:

$$\text{Nat. Gas: } \frac{5.9 \text{ MBtu}}{\text{hr}} \cdot \frac{6000 \text{ hrs}}{\text{yr}} \cdot \frac{4}{12} \div 0.77 = \underline{\underline{15,300 \frac{\text{MBtu}}{\text{yr}}}}$$

$$\text{Fuel Oil: } \frac{5.9 \text{ MBtu}}{\text{hr}} \cdot \frac{6000 \text{ hrs}}{\text{yr}} \cdot \frac{8}{12} \div 0.83 = \underline{\underline{28,400 \frac{\text{MBtu}}{\text{yr}}}}$$

Annual Electricity Sales

$$1130 \text{ kW} \cdot \frac{6000 \text{ hrs}}{\text{yr}} \cdot \frac{\$0.06}{\text{kWh}} = \underline{\underline{\$406,800/\text{yr.}}}$$



SUBJECT ECO #3 -
Gas Turbine Option
DESIGNER P. Hutchins
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

Annual maintenance costs $\approx 1.0 \text{¢/kwh}$

$$\frac{\$0.01}{\text{kwh}} \times 1130 \text{ kw} \times \frac{6000 \text{ hrs}}{\text{yr}} = \underline{\underline{\$68,000/\text{yr.}}}$$

Summary of energy use changes for total installation

Annual Use (MBtu)

	<u>CURRENT</u>	<u>w/ COGEN</u>	<u>SAVINGS</u>
ELC	173,000	173,000	0
FSR	278,000	249,600	28,400
NGAS	65,000	142,700	(77,700)

Annual dollar savings due to electricity sales

$$= \underline{\underline{\$406,800}}$$

Estimated payback = initial cost $\div$ annual savings

$$\frac{1130 \text{ kw} \times 1200 \text{ \$/kw}}{\$406,800 - 68,000 + 28,400 \text{ MBtu} \times \frac{\$6.61}{\text{MBtu}} - 77,700 \text{ MBtu} \times \frac{\$4.66}{\text{MBtu}}}$$

$$\approx \underline{\underline{8.3 \text{ years}}}$$

02/05/92

ECO Construction Cost Estimate Calculations

ECO Name: COGENERATION

ECO #: 3

1991 ECO "bare" costs		
Material		\$672,927
Labor		\$168,232
	Subtotal bare costs	\$841,159
FICA Insurance (20% of Labor)		\$33,646
Sales Tax (not applicable for GOGO)		\$0
	Subtotal	\$874,805
Overhead (15%)		\$131,221
	Subtotal	\$1,006,026
Profit (10%)		\$100,603
	Subtotal	\$1,106,629
Bond (1%)		\$11,066
	Subtotal	\$1,117,695
Contingency (10%)		\$111,770
		+-----+
Subtotal (Construction Cost Input For LCCID *)		!\$1,229,464 !
		+-----+
SIOH (6% of Construction Cost)		\$73,768
	Subtotal	\$1,303,232
Design (6% of Construction Cost)		\$73,768

Total Project Cost		\$1,377,000

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

Project No. 290-0379-002

Local ✓ L.D. Placed ✓ Rec'd. Date 8/7/91

P. Hutchins Conversed With Roger Adkins

Of Caterpillar Regarding Solar Turbines

- Noel Schonmaler is the POC for Solar Turbines

- Solar Turbine Joe St. Pierre

- Price & performance data

Saturn 1130 kW T-1500 New rating

~~432~~ 13,764 Btu/kWh

904°F exhaust

#750,000 materials engine, generator & controls

Distribution:



VAPORPHASE
ENGINEERING CONTROLS, INC.

August 14, 1991

Reynolds, Smith & Hill
4651 Salisbury Road
Jacksonville, FL 32256

Attn: Mr. Paul Hutchins

Subject: Our Budget Proposal #7319

Dear Paul:

We offer the following equipment for (1) Solar T-1500 Gas Turbine rated 1120 KW.

- (1) Model ECKWTSE-4000-750 2-drum, natural circulation, high fin exhaust only waste heat recovery silencer with insulation and full steam trim per Drawing B-P-2481, Rev. 0.
Unit includes the following:

- (1) Economizer
- (2) Stack
- (3) Exhaust Diversion Valve
- (4) Exhaust Diversion Valve Silencer
- (5) Flexible Connections
- (6) Duct and Platform

Approximate size: 7'-0" wide x 3'-6" high x 28'-0" long.

Anticipated recovery of 125 PSIG steam with 220 Deg. F

feed water: 8,000 #/HR.

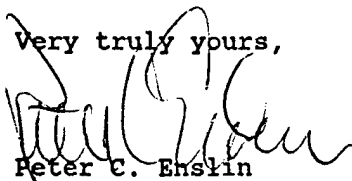
Unit weight: 25,000# Budget Price: \$247,100.00 Each

FOB St. Louis, MO. Terms are Net 30 Days. Progress payments would be required.

Delivery is 16 weeks after receipt of approved submittal package.

We trust this gives you the information you require for now. Please feel free to contact us if we can be of any further assistance.

Very truly yours,


Peter C. Enslin

PCE/rb

Enclosures

SUBJECT ECO#4 WVAAEP NO 290-0379-002DIP TANK

SHEET _____ OF _____

DESIGNER P. HutchinsDATE 7/22/91CHECKER B. ToddDATE 9/16/91

ECO#4 Dip Tank Covers with Exhaust Fan Controllers

Assumptions:

- Room Temperature = 68°F
- Heat Load Factor (HLF) (Vol. II, App B. p I-8 thru I-10)
 - HLF₁ = 0.145 MBtu/yr/cfm (24h/d, 5d/w)
 - HLF₂ = 0.092 MBtu/yr/cfm (16h/d, 5d/w)
 - HLF₃ = 0.044 MBtu/yr/cfm (8h/d, 5d/w)
 - HLF₄ = 0.204 MBtu/yr/cfm (24h/d, 7d/w)
- Fan and motor efficiency = 0.5
- Steam Generation Efficiency Avg. = 0.80 (ECO#6)
- Fan AP = 3 in. w.c.
- Leakage with cover in place - 10% of uncovered
- Calculate present energy use - fuel oil for heating OSA replacing exhausted air and electricity used by fan motors

Fuel Oil

$$E_{OSA} = \frac{CFM \times 0.204 \text{ MBtu/yr/cfm}}{\text{STEAM Gen. eff}}$$

$$hp = \frac{cfm \cdot \Delta P}{6356 \cdot \eta_{fan}} \Rightarrow cfm = \frac{0.75 hp \times 6356 \cdot \eta_{fan}}{\Delta P}$$

- Calculate current fan energy use

$$\frac{E_{elec}}{E_{fan}} = \frac{2545}{hp \times Btu/hp \times 8760 \text{ hr/yr} \times \frac{1 \text{ MBtu}}{10^6 \text{ Btu}} \times 0.75}$$

$$\text{where } hp = \frac{cfm \cdot \Delta P}{6356 \cdot \eta_{fan}}$$

Assume fan/motor operate at 75% of rated hp



SUBJECT ECO # 4

AEP NO _____

SHEET _____ OF _____

DESIGNER _____

DATE _____

CHECKER _____

DATE _____

- Calculate energy use with tank covers and VSDs

Plating operations are active for 1, 2 or 3 shifts
five days per week

# shifts	Hours/yr	
	covered	uncovered
1	6240	2520
2	4600	4160
3	2080	6680

With covers in place it is estimated that the
cfm will be reduced to 10% of the original flow

Fuel Oil

$$\text{Energy Use} = \frac{\text{CFM}_c * \text{HLF}_c}{0.80} + \frac{\text{CFM}_{uc} * \text{HLF}_{uc}}{0.80}$$

where the subscript c and uc represent covered and
uncovered events

$$\text{CFM}_c = \text{CFM}_{uc} \div 10$$

$$\text{CFM}_{uc} = \frac{\text{hp} * 6356 * \eta_{fan}}{\Delta P}$$

$$\text{HLF}_{uc} = \text{HLF}_4 - \text{HLF}_{\# \text{SHIFTS}}$$

Elec

hp varies with the cube of the flow

$$\frac{\text{hp}_2}{\text{hp}_1} = \left(\frac{\text{cfm}_2}{\text{cfm}_1} \right)^3 \quad \frac{\text{hp}_2}{\text{hp}_1} = \left(\frac{\text{cfm}_1 * 0.10}{\text{cfm}_1} \right)^3 = 0.001$$

Therefore, if the flow is reduced to 10% of original
the hp is reduced to 0.001 times the original hp.



SUBJECT ECO#4

DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

$$\text{Energy use} = h_{pc} * 2545 * 0.75 * H_c +$$
$$h_{puc} * 2545 * 0.75 * H_{uc}$$

where H = hours

c = covered

uc = uncovered

$h_{puc} = h_{pc} * 0.001$

0.75 = fraction of rated hp for actual operation

- Savings equal the difference between the present energy use and use with proposed covers & USD.

The following spreadsheet implements these equations.

Small Parts Plating Exhaust Fans

	Exhaust Fan ID	hp	Est. CFM	Supply Fan ID	hp	Tanks Served (IDs)	Type *
Line 1	103	60	47,670	?	?	3,7,8,9,11,15,16,21,22,23,24	PP
	106	10 **	7,945	103	10	14	PP
	107	10 **	7,945	103	10	19	PP
	104	40 **	31,780	103	10	28,29,30	PP
	105	60	47,670	103	10	31,32,33	BL
Line 2	101	25	19,863	101	1.5	3,5,13,16	PP
	102	40	31,780	102	2	19,20,21,30,31	PP
Line 3	108	60 **	47,670	104	?	2,3,4,5,6,7,8,9,10,11,12,13,14	PP
	109	40 **	31,780	-	-	19,20,25,26	BL
Line 4	110	15 **	11,918	-	-	4,5	BL
	111	40 **	31,780	-	-	6,7,8,9,11	BL
	112	10	7,945	-	-	10	BL

*Exhaust system

PP = push-pull

BL = bilateral pull only

**Estimated

	Exhaust Fan ID	# Shifts	# Tanks	Present Use(MBtu/yr)			Proposed Use (MBtu/yr)			Savings (MBtu/yr)		
				#6 F.O.	N Gas	Elec	#6 F.O.	N Gas	Elec	#6 F.O.	N Gas	Elec
Line 1	103	3	11	12,156	0	1,003	8,987	0	767	3,168	0	236
	106	3	1	2,026	0	167	1,498	0	128	528	0	39
	107	3	1	2,026	0	167	1,498	0	128	528	0	39
	104	3	3	8,104	0	669	5,992	0	512	2,112	0	157
	105	3	3	12,156	0	1,003	8,987	0	767	3,168	0	236
Line 2	101	2	4	5,065	0	418	3,745	0	201	1,320	0	217
	102	2	5	8,104	0	669	5,992	0	321	2,112	0	348
Line 3	108	1	13	12,156	0	1,003	8,987	0	296	3,168	0	707
	109	1	4	8,104	0	669	5,992	0	197	2,112	0	472
Line 4	110	3	2	3,039	0	251	2,247	0	192	792	0	59
	111	3	5	8,104	0	669	5,992	0	512	2,112	0	157
	112	3	1	2,026	0	167	1,498	0	128	528	0	39
Totals			53	83,065	0	6,855	61,415	0	4,148	21,650	0	2,707

SUBJECT ECO #4

AEP NO _____

SHEET _____ OF _____

DESIGNER _____

DATE _____

CHECKER _____

DATE _____

Additional O&M :

Covers should be replaced every five years.
On an annual basis assume $\frac{1}{5}$ th are replaced every year

$$\text{Annual cost} = \frac{1}{5} \$200 \times 53 = \underline{\underline{\$3480/\text{yr}}}$$

QRIIP/OSD PIF CALC'SPresent Cost of Energy

Fuel oil	=	83,065	*	4.40	=	\$ 365,486
Elec.	=	6855	*	20.35	=	<u>139,499</u>
TOTAL						\$ 504,985

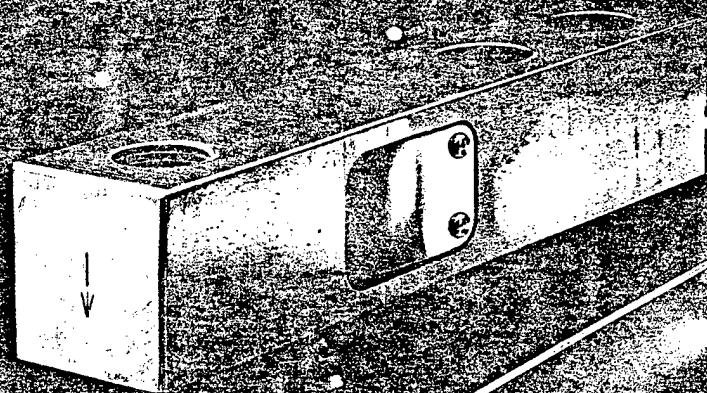
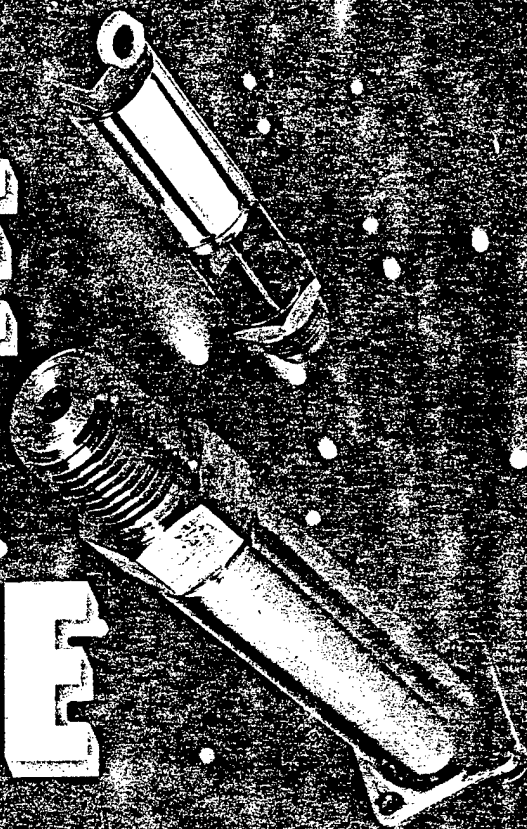
Proposed

Fuel Oil	=	61,415	*	4.40	=	\$ 270,226
Elec	=	4148	*	20.35	=	<u>84,412</u>
Total	=					\$ 354,638

Savings

Fuel Oil	=	21,650	*	4.40	=	\$ 95,260
Elec	=	2707	*	20.35	=	<u>55,087</u>
Total	=					\$ 150,347

THE PRESSURE STRAIN AND FORCE HANDBOOK™



Ω OMEGA
An OMEGA Technologies Company

LOW PRESSURE DIFFERENTIAL TRANSDUCERS

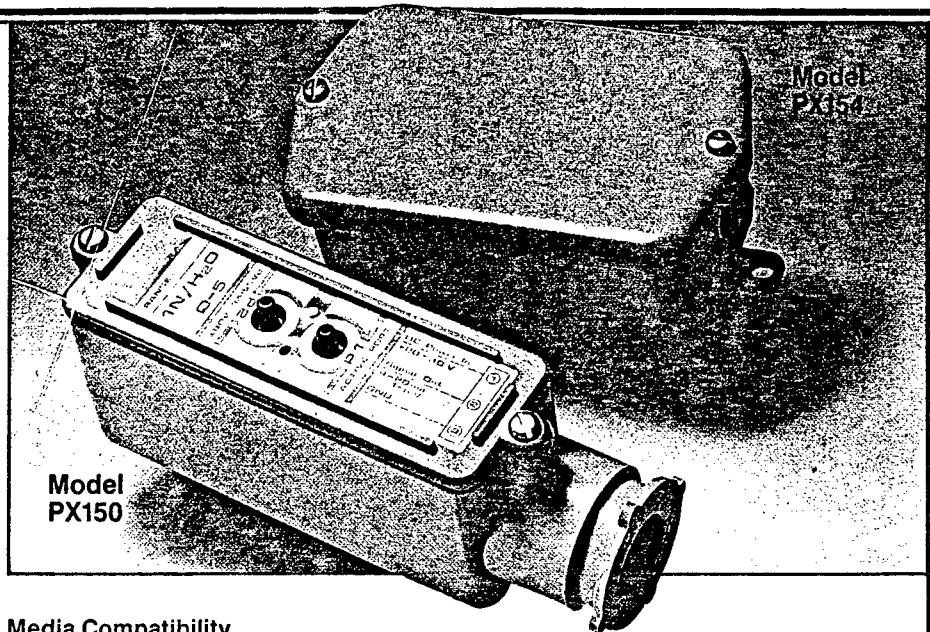
PX150/154 Series 0-1" to 0-25" H₂O

MADE IN

USA

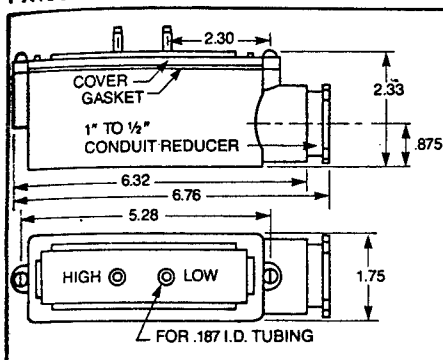
- Weatherproof NEMA-4 Enclosure or Electrical Conduit Enclosure
- Zero and Span Controls Are Provided For Easy Field Adjustment

From
\$305



CURRENT LOOP OUTPUT
TYPE PRESSURE TRANSMITTERS **B**

PX150



Media Compatibility

PX150

Low: Dry gases only

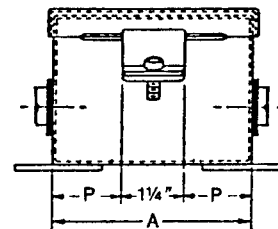
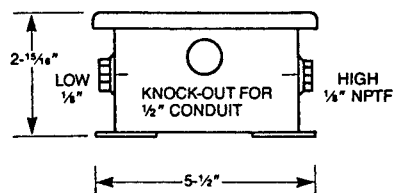
High: Liquids or gases, except highly ionic solutions (acids, lye, etc.)

PX154

P1 P2: Non-corrosive, non-aqueous liquids or gases

PX155: SLIGHTLY CORROSIVE LIQUIDS OR GASES

PX154



SPECIFICATIONS

Excitation: 24 Vdc (18 to 30 Vdc)

Output: 4 to 20 mA, 2 wire system

Maximum Loop Resistance: 400 ohms @ 18 Vdc, 700 ohms @ 24 Vdc, 1000 ohms @ 30 Vdc

Accuracy: (linearity & hysteresis) PX154 0.1% FS; PX150 2.0% FS

Zero and Span Adjustments: $\pm 10\%$

Compensated Temperature Range: 32 to 122°F (0 to 50°C)

Zero and Span Thermal Effects: PX154 (.311/FS range) % FS/°F; PX150 (3.9/FS range) % FS/°F

Proof Pressure: PX150 3 PSI; PX154 15 PSI

Burst Pressure: PX150 5 PSI; PX154 20 PSI

Gages: Solid state piezoresistive

Cover Material: PX150 PVC-1" electrical access enclosure; PX154 NEMA-4 gasketed steel enclosure with enamel finish

Pressure Port: PX150 0.187" diameter tube fitting ports; PX154 1/4" NPT female

Electrical Connection: Internal screw terminations

To Order (Specify Model Number)

RANGE Inches of H ₂ O	MODEL	PRICE	COMPATIBLE METER
NEMA-4 Enclosure Models			
0 to 1"	PX154-001DI	\$305	DP100R8, DP2000P9, TX81
0 to 3"	PX154-003DI	305	DP100R8, DP2000P9, TX81
0 to 5"	PX154-005DI	305	DP100R8, DP2000P9, TX81
0 to 10"	PX154-010DI	305	DP100R8, DP2000P9, TX81
0 to 25"	PX154-025DI	305	DP100R8, DP2000P8, TX81
Conduit Enclosure Models			
0 to 1"	PX150-001DI	315	DP100R8, DP2000P9, TX81
0 to 3"	PX150-003DI	315	DP100R8, DP2000P9, TX81
0 to 5"	PX150-005DI	315	DP100R8, DP2000P9, TX81
0 to 10"	PX150-010DI	315	DP100R8, DP2000P9, TX81
0 to 25"	PX150-025DI	315	DP100R8, DP2000P8, TX81

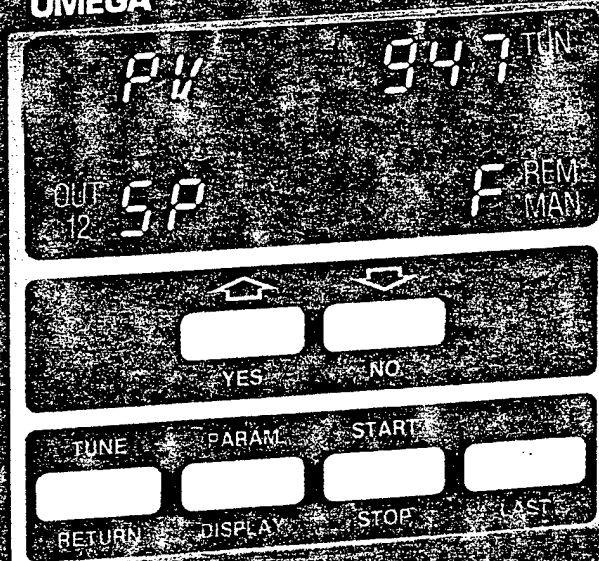
PROCESS CONTROLLER

CN 2000 SERIES

MADE IN

USA

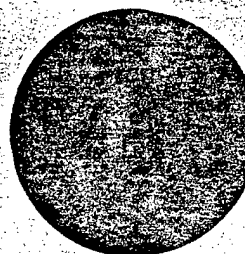
OMEGA



- For Millivolt, Volt and Milliamp Transducers
- RS-232 and RS-422 Communication for Remote Control through a Computer System
- Wide Variety of Output and Alarm Options Available

Features

- PID Control
- User Friendly Tuning Via Front Keypad
- Continuous Indication of Output, Alarm, and Operating Status
- Comprehensive Manual Included



To Order (Specify model number)

Model No.	Price	1st Output and Mode	2nd Output and Mode	Alarms
CN2001 (*)	\$415	1A SSR PID	—	None
CN2002 (*)	445		1 A SSR, ON/OFF	
CN2001A (*)	465		—	Dual
CN2002A (*)	505		1A SSR, ON/OFF	

*Insert input code. Price includes range premiums.

EXCITATION OPTIONS*

Excitation	Code	Price	Description
*Not Available with Options D2-D6 or Model CN2000A.			
5 V dc	X5 V	\$50	5 V dc @ 40 mA
10 V dc	X10 V	50	10 V dc @ 100 mA

COMMUNICATION OPTIONS

Code	Price	Description
D1	\$ 50	remote analog setpoint (n/a with 2000A)
D2	195	non-isolated RS-232C
D3	195	isolated RS-232C
D4	195	non-isolated RS-422
D5	195	isolated RS-422
D6	195	isolated 20 mA loop
D7	50	remote start/stop (N/A with 2000A)

INPUT TYPES

Code	Range	Type
mA	4-20 mA	Current
mV	0-100 mV dc	Voltage
V5	0-5 V dc	Voltage
V10	0-10 V dc	Voltage

Units factory scaled for 0-100% display. Zero and span field selectable. Max. display is 3200 counts.

OUTPUT OPTIONS

Ordering Suffix	Price	Description
-F1	N/C	4-20mA, output 1, reverse
-F2	N/C	4-20mA, output 2, direct
-DC1	N/C	0-5 Vdc, output 1, reverse
-DC2	N/C	0-5 Vdc, output 2, direct

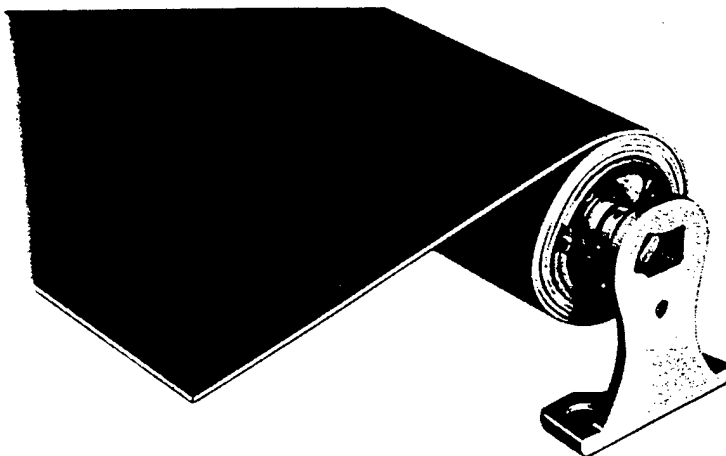
Also Available Auto/Manual Output Control. To Order, Add Suffix AM to Model No., and Add \$50 to Price.

GORTITE

SHADE ROLLER COVERS

PROTECT WAYS AGAINST CHIPS AND COOLANTS

GORTITE SHADE ROLLERS AND COVERS ARE AVAILABLE FOR ALL APPLICATIONS THAT REQUIRE PROTECTION FROM CHIPS, ABRASIVES, OIL AND COOLANTS WITHOUT THE SEAL OF A BELLOWS COVER. VARIOUS DIAMETER SPRING LOADED METAL ROLLERS ARE AVAILABLE WITH COVER MATERIALS TO SUIT THE SIZE AND SEVERITY OF THE APPLICATION.



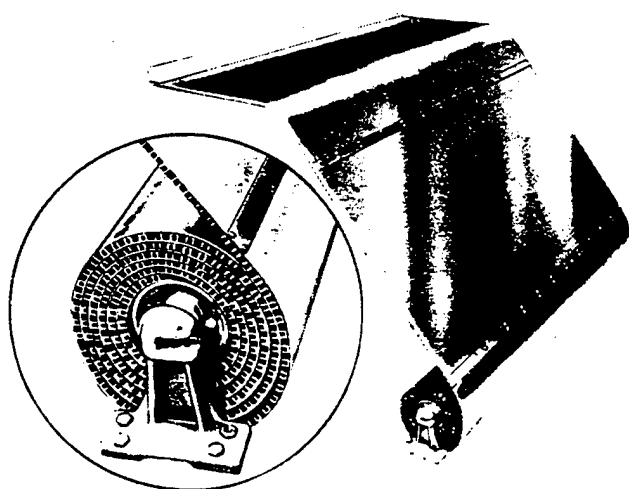
— DESCRIPTION OF COVER MATERIALS —

COVER MATERIALS *

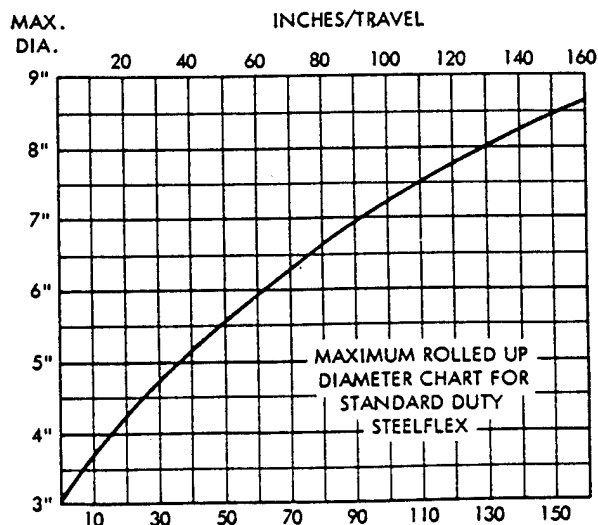
DESCRIPTION

● 18NN	.018 GAUGE NEOPRENE COATED NYLON - FOR LIGHT DUTY PROTECTION AGAINST COOLANTS AND CHIPS
33NN	.033 GAUGE NEOPRENE COATED NYLON - FOR MODERATE DUTY PROTECTION AGAINST COOLANTS AND CHIPS
60HN	.060 GAUGE HYPALON COATED NYLON - HEAVY DUTY PROTECTION AGAINST ABRASION, COOLANT, AND CHIPS INCLUDING MODERATE HOT CHIP LOADS
STANDARD DUTY STEELFLEX	CONTINUOUS STAINLESS STEEL TOP SURFACE WITH SUPPORTING ALUMINUM RIBS. FOR HEAVY DUTY PROTECTION AGAINST LARGE CHIP LOADS, COOLANT, HOT CHIPS, ETC.

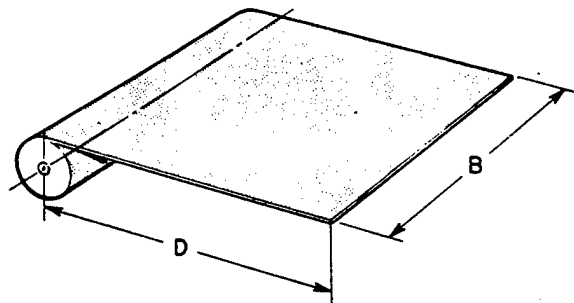
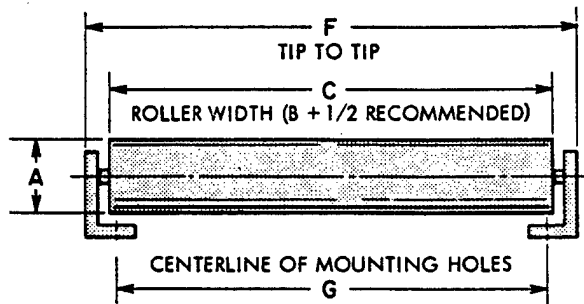
*SPECIAL MATERIALS AVAILABLE UPON REQUEST.



STANDARD DUTY STEELFLEX ON SPRING LOADED ROLLER

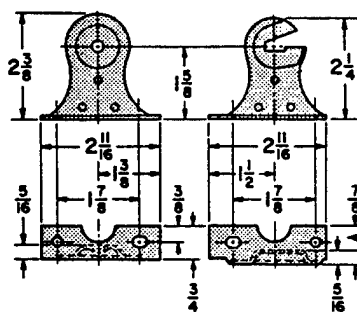


— ROLLER DIMENSIONS AND COVER MATERIALS —

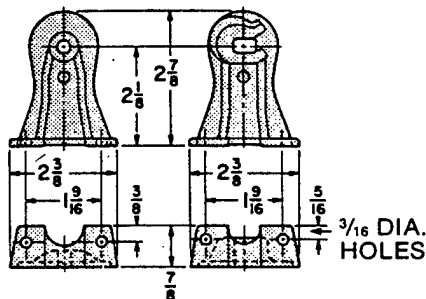


ROLLER DIAMETER	TIP TO TIP	CENTERLINE OF MTG. HOLES	COVER MATERIALS AVAILABLE ON VARIOUS ROLLER DIAMETERS			
A	F	G	18NN	33NN	60HN	STD. DUTY STEELFLEX
1-1/2"	$C + 1-1/8"$	$C + 1/8"$	X			
2" HD	$C + 1-5/16"$	$C + 5/16"$	X	X	X	
3" HD	$C + 1-1/2"$	$C - 11/4", C + 1/2"$	X	X	X	X

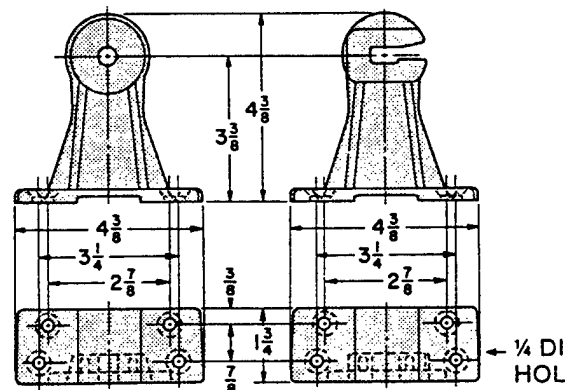
— DIMENSIONS OF ROLLER MOUNTING BRACKETS —



1-1/2" DIAMETER ROLLER



2" DIAMETER ROLLER



3" DIAMETER ROLLER

— HOW TO ORDER —

TO ORDER OR FOR QUOTATION, PLEASE SPECIFY THE FOLLOWING DIMENSIONS AND INFORMATION.

A ROLLER DIAMETER _____
 B COVER WIDTH _____
 (WAY WIDTH + 2" RECOMMENDED)
 C ROLLER WIDTH _____
 (COVER + 1/2" RECOMMENDED)
 D MAX. OPEN LENGTH OF COVER _____
 (FOR _____ MACHINE TRAVEL)
 MAX. MACHINE TRAVEL SPEED _____ IN./MIN.
 COVER MATERIAL PREFERRED
 _____ 18NN _____ 33NN _____ 60HN
 _____ STANDARD DUTY STEELFLEX _____ OTHER
 _____ WITH _____ WITHOUT MOUNTING BRACKETS

DATE _____ FOR QUOTATION ONLY _____
 QUANTITY REQUIRED _____
 DATE REQUIRED _____
 ORDER NUMBER _____
 COMPANY NAME _____
 ADDRESS _____
 CITY _____ STATE _____ ZIP _____
 ATTENTION _____

PLEASE BE SURE YOU HAVE FILLED IN AS MUCH OF THE REQUESTED INFORMATION AS IS AVAILABLE.

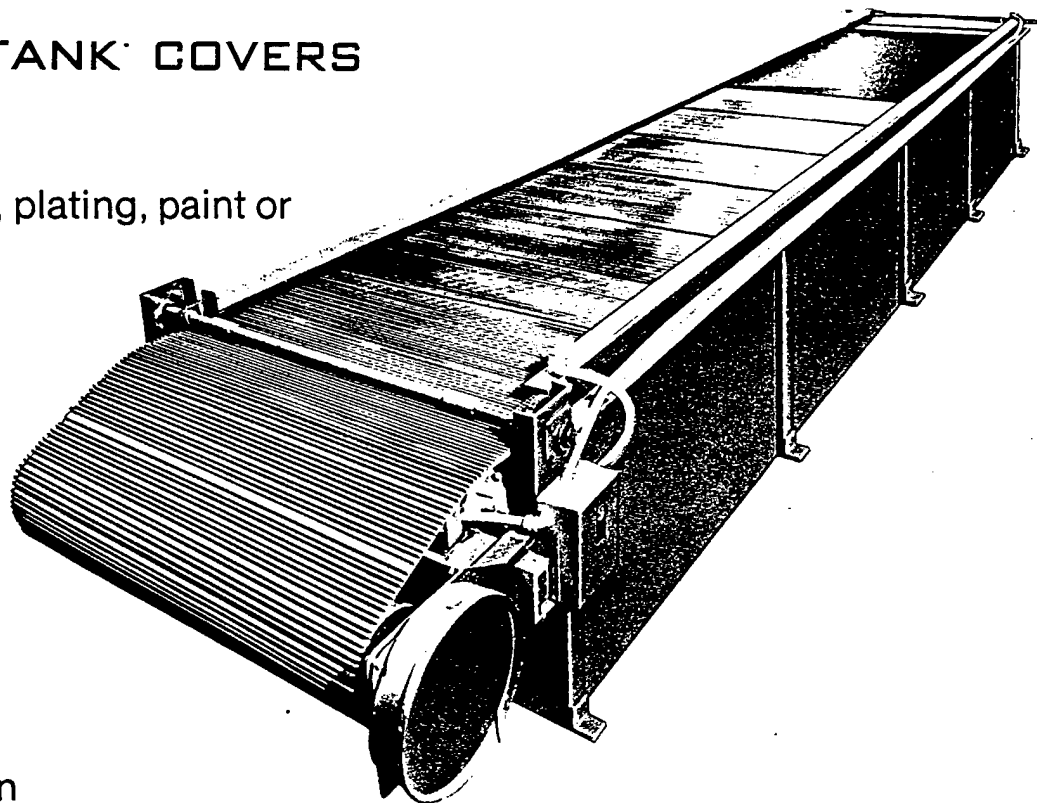
A and A Manufacturing Company

2300 So. Calhoun Rd., New Berlin, Wis. 53151 • Phone 414-786-1500

STEELFLEX[®]

MOTOR-DRIVEN TANK COVERS

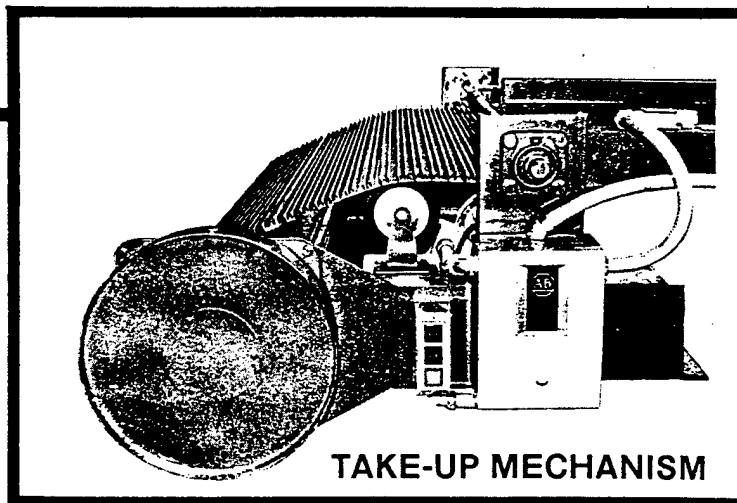
for chemical, degreasing, plating, paint or any other type of tank



- Protect Personnel
- Control Evaporative Emissions
For Energy Savings
- Prevent Contamination
- Contain Dangerous Fumes

CONSTRUCTION

STEELFLEX motor-driven tank covers are designed to provide a complete system for covering all types of tanks. Steelflex covers are made of continuous stainless steel surface reinforced with aluminum, steel or stainless steel support ribs which allow personnel to walk on the cover. The support ribs are bonded to top for strong, durable construction. Stainless steel or aluminum guide channels can be provided for the sides of the tank to contain the cover. Tank covers can be furnished stainless steel side on top or bottom. Any tank width or length can be accommodated.



TAKE-UP MECHANISM

Steelflex Tank Covers are supplied with electric motor drive and take-up mechanism with electrical control for forward, reverse and stop.



A and A Manufacturing Co. Inc.

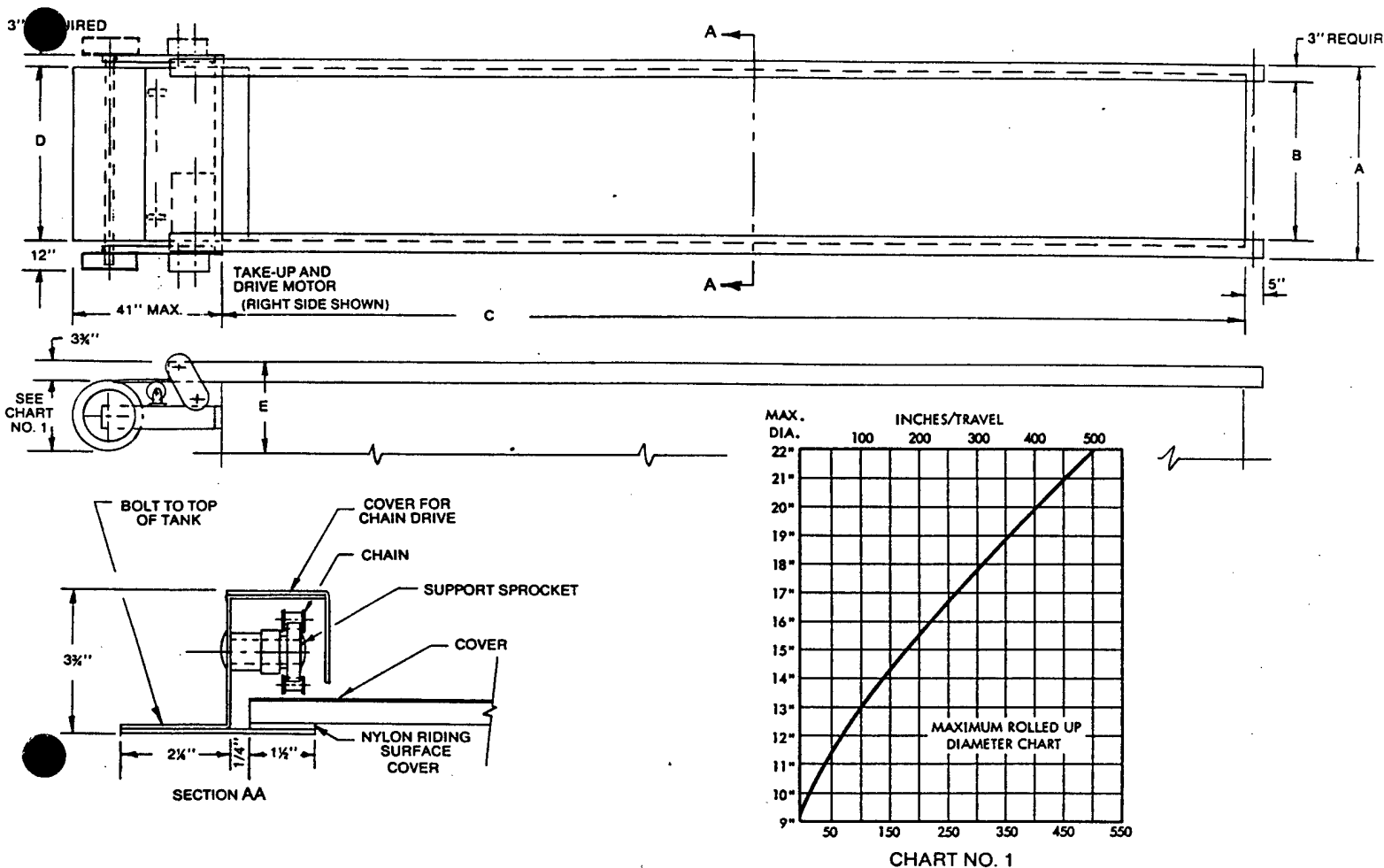
2300 South Calhoun Road
New Berlin, WI 53151 Phone 414-786-1500



STEELFLEX®

MOTOR-DRIVEN

TANK COVERS DATA SHEET



HOW TO ORDER

TO ORDER OR FOR QUOTATION, PLEASE SPECIFY THE FOLLOWING DIMENSIONS AND INFORMATION.

A. OVERALL TANK WIDTH _____
B. INSIDE TANK WIDTH _____
C. OVERALL TANK LENGTH (INSIDE) _____
D. COVER WIDTH _____
E. TANK HEIGHT ABOVE FLOOR _____
SUBSTANCE BEING COVERED _____
TAKE-UP & DRIVE MOTOR LOCATION _____
RIGHT SIDE _____ LEFT SIDE _____
MOTOR STARTER VOLTAGE REQUIRED _____
_____ VOLT _____ PHASE

DATE _____ FOR QUOTATION ONLY _____
QUANTITY REQUIRED _____
DATE REQUIRED _____
ORDER NUMBER _____
COMPANY NAME _____
ADDRESS _____
CITY _____
STATE _____ ZIP _____
ATTENTION _____
TELEPHONE _____



A and A Manufacturing Co. Inc.

2300 South Calhoun Road
New Berlin, WI 53151 Phone 414-786-1500

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ECO 5

Electrical Demand Peak Reduction

Assumptions:

1. Electric motors driving the process equipment are operating at 65% of full load.
2. The average motor efficiency is 88 %
3. The electric heating elements of the Selas Furnace draw about 500 KW.
4. Only one vertical furnace (in Bldg. 135) operates each day.
5. Only one of the Wellman Furnaces operates at any one time.
6. The equipment kw draws and operating times are:

	Stage 1	Stage 2
Tocco Furnace	1250 kw, .33 hr	625 kw, 1.17 hr
Rotary Forge	1650 kw, .33 hr	NA
Selas Furnace	636 kw, 24 hr	NA
Wellman Furnace	1000 kw, 1 hr	500 kw, 7 hr
Swage	227 kw, 0.5 hr	NA
Vertical Furnace	471 kw, 3 hr	202 kw, 8 hr

ECO 5 - continued

The motor kw was calculated on a computer spreadsheet. The results are located on page 5-4 of this appendix.

The total equipment kw was input into a spreadsheet, scheduled at random.

The results show a maximum kw draw of 4,465 kw at about 10:30 am. See page 5-5 for details.

The same pieces of equipment were then scheduled for various times during the day and input on the same spreadsheet.

The results show a maximum kw draw of 2286 kw (say 2285) when the loads are properly scheduled. See page 5-6 for details.

Kw Savings = Unscheduled Kw - Scheduled Kw

$$\text{Savings} = 4465 \text{ kw/mo} - 2285 \text{ kw/mo} = \underline{2180 \text{ kw/mo}}$$

Cost Savings:

$$2180 \text{ kw/mo} \times 12 \text{ mo/yr} \times \$5.53/\text{kw} = \underline{\$144,665/\text{yr}}$$

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT Wateruliet LES

AEP NO 290-0379-002

SHEET _____ OF _____

DESIGNER W. T. T.

DATE 8-9-91

CHECKER _____

DATE _____

ECD 5 - Continued

Construction Costs:

There are no direct installation cost for this project. It requires some industrial engineering and cooperation from the production staff.

Scheduled Process Equipment
Filename: EQUIP

08/09/91

	Equipment					
Equipment Description	Tocco	Forge	Selas	Wellman	Swage	V.Furn
Number of Machines	5	1	1	2	3	2
Operating Machines	1	1	1	1	1	1
Parts per Day	5	5	5	5	5	5
Hours per Part	1.5	0.3	13.1	8.0	0.5	12.0
Hours per Day	7.5	1.3	24.0	8.0	2.5	12.0
HP/Machine	0.0	2961.0	246.0	0.0	407.5	3.5
Total Horsepower	0.0	2961.0	246.0	0.0	407.5	3.5
Motor KW	0.0	1631.6	135.6	0.0	224.8	1.9
Heating KW	1250	0	500	1000	2	469
Total KW	1250	1632	636	1000	227	471

Assumptions:

1. Motors are operating at 65% of full load
2. Average motor efficiency is 88%
3. Selas furnace electric heat is 500 KW

Daily Demand (KW) Load - Not Scheduled

Time	Selas	V. Furn	Tocco	Forge	Swage	Wellman	Total
0	636	471					1107
	636	471					1107
	636	471					1107
	636	471					1107
2	636	202					838
	636	202					838
	636	202					838
	636	202					838
4	636	202					838
	636	202					838
	636	202					838
	636	202					838
6	636	202					838
	636	202				1000	1838
	636	202				1000	1838
	636	202	1250			500	2588
8	636	202	625			500	1963
	636	202	625		227	500	2190
	636	202	1250	1650		500	4238
	636	202	625		227	500	2190
10	636	202	625			500	1963
	636	202	1250	1650	227	500	4465
	636		625			500	1761
	636		625		227	500	1988
12	636		1250	1650		500	4036
	636		625		227	500	1988
	636		625			500	1761
	636		1250	1650		500	4036
14	636		625			500	1761
	636		625				1261
	636			1650			2286
	636						636
16	636						636
	636						636
	636						636
	636						636
18	636						636
	636						636
	636						636
	636						636
20	636						636
	636						636
	636						636
	636						636
22	636						636
	636						636
	636	471					1107
	636	471					1107
Maximums	636	471	1250	1650	227	1000	4465

Daily Demand (KW) Load - Scheduled

Time	Selas	V. Furn	Tocco	Forge	Swage	Wellman	Total
0	636	202				500	1338
	636	202				500	1338
	636	202					838
	636	202					838
2	636	202					838
	636	202					838
	636	202					838
	636	202					838
4	636	202					838
	636	202					838
	636	202					838
	636	202					838
6	636						636
	636		1250				1886
	636		625		227		1488
	636		625				1261
8	636			1650			2286
	636		1250				1886
	636		625		227		1488
	636		625				1261
10	636			1650			2286
	636		1250				1886
	636		625		227		1488
	636		625				1261
12	636			1650			2286
	636		1250				1886
	636		625		227		1488
	636		625				1261
14	636			1650			2286
	636		1250				1886
	636		625		227		1488
	636		625				1261
16	636			1650			2286
	636						636
	636					1000	1636
	636					1000	1636
18	636	471				500	1607
	636	471				500	1607
	636	471				500	1607
	636	471				500	1607
20	636	471				500	1607
	636	471				500	1607
	636	202				500	1338
	636	202				500	1338
22	636	202				500	1338
	636	202				500	1338
	636	202				500	1338
	636	202				500	1338
Maximums	636	471	1250	1650	227	1000	2286

Watervliet Electric Demand Data
 Filename: KWDATA

Month	Year	Billed KW	Billed Amount	Demand Charge
6	1990	10818.7	\$53,270.03	\$4.92
7	1990	11205.0	\$55,172.13	\$4.92
8	1990	11011.9	\$54,942.35	\$4.99
9	1990	11205.0	\$55,905.80	\$4.99
10	1990	11591.4	\$57,833.69	\$4.99
11	1990	10818.7	\$53,978.41	\$4.99
12	1990	11591.4	\$57,833.69	\$4.99
1	1991	10239.1	\$56,079.04	\$5.48
2	1991	10432.3	\$57,736.85	\$5.53
3	1991	10142.5	\$56,132.97	\$5.53
4	1991	10915.3	\$60,409.98	\$5.53
5	1991	11108.4	\$61,478.68	\$5.53
Maximum		11591.4	\$61,478.68	\$5.53
Average		10923.3	\$56,731.14	\$5.20
Total			\$680,773.62	

Watervliet Demand And Power Factor Data
 Filename: ELECDATA

6/13/90

Hour	Metered KW	Demand KW	Metered KVAR	Reactive KVAR	KVA	PF
0	191	5500.8	135	4665.6	7212.9	0.763
	192	5529.6	139	4803.8	7324.8	0.755
	194	5587.2	141	4873.0	7413.7	0.754
	192	5529.6	142	4907.5	7393.3	0.748
1	193	5558.4	141	4873.0	7392.0	0.752
	194	5587.2	141	4873.0	7413.7	0.754
	195	5616.0	146	5045.8	7549.8	0.744
	194	5587.2	144	4976.6	7482.2	0.747
2	192	5529.6	142	4907.5	7393.3	0.748
	193	5558.4	143	4942.1	7437.7	0.747
	192	5529.6	144	4976.6	7439.3	0.743
	198	5702.4	146	5045.8	7614.3	0.749
3	195	5616.0	145	5011.2	7526.7	0.746
	195	5616.0	144	4976.6	7503.8	0.748
	193	5558.4	143	4942.1	7437.7	0.747
	189	5443.2	139	4803.8	7259.8	0.750
4	186	5356.8	137	4734.7	7149.3	0.749
	184	5299.2	136	4700.2	7083.3	0.748
	184	5299.2	135	4665.6	7060.4	0.751
	186	5356.8	137	4734.7	7149.3	0.749
5	188	5414.4	140	4838.4	7261.3	0.746
	188	5414.4	139	4803.8	7238.3	0.748
	188	5414.4	137	4734.7	7192.6	0.753
	194	5587.2	139	4803.8	7368.4	0.758
6	196	5644.8	138	4769.3	7389.8	0.764
	196	5644.8	138	4769.3	7389.8	0.764
	198	5702.4	136	4700.2	7389.8	0.772
	204	5875.2	133	4596.5	7459.6	0.788
7	211	6076.8	132	4561.9	7598.6	0.800
	243	6998.4	132	4561.9	8354.0	0.838
	275	7920.0	154	5322.2	9542.2	0.830
	304	8755.2	176	6082.6	10660.7	0.821
8	315	9072.0	184	6359.0	11078.7	0.819
	313	9014.4	187	6462.7	11091.7	0.813
	312	8985.6	181	6255.4	10948.5	0.821
	310	8928.0	186	6428.2	11001.4	0.812
9	308	8870.4	185	6393.6	10934.4	0.811
	306	8812.8	189	6531.8	10969.5	0.803
	311	8956.8	199	6877.4	11292.6	0.793
	322	9273.6	210	7257.6	11775.9	0.788
10	320	9216.0	207	7153.9	11666.8	0.790
	337	9705.6	214	7395.8	12202.3	0.795
	327	9417.6	213	7361.3	11953.2	0.788
	318	9158.4	211	7292.2	11706.9	0.782
11	319	9187.2	212	7326.7	11751.0	0.782
	319	9187.2	202	6981.1	11538.7	0.796
	305	8784.0	192	6635.5	11008.6	0.798
	293	8438.4	191	6601.0	10713.5	0.788
12	298	8582.4	202	6981.1	11063.2	0.776
	319	9187.2	218	7534.1	11881.4	0.773

	332	9561.6	219	7568.6	12194.6	0.784
	328	9446.4	218	7534.1	12082.9	0.782
13	317	9129.6	213	7361.3	11727.7	0.778
	325	9360.0	212	7326.7	11886.6	0.787
	319	9187.2	213	7361.3	11772.6	0.780
	335	9648.0	221	7637.8	12305.3	0.784
14	324	9331.2	217	7499.5	11971.4	0.779
	318	9158.4	220	7603.2	11903.1	0.769
	292	8409.6	203	7015.7	10951.8	0.768
	275	7920.0	186	6428.2	10200.4	0.776
15	270	7776.0	182	6289.9	10001.5	0.777
	268	7718.4	179	6186.2	9891.6	0.780
	258	7430.4	165	5702.4	9366.3	0.793
	241	6940.8	155	5356.8	8767.6	0.792
16	233	6710.4	155	5356.8	8586.3	0.782
	238	6854.4	167	5771.5	8960.6	0.765
	237	6825.6	171	5909.8	9028.5	0.756
	237	6825.6	172	5944.3	9051.2	0.754
17	234	6739.2	170	5875.2	8940.6	0.754
	238	6854.4	174	6013.4	9118.3	0.752
	238	6854.4	173	5978.9	9095.6	0.754
	235	6768.0	170	5875.2	8962.4	0.755
18	240	6912.0	169	5840.6	9049.2	0.764
	242	6969.6	169	5840.6	9093.3	0.766
	256	7372.8	177	6117.1	9580.0	0.770
	234	6739.2	164	5667.8	8805.7	0.765
19	244	7027.2	170	5875.2	9159.7	0.767
	228	6566.4	158	5460.5	8540.2	0.769
	222	6393.6	153	5287.7	8296.8	0.771
	218	6278.4	153	5287.7	8208.4	0.765
20	219	6307.2	152	5253.1	8208.3	0.768
	214	6163.2	150	5184.0	8053.5	0.765
	221	6364.8	157	5425.9	8363.7	0.761
	222	6393.6	160	5529.6	8453.1	0.756
21	224	6451.2	161	5564.2	8519.3	0.757
	219	6307.2	161	5564.2	8410.7	0.750
	221	6364.8	161	5564.2	8454.0	0.753
	220	6336.0	162	5598.7	8455.2	0.749
22	215	6192.0	160	5529.6	8301.6	0.746
	218	6278.4	160	5529.6	8366.3	0.750
	213	6134.4	157	5425.9	8189.7	0.749
	211	6076.8	154	5322.2	8078.0	0.752
23	209	6019.2	153	5287.7	8011.9	0.751
	204	5875.2	151	5218.6	7858.2	0.748
	204	5875.2	147	5080.3	7767.1	0.756
	200	5760.0	146	5045.8	7657.5	0.752

Watervliet Demand And Power Factor Data
 Filename: ELECDATA

6/14/90

Hour	Metered KW	Demand KW	Metered KVAR	Reactive KVAR	KVA	PF
0	201	5788.8	147	5080.3	7701.9	0.752
	198	5702.4	145	5011.2	7591.4	0.751
	197	5673.6	144	4976.6	7547.0	0.752
	200	5760.0	149	5149.4	7726.2	0.746
1	199	5731.2	151	5218.6	7751.1	0.739
	200	5760.0	152	5253.1	7795.7	0.739
	200	5760.0	154	5322.2	7842.4	0.734
	203	5846.4	158	5460.5	7999.8	0.731
2	200	5760.0	153	5287.7	7819.0	0.737
	195	5616.0	151	5218.6	7666.3	0.733
	195	5616.0	152	5253.1	7689.9	0.730
	194	5587.2	152	5253.1	7668.9	0.729
3	191	5500.8	151	5218.6	7582.4	0.725
	195	5616.0	154	5322.2	7737.3	0.726
	193	5558.4	152	5253.1	7647.9	0.727
	195	5616.0	151	5218.6	7666.3	0.733
4	188	5414.4	148	5114.9	7448.3	0.727
	185	5328.0	144	4976.6	7290.7	0.731
	187	5385.6	144	4976.6	7332.9	0.734
	189	5443.2	147	5080.3	7445.7	0.731
5	189	5443.2	147	5080.3	7445.7	0.731
	190	5472.0	149	5149.4	7514.0	0.728
	196	5644.8	150	5184.0	7664.0	0.737
	199	5731.2	148	5114.9	7681.7	0.746
6	206	5932.8	150	5184.0	7878.6	0.753
	227	6537.6	150	5184.0	8343.5	0.784
	233	6710.4	147	5080.3	8416.6	0.797
	235	6768.0	152	5253.1	8567.4	0.790
7	265	7632.0	154	5322.2	9304.5	0.820
	275	7920.0	154	5322.2	9542.2	0.830
	294	8467.2	164	5667.8	10189.1	0.831
	309	8899.2	183	6324.5	10917.6	0.815
8	322	9273.6	207	7153.9	11712.3	0.792
	313	9014.4	214	7395.8	11660.1	0.773
	335	9648.0	217	7499.5	12219.9	0.790
	327	9417.6	216	7465.0	12017.4	0.784
9	316	9100.8	216	7465.0	11770.7	0.773
	318	9158.4	216	7465.0	11815.3	0.775
	304	8755.2	211	7292.2	11394.3	0.768
	325	9360.0	221	7637.8	12080.8	0.775
10	339	9763.2	223	7706.9	12438.5	0.785
	336	9676.8	223	7706.9	12370.8	0.782
	347	9993.6	233	8052.5	12834.1	0.779
	364	10483.2	238	8225.3	13324.9	0.787
11	375	10800.0	232	8017.9	13450.9	0.803
	328	9446.4	210	7257.6	11912.5	0.793
	305	8784.0	198	6842.9	11134.8	0.789
	310	8928.0	200	6912.0	11290.9	0.791
12	317	9129.6	215	7430.4	11771.2	0.776
	320	9216.0	221	7637.8	11969.5	0.770

6/14/95

	337	9705.6	220	7603.2	12329.1	0.787
	334	9619.2	222	7672.3	12304.2	0.782
13	328	9446.4	219	7568.6	12104.5	0.780
	300	8640.0	208	7188.5	11239.4	0.769
	311	8956.8	209	7223.0	11506.4	0.778
	317	9129.6	217	7499.5	11814.9	0.773
14	315	9072.0	216	7465.0	11748.5	0.772
	297	8553.6	211	7292.2	11240.1	0.761
	302	8697.6	207	7153.9	11261.7	0.772
	280	8064.0	185	6393.6	10291.1	0.784
15	271	7804.8	179	6186.2	9959.1	0.784
	265	7632.0	175	6048.0	9737.9	0.784
	251	7228.8	161	5564.2	9122.2	0.792
	238	6854.4	149	5149.4	8573.2	0.800
16	228	6566.4	152	5253.1	8409.1	0.781
	233	6710.4	159	5495.0	8673.2	0.774
	230	6624.0	160	5529.6	8628.7	0.768
	227	6537.6	159	5495.0	8540.2	0.766
17	239	6883.2	168	5806.1	9004.9	0.764
	230	6624.0	168	5806.1	8808.4	0.752
	249	7171.2	176	6082.6	9403.4	0.763
	233	6710.4	165	5702.4	8806.1	0.762
18	222	6393.6	160	5529.6	8453.1	0.756
	222	6393.6	160	5529.6	8453.1	0.756
	219	6307.2	159	5495.0	8365.2	0.754
	220	6336.0	160	5529.6	8409.6	0.753
19	219	6307.2	156	5391.4	8297.4	0.760
	214	6163.2	155	5356.8	8165.8	0.755
	214	6163.2	146	5045.8	7965.2	0.774
	215	6192.0	144	4976.6	7944.0	0.779
20	211	6076.8	140	4838.4	7767.7	0.782
	211	6076.8	142	4907.5	7811.0	0.778
	214	6163.2	142	4907.5	7878.4	0.782
	215	6192.0	147	5080.3	8009.4	0.773
21	215	6192.0	148	5114.9	8031.4	0.771
	216	6220.8	150	5184.0	8097.7	0.768
	217	6249.6	153	5287.7	8186.4	0.763
	215	6192.0	153	5287.7	8142.5	0.760
22	213	6134.4	151	5218.6	8053.8	0.762
	214	6163.2	153	5287.7	8120.6	0.759
	213	6134.4	153	5287.7	8098.8	0.757
	206	5932.8	148	5114.9	7833.3	0.757
23	204	5875.2	145	5011.2	7722.1	0.761
	200	5760.0	142	4907.5	7567.1	0.761
	200	5760.0	137	4734.7	7456.2	0.773
	197	5673.6	134	4631.0	7323.7	0.775



SUBJECT ECO #6 - Plating
Area Condensate Return
DESIGNER P. Hutchins
CHECKER B. Todd

AEP NO 290-0379-002
SHEET OF
DATE 7/11/91
DATE 9/16/91

ECO #6 - PLATING AREA CONDENSATE RETURN

- Estimate existing energy use for making steam

FY 90

BLDG 136 - 278,000 MBtu FSR

BLDG 35 - 29,500 MBtu NGAS

- Calculate total steam generated

$$\text{Stm} = \text{FUEL USE} \times \text{BLR EFF} \quad (\text{App B, p. I-11})$$

	<u>BLR EFF</u>	<u>MBtu</u>	<u>#</u>
BLDG 136	0.83	230,700	232,133,000
BLDG 35	0.77	22,700	22,852,000

- Estimate condensate to be returned from plating areas

Since Bldg 35 boiler supplies only the plating areas and no condensate is returned, the steam production during the summer months will be a good approximation for year-round use.

Average steam production for Aug and Sept '90

$$(3,676,600 + 3,983,500) / 2 \approx 3,830,000 \text{ \# / mon.}$$

Plating area annual steam use is $\Rightarrow 3,830,000 \times 12 \approx 45,960,000 \text{ \# / yr}$
 $\approx \underline{\underline{46,000 \text{ MBtu / yr}}}$



SUBJECT ECO #6

DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE 7/11/91
DATE _____

- Calculate energy savings by returning
plating area condensate

Assume 90% is returned at 180°F to
Bldg 35 and 150°F to Bldg 136.

$$\text{Fuel Energy Saved} = \frac{\text{condensate amount} \times (\text{cond. temp} - \text{make-up temp.})}{\text{Boiler EFF}}$$

Boiler EFF

$$\text{Bldg 35} \Rightarrow \frac{22,852,000^{\#} \times (180 - 60)^{\circ}\text{F} \times 1 \frac{\text{Btu}}{\text{lb}^{\circ}\text{F}} \times 0.9}{0.77}$$

$$= \underline{3205 \text{ MBtu}} \text{ Natural gas}$$

$$\text{Bldg 136} \Rightarrow \frac{(45,960,000 - 22,852,000) \times (150 - 60) \times 0.9}{0.83}$$

$$= \underline{2255 \text{ MBtu}} \text{ \#6 Fuel Oil}$$



SUBJECT ECO #6

DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

QRIP Calc.s

- Calculate present, proposed and savings costs

Present annual energy use to Bldg. 35 plating is estimated using natural gas use at dunker boiler in Bldg #35

	<u>STEAM</u>		<u>Nat. Gas</u>	
	(lbs)	(MBtu)	(MCF)	(MBtu)
June '90	4,110,000	4110	51,373	5291
July '90	2,572,000	2572	32,494	3347
Aug. '90	3,676,000	3676	46,329	4772
Sept. '90	3,984,000	3984	49,696	5119
Oct. '90	3,155,000	3155	37,780	<u>3891</u>

Using Aug and Sept as avg., monthly use is:

$$\text{steam} = \frac{3676 + 3984}{2} = \underline{3830} \text{ MBtu/month.}$$

$$\text{n. gas} = \frac{4772 + 5119}{2} = \underline{4946} \text{ MBtu/month.}$$

$$\text{Annual N gas} = 4946 \frac{\text{MBtu}}{\text{mon}} \times 5 \text{ mos} \times \frac{\$4.16}{\text{MBtu}} = \underline{\$102,900}$$

$$\text{Annual Fuel Oil}^{\#6} = 3830 \frac{\text{MBtu}}{\text{mon}} \div 0.83 \times 7 \text{ mos} \times \frac{\$4.40}{\text{MBtu}} = \underline{\$142,100}$$

$$\text{TOTAL ENERGY COST} = \underline{\underline{\$245,000}}$$

SUBJECT ECO #6

AEP NO _____

SHEET _____ OF _____

DESIGNER _____

DATE _____

CHECKER _____

DATE _____

- Cost of proposed method

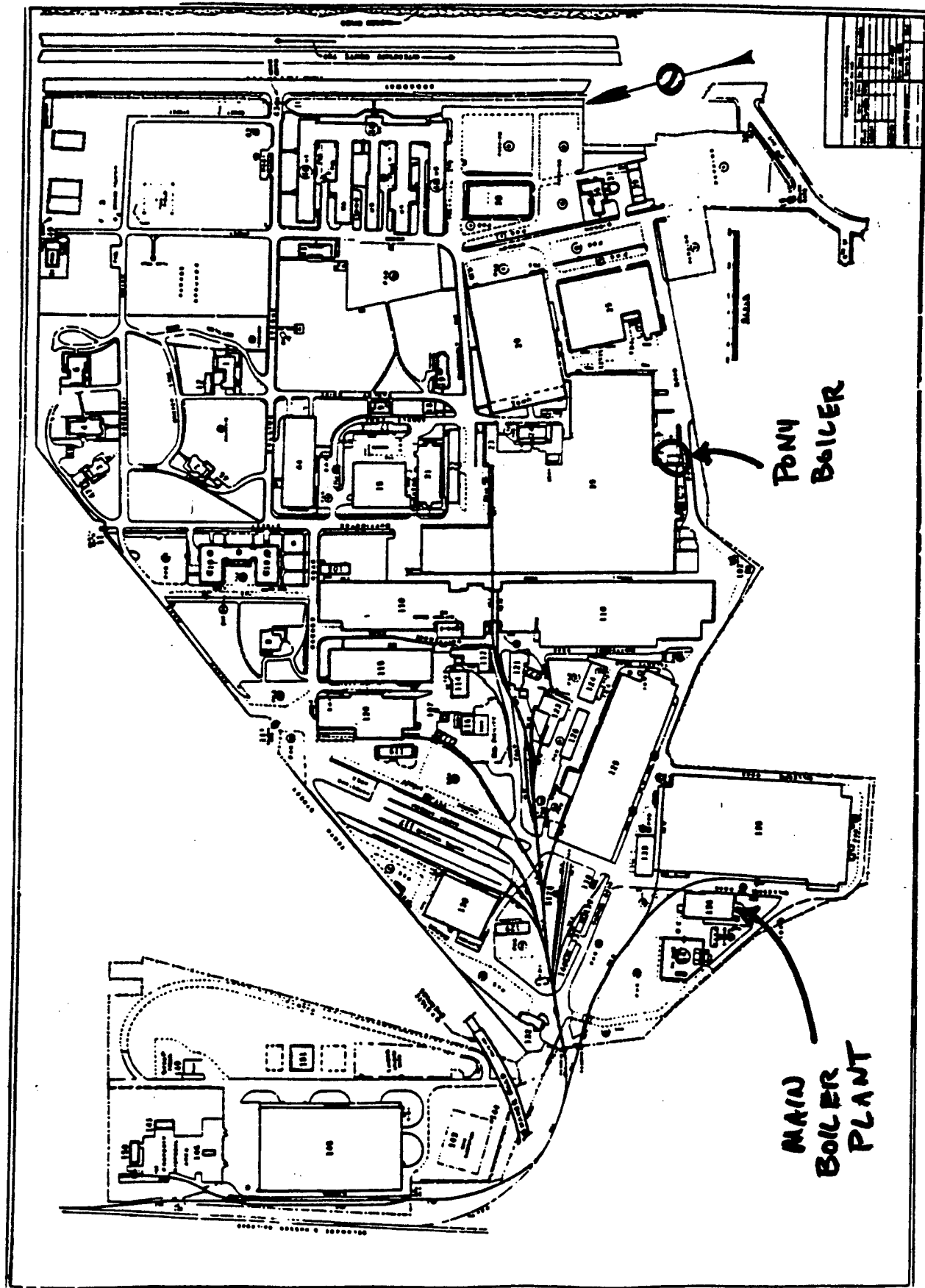
$$N_{\text{Gas}} = (4946 \times 5 - 3205) \times 4.16 = \$ 89,500$$

$$\#6 \text{ Fuel Oil} = \frac{(3830 \times 7 - 2255)}{0.83} \times 4.40 = \$ 132,200$$

$$\text{Total} \quad \$ 221,700$$

- Savings, annual

$$\begin{array}{r} \$ 245,000 \\ - 221,700 \\ \hline \$ 23,300 \end{array}$$

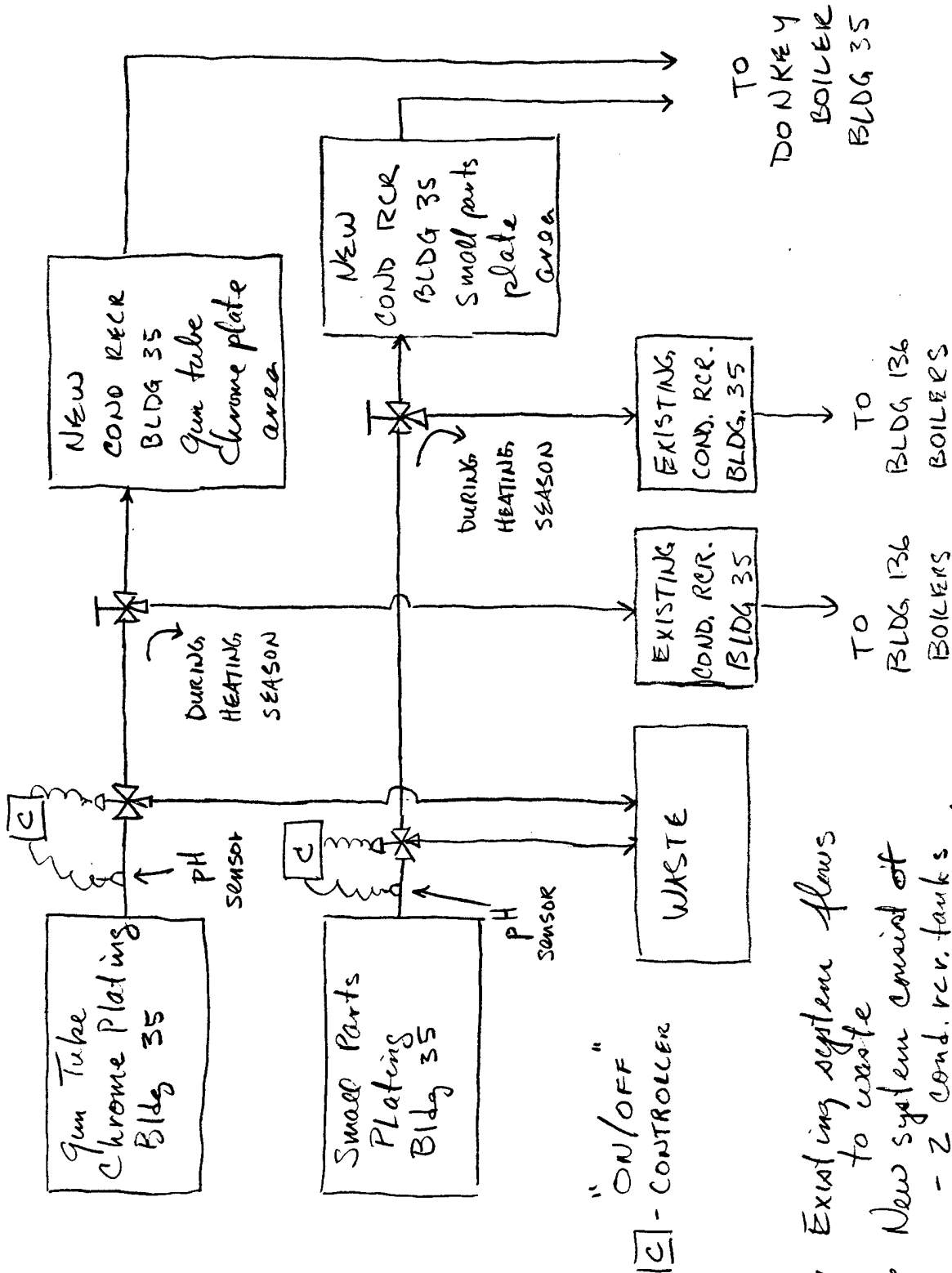




SUBJECT _____
 DESIGNER P. Hutchins
 CHECKER _____

AEP NO _____
 SHEET _____ OF _____
 DATE _____
 DATE _____

CONDENSATE RETURN SYSTEM SCHEMATIC



"ON/OFF"
 [C] - CONTROLLER

- Existing system flows to waste
- New system consist of
 - 2 cond. rev. tanks
 - 2 manual 3-way valves
 - 2 pH sensors and controls for 2 motorized 3-way valves

02/05/92

ECO Construction Cost Estimate Calculations

ECO Name: PLATING AREA STEAM CONDENSATE RETURN

ECO #: 6

1991 ECO "bare" costs (from cost estimate sheet)

Material	\$6,370
Labor	\$4,040

Subtotal bare costs	\$10,410

FICA Insurance (20% of Labor)	\$808

Sales Tax (not applicable for GOGO)	\$0

Subtotal	\$11,218

Overhead (15%)	\$1,683

Subtotal	\$12,901

Profit (10%)	\$1,290

Subtotal	\$14,191

Bond (1%)	\$142

Subtotal	\$14,333

Contingency (10%)	\$1,433

Subtotal (Construction Cost Input For LCCID *)	\$15,766

SIOH (6% of Construction Cost)	\$946

Subtotal	\$16,712

Design (6% of Construction Cost)	\$946

Total Project Cost	\$17,658

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

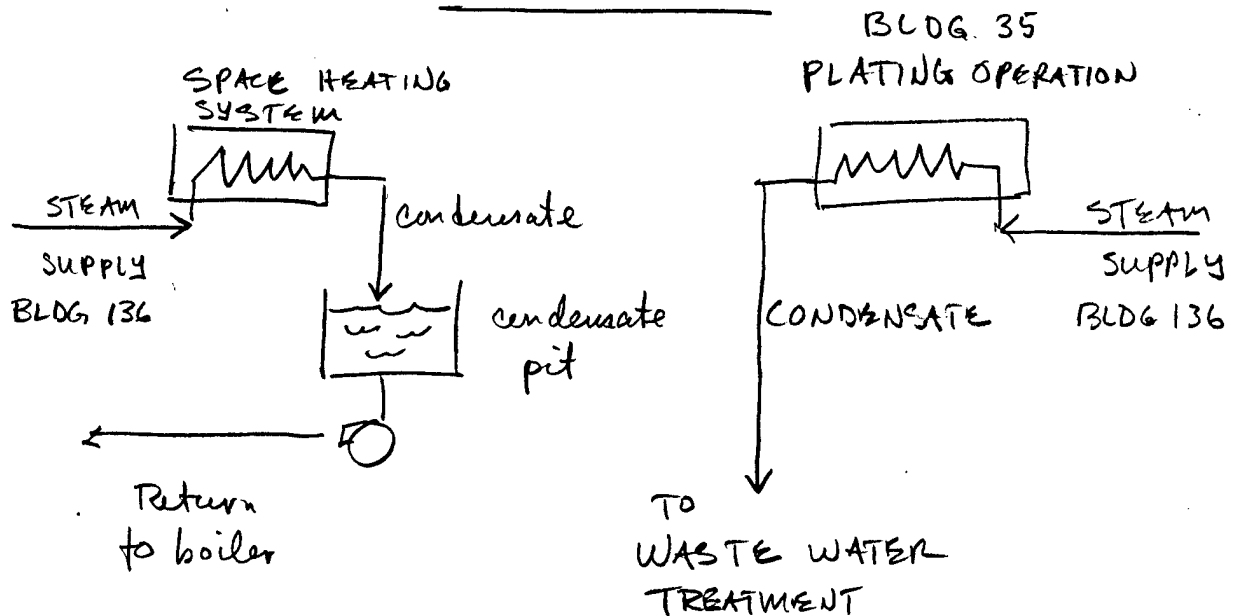


SUBJECT ECO # 6
COST ESTIMATE BACKUP
DESIGNER _____
CHECKER _____

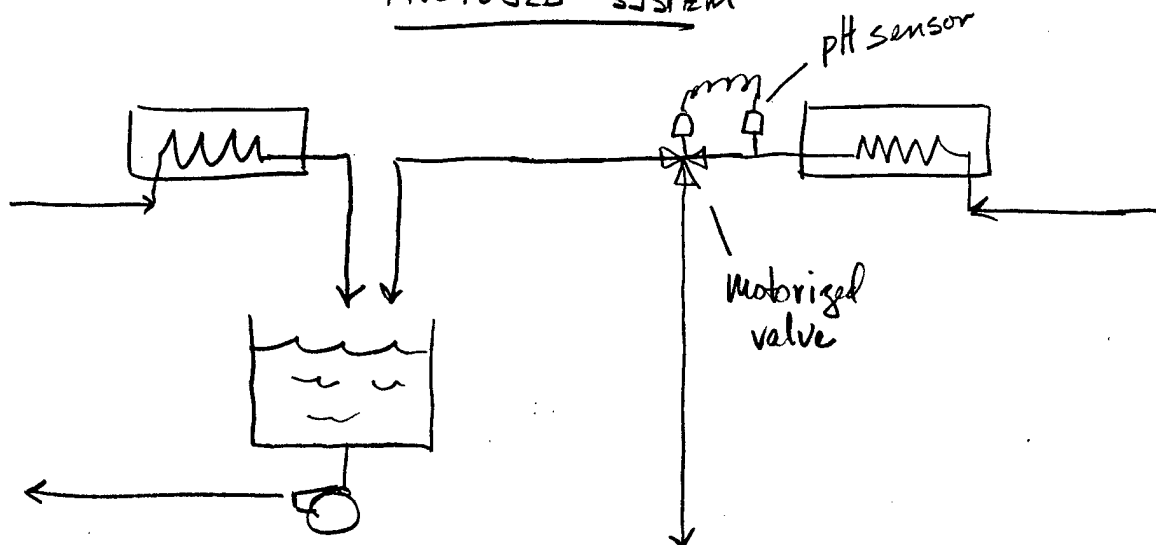
AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

Non-Summer Operation - Condensate return to Bldg 136

EXISTING SYSTEMS



PROPOSED SYSTEM



- The proposed system will require piping between the existing plating system condensate lines and the condensate pit, a motorized valve, pH sensor and associated controls. The pH sensor is used to divert the condensate to waste when the pH drops below a preset value.



SUBJECT ECO #6

DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

Summer Operation - Condensate return to
Bldg 35 boiler

Since the Bldg. 35 boiler has no condensate
return system, it will require all items
mentioned earlier for Bldg 136 condensate
return plus:

- condensate pit
- condensate pump
- pit/pump controls
- piping from pit pump
to boiler



SUBJECT ECO# 6
DESIGNER P. Hutchins
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE 3/7/91
DATE _____

- Determine condensate return requirements for donkey boiler from Bldg 3's plating areas
- Calculate condensate return pipe size

Ref.: "Flow of Fluids", Crane, 1979, p. 3-6, 7

- Reasonable velocities are:

Boiler Feed	8 to 15 fps
General Service	4 to 10 fps

The steam flow is ~ 7000 lbs/hr

The water density @ 200F is 60.1 lbs/cf

$$\frac{7000 \text{ lbs}}{\text{hr}} \cdot \frac{\text{cf}}{60.1 \text{ lbs}} \cdot \frac{\text{hr}}{3600 \text{ sec}} = \underline{\underline{0.032 \text{ cf/sec}}}$$

To keep the flow around 10 fps the pipe diameter should be

$$\begin{aligned} Q &= VA \\ A &= Q/V \\ A &= \pi D^2/4 \\ \pi D^2/4 &= Q/V \end{aligned}$$

$$0.032 \frac{\text{ft}^3}{\text{sec}} \cdot \frac{7.5 \text{ gal}}{\text{ft}^3} \cdot \frac{60 \text{ sec}}{\text{min}} = 14.4 \text{ gpm}$$

$$D = \sqrt{\frac{4Q}{\pi V}} = \sqrt{\frac{4(0.032 \frac{\text{cf}}{\text{sec}})}{3.14 \times 10 \frac{\text{ft}}{\text{sec}}}}$$

$$= 0.064 \text{ ft} = 0.77 \text{ inches}$$

or
3/4" pipe



SUBJECT ECO #6

DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

- Calculate condensate return pump size
Using Bernoulli's Egn.

$$H = 144 \frac{P_2 - P_1}{\rho} + \frac{V_2^2 - V_1^2}{2g} + Z_2 - Z_1 + h_f$$

where H = total head (ft)
 P_1 = pressure at ① (psig)
 P_2 = pressure at ② (psig)
 ρ = density of water @ 200°F (lbs/cf)
 $Z_{1,2}$ = elevations at ①, ②
 h_f = friction loss (ft)

Pumping will be from the gun tube chrome plate area condensate tank to the pony boiler located due east of this area and outside of the building.

$P_1 = P_2$ = atmospheric pressure (pumping from one tank to another)

$$V_1 = V_2 = 0$$

$$H = Z_2 - Z_1 + h_f$$

$$h_f = f \frac{L}{D} \frac{V^2}{2g}$$



SUBJECT ECO#6

DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

- Calculate f , friction factor

f is read from the Moody friction factor chart

knowing the Reynolds number and ϵ/D

where $\epsilon = 0.0002$ for steel pipe

$$\epsilon/D = \frac{0.0002}{0.0687'} = 0.0029$$

$$N_{RE} = \frac{DV}{\nu} = \frac{0.0687 \text{ ft} \cdot 10 \text{ ft/sec}}{0.341 \times 10^{-5} \text{ ft}^2/\text{sec}} =$$

$$= 2.01 \times 10^5$$

For $\epsilon/D = 0.0029$ and $N_{RE} = 2.01 \times 10^5$, $f = 0.0265$

$$h_f = 0.0265 \frac{300 \text{ ft}}{0.0687 \text{ ft}} \frac{(10 \text{ ft/sec})^2}{2 (32.2 \text{ ft/sec}^2)}$$

$$h_f = 180 \text{ feet}$$

$$z_2 = -30 \text{ feet}$$

$$H = -30 + 180 = 150 \text{ ft}$$

$$bhp = \frac{QH}{3960 \eta_p}$$

where $Q = \text{gal/min}$ $H = \text{head in ft}$ $\eta_p = \text{pump eff}$

$$= \frac{14.4 \cdot 150}{3960 (0.7)} = 0.78 \text{ hp} - \text{use } \underline{1 \text{ hp}} \text{ pump}$$



SUBJECT ECO #6

DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

for return from the small parts plating
area

$$H = z_2 - z_1 + h_f$$

$$z_2 - z_1 = 0$$

$$h_f = f \frac{L}{D} \frac{V^2}{2g} = 0.0265 \frac{300}{0.0687} \frac{10^2}{2 \cdot 32.2}$$

$$h_f = 180 \text{ ft}$$

$$\text{bhp} = \frac{14.4 \cdot 180}{3960 (0.7)} = 0.9 \text{ hp use } \underline{1 \text{ hp pump}}$$

Summary

Use 1" schedule 40 pipe - 600 ft
due to sensor requirements
and 2, 1 hp pumps



SUBJECT ECO # 6

DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

- Determine equipment requirements for returning condensate from Bldg 35 plating areas to the Main Boiler Plant

Since condensate from the steam space heating system is already returned, the only requirements will be piping from the proposed receivers for returning condensate to the donkey boiler

Include 100' of 3/4" pipe plus valves

- Summarize total system requirements

The schematic on the following page shows the proposed condensate return system. pH sensors are used to divert condensate to waste drain if pH falls below a preset level, indicating acid contamination from plating areas. Otherwise, condensate flows to Bldg 136 during heating season and Bldg 35 donkey boiler during non-heating times.

QUOTATION



TO: REYNOLDS SMITH + HILLS
JACKSONVILLE, FL

DATE: 8/9/91

YOUR INQUIRY:
CONDENSATE DIVERTING
VALVES

ATTN MR PAUL HUTCHINS

GENTLEMEN:

WE HEREBY SUBMIT OUR QUOTATION WHICH IS SUBJECT TO IMMEDIATE ACCEPTANCE.

ITEM NO.	QUANTITY	DESCRIPTION	NET UNIT PRICE	TOTAL
		FOR CONDENSATE SERVICE AT 25 PSIG * 200°F.		
A	1	1" WORCESTER #D-446TTSEVI DIVERTING BALL VALVE CS BODY, 1" NPT(F), 316 TRIM, TEFLON SEALS + SEALS, Q10, ASSEMBLED WITH RCS #MAR 25-10-4 ELECTRIC ACTUATOR, N7, 115VAC, 0.75AMP LOCKED ROTOR DRAW, 2 EXTRA SWITCHES	\$602 ¹⁰	
3	2	1" WORCESTER #D-446TTSEVI DIVERTING BALL VALVE S/A ABOVE EXCEPT WITH MANUAL LEVER 90°	123 ⁷⁰	

DELIVERY: 3 wks

F.O.B. PHILA

PRICES IN EFFECT AT TIME OF SHIPMENT WILL APPLY.

TERMS: 2% 10TH AND 25TH - NET 30 UNLESS OTHERWISE INDICATED

HERMAN GOLDNER CO., INC.

PER

Birney



SPEC SHEET

PHCN-28

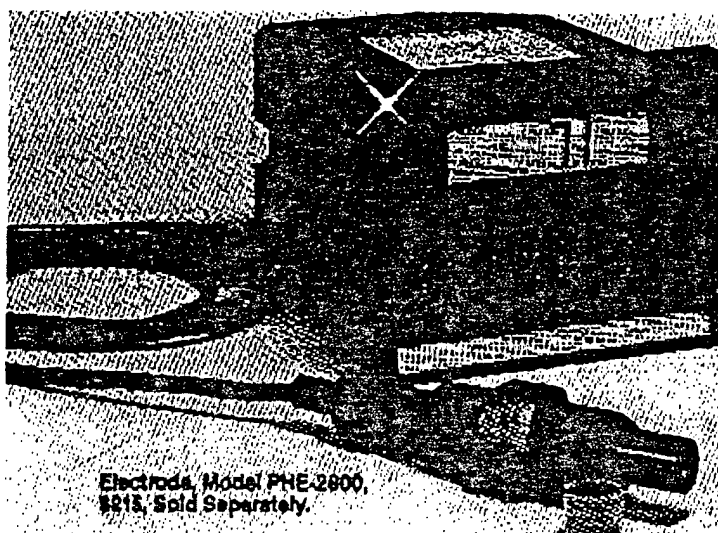
Versatile Microprocessor-Based pH Controller

From
\$625

- ✓ Compact NEMA-4X Polycarbonate Enclosure
- ✓ Two Independently Adjustable Alarm Contacts with Adjustable Deadband
- ✓ Choice of 4-20 mA dc or RS232C Output
- ✓ Auto Calibration, Dual Point or "Grab Sample"
- ✓ 10 Self Diagnostic Functions
- ✓ Direct or Reverse Analog Output with Span From 0.1 to 20 pH Units
- ✓ CSA Approved

The OMEGA PHCN-28 microprocessor pH controller features auto buffering, solution temperature compensation, self-diagnostics and communication capabilities. Designed with the end-user in mind, this controller is user friendly and easy to operate. Four tactile membrane keypads allow for the selection and input of set-up parameters, input of calibration data and alarm setpoint adjustments. The two 5 A, 230 Vac relays can be configured as high/low, high/high or low/low.

The PHCN-28 is offered with a choice of an isolated 4-20 or 0-20 mA dc output (field selectable) or an RS232C interface with a non-isolated 0-5 V analog output. The analog output is flexible enough to be used as either a proportional control output or recorder output. The self-diagnostics of the PHCN-28 can alert the user to such conditions as internal circuitry malfunction, pH out of range, pH slope out of normal range, ATC short or open, or electrode failure to stabilize in buffer.



Electrode, Model PHE-2800,
\$215, Sold Separately.

The PHCN-28 has an integral pre-amplifier and is designed for use with the PHE-2800 gel filled, double junction combination electrode with ATC. For locations where the electrode and controller must be separated by more than 50 ft, the PHCN-28-PA external pre-amplifier should be considered. The unit features a rugged NEMA-4X polycarbonate enclosure. If an application requires an electrode other than the PHE-2800, then the PHCN-28-PA must be used. In this case a Pt100 is necessary for ATC.

SPECIFICATIONS

Ranges: -4 to 16 pH, -100 to 200°C

Resolution: 0.01 pH, 0.1°C

Temperature Compensation:

Automatic

0 to 100°C, Pt100 ohm RTD

pH Accuracy: ±0.02 pH over range,
-4 to 16 pH

Temp Accuracy: ±0.25°C over 0 to 100°C

Stability: ±0.01 pH, ±1 mV ORP
over 30 days non-cumulative

Sensitivity: ±0.01 pH, ±1 mV ORP

Repeatability: ±0.01 pH, ±1 mV ORP

Ambient Temperature Coefficient:
±0.002 pH/°C

Power Input: 120 V 50/60 Hz 8 Watts,
240 V 50/60 Hz 8 Watts, jumper
selectable (requires fuse change)

Outputs: 4-20 mA dc isolated,
RS232C with 0-5 V non-isolated

Output Span: Any 0.1 to 20 pH span
(0.1 pH increments) selectable
reverse or direct acting

Alarms: 2 SPST electromechanical
relays rated 5 A 230 Vac, resistive
load; supplied as normally open;
alarms can be configured H/H, H/L,
L/L; alarm deadband fully adjustable
over pH span

Dimensions: 4.45"H x 5.75"W x
6.95"D (113 x 146 x 177 mm)

Weight: 3 lbs (1.35 kg)



OMEGA ENGINEERING, INC.
One Omega Drive, Box 4047, Stamford, CT 06907
Telex 996404 Cable OMEGA EASYLINK 62968934

1-800-82-66342
1-800-TC OMEGA
In CT Dial (203) 359-1660
24 Hour FAX: (203) 359-7700

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To Order (Specify Model No.)		
Model No.	Price	Description
PHCN-28-650	\$625	pH controller w/isolated 4-20 or 0-20 mA dc output
PHCN-28-D	730 760	pH controller w/RS232C interface and 0-5 V analog output (software available)
PHE-2800	215 235 250	Combination gel filled, double junction electrode w/ATC (integral Pt100); Kynar body construction; 1" MNPT connections at both ends for insertion or submersion, max pressure 100 PSIG at 65°C. Overall electrode length 5.67", insertion length 2.52"
PHCN-28-PA	315 365	Pre-amplifier for distances > 50 ft or for use w/electrodes other than PHE-2800; NEMA-4X enclosure (6.94" x 5.25" x 3.25")

OMEGACARE™ Extended Warranty: not available for this product.

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)															INSTALLATION		PLANT		BLDG. NO.		MONTH			
For use of this form, see AR 420-49; the proponent agency is USACE.															WATERVLIET ARSENAL		Boilers Plant		136		May -90			
#	#1	STEAM PRODUCED					FEED. WATER USED LB. PER UNIT	EVAP. LB. PER UNIT	OUTSIDE TEMP. AV.	FEEDWATER HEATER		BOILER	FLUE GAS TEMPERATURE			FLUE TEMP	EFF.	INIT.						
		#2	#3	#4	#5	TOTAL				PRESS. LB.	TEMP. °F.		1	2	3				TEMP. °F.	TEMP. °F.				
1	324.9					282.9	544	530.9	15.4	63.3	6	230	42.2	2.7	353	353	480	38.8	81.8	RAH				
2	357.9					286.3	558	551.8	15.4	55.5	6	230	41.0	2.8	352	352	480	36.7	81.9	RAH				
3	317.2					289.7	515	518.7	15.4	53.6	6	230	38.0	2.7	357	357	479	36.9	82.0	HH				
4	314.3					291.6	510	527.2	15.0	54.9	6	230	40.1	2.6	353	353	483	40.0	80.2	HH				
5	3276.5					397.7	488	509.3	14.7	47.3	6	230	34.3	2.8	346	346	490	35.1	78.3	HH				
6	396.8					288.4	585.4	519	14.5	50.6	6	230	37.4	2.6	360	360	470	36.0	77.1	HH				
7	310					274.4	857.3	604	16.8	50.9	6	230	43.5	2.8	417	417	480	36.0	87.8	HH				
8	703.2					703.2	596	555.5	15.6	53.7	6	230	40.5	2.8	430	430		83.3	HH					
9	630.5					630.5	541	500.4	15.6	48.2	6	230	43.1	2.8	407	407		83.9	HH					
10	610.1					610.1	512	486.2	15.5	45.6	6	230	41.5	2.8	400	400		82.6	RAH					
11	300.7					300.7	240	231.7	16.0	51.9	6	230	49.2	2.7	410	410		85.4	RAH					
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31	TOTAL	2796.4				2011.2	6726.2	5627	169.3	615.4	60	2530	49.8	19	2474	2664		3352	412.9	905.3				
32	MAXIMUM	203.2				2927.7	852.3	604	16.8	63.2	6	230	43.5	2.8	360	430		433	405	89.8				
33	MINIMUM	300.7				274.4	300.7	240	14.5	47.2	6	230	41.2	2.6	346	400		470	34.0	77.1				
34	AVERAGE	559.3				287.3	611.5	511.5	15.4	55.9	6	230	38.2	2.7	353	413		479	37.5	82.3				
35	EVAPORATION LB. STEAM PER LB. STD. FUEL																							
															REMARKS: * total includes 17,300 gal #2 oil and 38,174 gal #6 oil									
PREPARED BY: R.D. Drank															DATE: 6/11/90		APPROVED BY:		DATE:		POST ENGINEER:		DATE:	

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)										INSTALLATION		PLANT		BLOG. NO.		ONTH					
For use of this form, see AR 420-49; the proponent agency is USACE.										WATERVLIET ARSENAL		Boiler Plant		35		JUNE 90					
DATE	STEAM PRESSURE LB.	STEAM PRODUCED				FEED-WATER TO BOILER 1,000 LB.	GAS LB. M.C.F. GAL.	EVAP. PER UNIT	FEEDWATER HEATER	BOILER		FLUE GAS TEMPERATURE		TEMP. H.W. SUPPLY °F.	TUBES CLEANED NUMBER OF TIMES	PREVENT MAINT. CHECK	EFF	INIT			
		1,000 LB.	2	3	1,000 LB.					1,000 LB.	1,000 LB.	1,000 LB.	1,000 LB.						1,000 LB.	1,000 LB.	1,000 LB.
1	135	138.4				138.4	1701	17.3	278	6	230	21.2	47				92.3	JH			
2	135	102.6				102.6	1321	16.6	280	6	230	15.9	6.0				58.5	RH			
3	135	133.4				133.4	1800	17.0	270	6	230	20.5	4.3				67.7	RH			
4	135	223.4				223.4	2666	17.8	278	6	230	25.8	3.3				94.9	RH			
5	135	204.7				204.7	2447	17.8	280	6	230	28.7	4.0				94.9	PH			
6	135	193.5				193.5	2332	17.7	280	6	230	27.2	4.7				94.3	PH			
7	35	157.1				157.1	1901	17.5	280	6	230	15.9	4.4				93.3	RH			
8	135	40.7				40.7	663	13.1	280	6	230	9.5	6.5				65.6	PH			
9	135	75.4				75.4	1007	15.9	280	6	230	12.5	6.8				84.9	PH			
10	135	174.4				174.4	2181	17.5	280	6	230	21.9	5.8				93.3	PH			
11	135	169.3				169.3	2180	17.3	280	6	230	24.3	5.6				92.3	PH			
12	135	169.2				169.2	2070	17.4	280	6	225	24.0	4.7				92.7	PH			
13	135	190.0				190.0	2307	17.5	280	6	225	27.2	4.7				93.4	PH			
14	135	86.4				86.4	1089	16.8	280	6	235	12.5	5.0				89.9	PH			
15	135	92.0				92.0	1660	11.7	280	6	230	32.2	6.5				62.3	HH			
16	135	167.0				167.0	3080	17.0	280	6	230	34.5	6.0				90.2	HH			
17	135	169.3				169.3	3101	17.0	280	6	230	34.1	4.8				90.2	HH			
18	135	171.4				171.4	2110	17.3	280	6	230	24.5	5.5				91.7	HH			
19	135	189.2				189.2	2299	17.5	280	6	230	26.5	4.8				93.3	PK			
20	135	71.2				71.2	939	16.1	280	6	230	12.7	5.2				85.9	PK			
21	135	139.8				139.8	1752	16.9	280	6	230	19.4	4.0				90.4	PK			
22	135	212.7				212.7	2558	17.7	280	6	230	30.8	4.6				94.3	PH			
23	135	202.0				202.0	2434	17.2	280	6	230	30.3	4.0				94.1	PH			
24	135	201.4				201.4	2446	17.5	282	6	230	30.4	4.7				92.4	JH			
25	135	192.6				192.6	2328	17.6	277	6	230	29.0	4.3				93.8	JH			
26	135	179.1				179.1	1745	12.0	283	6	230	22.3	6.0				90.4	JH			
27	135	86.4				86.4	1251	15.0	285	6	230	15.3	7.4				91.2	PH			
28	135	4110.0				4110.0	51373	451.1	7553	16.2	195	611.6	137.7				2416.0				
29	135	223.4				223.4	2666	17.8	285	6	230	32.2	6.8				94.9				
30	135	40.7				40.7	663	11.7	270	6	225	9.5	3.3				62.3				
31	135	152.2				152.2	19027	16.8	275.7	6	229	22.6	5.1				89.5				
TOTAL										FUEL USED DURING MONTH (STANDARD TONS)										REMARKS	
MAXIMUM																					
MINIMUM																					
AVERAGE																					

SEE REVERSE SIDE
FOR INSTRUCTIONS

FORM 3007

PREPARED BY
R.O. Drank

DATE
7/9/90

APPROVED BY

DATE

POST ENGINEER

DATE

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)										INSTALLATION		PLANT		BLDG. NO.		DATE									
For use of this form, see AR 420-49; the proponent agency is USACE.										WATERVILLE ARSENAL		Boiler Plant		35		July 90									
DATE	STEAM PRESSURE LB.	STEAM PRODUCED				FEED-WATER BOILER 1,000 LB.	GAS FUEL LB. PER UNIT	EVAP. PER UNIT	TEMP. FEED-WATER °F.	PRESS. LB.	TEMP. °F.	MAKEUP GAL.	%O ₂			FLUE GAS TEMPERATURE			TUBES CLEANED NUMBER OF TIMES	PREVENT MAINT. CHECK	EFF	INIT			
		1,000 LB.	2	3	TOTAL								1	2	3	1	2	3					1	2	3
1	135	115.9				115.9	1591	15.5	285	8	230	18.7	7.7												
2	135	153.3				153.3	1881	17.3	283	8	230	22.7	6.3												
3	135	102.0				102.0	1346	16.1	280	8	230	15.5	6.2												
4	135	126.9				126.9	1716	15.7	280	8	230	15.3	6.2												
5	135	178.3				178.3	2185	17.4	280	8	230	26.8	5.6												
6	135	88.7				88.7	1082	17.4	280	8	230	12.3	5.9												
7																									
8	135	170.0				170.0	1557	17.2	280	8	230	15.9	3.7												
9	135	135.1				135.1	1705	16.8	280	8	230	19.0	6.1												
10	135	129.7				129.7	1645	16.7	280	8	230	18.6	6.8												
11	135	166.0				166.0	2051	17.2	280	8	230	27.0	6.0												
12	135	172.3				172.3	2115	17.2	280	8	230	26.6	6.2												
13	135	146.8				146.8	1789	17.5	285	8	230	23.4	6.5												
14	135	152.6				152.6	1903	17.1	280	8	230	23.1	6.0												
15	135	143.7				143.7	1781	16.8	280	8	230	16.8	6.0												
16	135	165.1				165.1	2055	17.0	300	8	230	21.8	5.5												
17	135	165.3				165.3	2053	17.0	300	8	230	25.7	5.5												
18	135	156.9				156.9	1965	17.0	292	8	230	25.5	5.6												
19	135	123.4				123.4	1597	16.4	290	8	230	21.7	5.8												
20	135	20.9				20.9	477	17.4	290	8	220	8.3	7.2												
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL		557.9				557.9	5202	32.2	5406			3447	115.3												
MAXIMUM		178.3				178.3	2185	17.4	300	8	230	27.0	7.7												
MINIMUM		88.7				88.7	1082	17.4	280	8	230	8.3	3.7												
AVERAGE		152.4				152.4	1710	16.6	285	8	230	20.3	6.1												
EVAPORATION LB. STEAM PER LB. STD. FUEL										FUEL USED DURING MONTH (STANDARD TONS)										REMARKS					
SEE REVERSE SIDE FOR INSTRUCTIONS										PREPARED BY										DATE		POST ENGINEER		DATE	
DA FORM 1 NOV 72 3967										8/6/90															
REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.																									

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)															INSTALLATION		PLANT		BLDG. NO.		INTH	
For use of this form, see AR 420-49; the proponent agency is USACE.															WATERVILLE RESERVOIR, BOILER PLANT		55		55		AUG 00	
DATE	STEAM PRODUCED				FEED-WATER TO BOILER, 1,000 LB.	GAS FUEL USED, LB. M.C.F.	EVAP. UNIT	OBSERVE FEED, LB.	FEEDWATER HEATER		%CO ₂		FLUE GAS TEMPERATURE		TEMP. HW. SUPPLY, °F.	TUBES CLEANED, NUMBER OF TIMES	PREVENT MAINT. CHECK	INIT				
	STEAM PRESSURE, LB.	1,000 LB.	2,000 LB.	3,000 LB.					TEMP. °F.	PRESS. LB.	MAKUP GAL.	6	2	3					6	2	3	6
1																						
2																						
3																						
4	135	123.5			109.1	10.0	16.8	390	8	120	21.2	5.0						89.9				
5	135	112.3			109.1	11.0	16.8	390	8	120	21.2	5.0						89.9				
6	135	159.8			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
7	135	139.5			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
8	135	157.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
9	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
10	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
11	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
12	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
13	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
14	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
15	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
16	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
17	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
18	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
19	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
20	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
21	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
22	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
23	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
24	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
25	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
26	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
27	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
28	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
29	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
30	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
31	135	167.1			109.1	11.5	17.0	390	8	120	21.2	5.0						89.9				
TOTAL																						
MAXIMUM																						
MINIMUM																						
AVERAGE																						
EVAPORATION LB. STEAM PER LB. STD. FUEL															REMARKS							
FUEL USED DURING MONTH (STANDARD TONS)															APPROVED BY							
PREPARED BY															DATE							
SEE REVERSE SIDE FOR INSTRUCTIONS															DATE							
DA FORM 3957															DATE							
1 NOV 72															DATE							
REPLACES DA FORM 5-98 1 JUN 58, WHICH WILL BE USED.															DATE							

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AF 420-49; the proponent agency is USACE.

MONTH

BLDG. NO.

PLANT

INSTALLATION

SEPT. 90

35

Boiler Plant

WATERVLIET ARSENAL

Boiler Plant

DATE	STEAM PRODUCED						FEED WATER TO BOILER 1,000 LB. (6)	GAS FUEL USED LB. M.C.F. GAL. (7)	EVAP. PER UNIT LB. M.C.F. (8)	OUTSIDE PRESS. LB. (9)	TEMP. °F. (11)	BOILER			BOILER			CLEANED NUMBER OF TIMES (120)	MAINT. CHECK (121)	EFF (122)	INIT (123)
	BOILER			MAKEUP GAL. (13)	BOILER																
	6	2	3		6	2						3									
													1,000 LB. (10)	1,000 LB. (14)	1,000 LB. (15)	1,000 LB. (16)	1,000 LB. (17)				
1	135	29.7		29.7	141		260	8	230	25.3	375							68.6	PK		
2	135	113.2		113.2	1792		250	8	230	25.3	375							93.3	PK		
3	135	142.0		142.0	250		250	8	230	24.9	3570							87.3			
4	135	110.6		110.6	250		250	8	230	19.7	362							91.7			
5	135	106.6		106.6	250		250	8	230	23.9	362							93.7			
6	135	122.4		122.4	250		250	8	230	19.1	362							63.9			
7	135	108.3		108.3	250		250	8	230	11.1	360							94.2			
8	135	42.6		42.6	250		250	8	230	15.7	362							92.2			
9	135	180.2		180.2	250		250	8	230	27.7	362							93.7			
10	135	176.2		176.2	250		250	8	230	27.1	362							93.7			
11	135	178.2		178.2	250		250	8	230	27.2	362							93.7			
12	135	178.2		178.2	250		250	8	230	26.5	362							93.7			
13	135	168.7		168.7	250		250	8	230	26.5	362							93.7			
14	135	81.2		81.2	270		270	8	230	16.5	360							94.2	JH		
15	135	115.2		115.2	250		250	8	230	35.0	362							91.6	JH		
16	135	151.5		151.5	253		253	8	230	24.9	363							92.2	JH		
17	135	153.4		153.4	253		253	8	230	25.0	367							91.8	JH		
18	135	154.5		154.5	250		250	8	230	25.3	368							92.3	JH		
19	135	157.2		157.2	250		250	8	230	28.0	367							97.7	PK		
20	135	172.5		172.5	250		250	8	230	15.3	360							90.3	PK		
21	135	143.2		143.2	250		250	8	230	16.9	360							89.6	PK		
22	135	148.3		148.3	250		250	8	230	16.5	362							90.4	PK		
23	135	138.8		138.8	250		250	8	230	16.0	365							92.6	PK		
24	135	154.9		154.9	250		250	8	230	17.1	365							92.2	PK		
25	135	166.3		166.3	250		250	8	230	17.3	363							92.6	PK		
26	135	179.8		179.8	250		250	8	230	28.1	368							92.6	PK		
27	135	176.9		176.9	253		253	8	230	31.6	368							92.7	PK		
28	135	177.8		177.8	250		250	8	230	24.4	360							2497.2			
29	135	177.8		177.8	250		250	8	230	24.4	360							93.3			
30	135	177.8		177.8	250		250	8	230	24.4	360							68.6			
31	135	177.8		177.8	250		250	8	230	24.4	360							89.2			
TOTAL		308.35		308.35	4969.6		7039			417.3	130.4										
MAXIMUM		180.3		180.3	2206		270			31.6	368										
MINIMUM		29.7		29.7	491		250			11.1	34										
AVERAGE		142.2		142.2	1775		251			22.0	41.6										

APPROVED BY	DATE	POST ENGINEER	DATE
	10/5/90		

REMARKS

FUEL USED DURING MONTH (STANDARD TONS)

SEE REVERSE SIDE FOR INSTRUCTIONS

NA FORM 3067

WHICH WILL BE USED.

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION

WATERVLIET AR, E. A. I.

PLANT

Boiler Plant

BLDG. NO.

133

MONTH

Oct. 90

FACILITIES ENGINEERING OPERATIONS LOG (BOILER ROOM)																									
For use of this form, see AR 420-49; the proponent agency is USACE.																									
DATE	STEAM PRODUCED						FEED-WATER TO BOILER 1,000 LB. (6)	GAS FUEL USED LB. M.C.F. GAL. (7)	EVAP. LB. PER UNIT (8)	OUTSIDE TEMP. °F. (9)	FEEDWATER HEATER		%CO ₂ BOILER			FLUE GAS TEMPERATURE						TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	EFF. (22)	INIT. (23)
	STEAM PRESSURE LB. (1)	BOILER			MAKEUP GAL. (12)	TEMP. °F. (11)					2	3	BOILER			TEMP. °F. (13)	H.W. SUPPLY °F. (19)								
		1,000 LB. (2)	1,000 LB. (3)	1,000 LB. (4)									1	2	3			1	2	3					
1	135	173.2			173.2		2156	17.0	250		8	230	26.6	4.0										91.1	PK
2	135	256.6			256.6		3083	17.7	250		8	230	37.1	4.2										93.3	PK
3	135	183.5			183.5		2254	17.3	250		8	230	28.8	4.2										92.3	PK
4																									
5	135	115.5																							
6																									
7																									
8																									
9																									
10																									
11																									
12																									
13																									
14																									
15																									
16																									
17																									
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24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									
TOTAL																									
MAXIMUM																									
MINIMUM																									
AVERAGE																									

REMARKS

DATE 11/16/91

APPROVED BY R. D. Prock

POST ENGINEER

DATE

DA FORM 3957 1 NOV 72 REPLACES DA FORM 598, 1 JUN 58, WHICH WILL BE USED.



SUBJECT E10 # 7 - Cooling
Tower Fan VSD
DESIGNER P. Hutchins
CHECKER B. Todd

AEP NO 290-0379-002
SHEET OF
DATE 8/8/91
DATE 9/17/91

- Calculate current energy use for the cooling tower fans in the gun tube chrome plating area

There are two cells, each with 40 hp centrifugal, forward-curve fans. One cell fan handles the load for all but the hottest days. The fan operates continuously at a constant speed, five days per week, 50 weeks per year. Assume the fan load is 85% of capacity.

$$E = 40 \text{ hp} \times \frac{0.746 \text{ kw}}{\text{hp}} \cdot \frac{5 \text{ da}}{\text{wk}} \cdot \frac{24 \text{ hr}}{\text{da}} \cdot \frac{50 \text{ wk}}{\text{yr}} \cdot \frac{3413 \text{ Btu}}{\text{kwh}} \cdot 0.85$$
$$= \underline{\underline{519}} \frac{\text{MBtu}}{\text{yr}} \text{ electricity}$$

- Calculate reduced energy use due to installation of variable speed drive and controls.

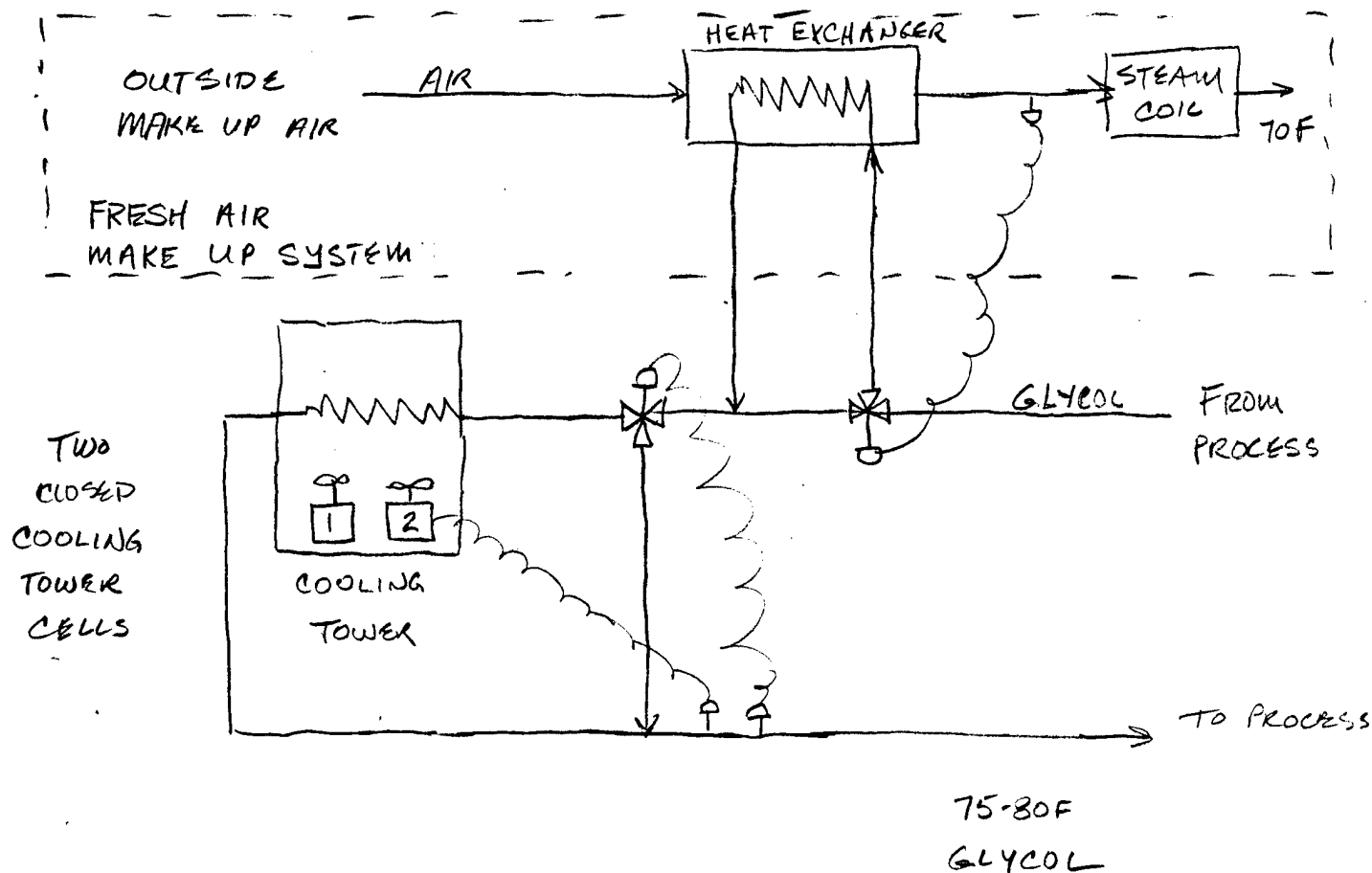
The diagram on the following page describes the glycol cooling system operation.

The calculation table following the diagram shows an energy use of 112 MBtu/yr using the VSD. The equation used for calculations are based on fan laws: $\frac{hp_2}{hp_1} = \left(\frac{Q_2}{Q_1}\right)^3$



SUBJECT ECO #7
 LEAD
 DESIGNER P. Hutchins
 CHECKER _____

AEP NO _____
 SHEET _____ OF _____
 DATE 8/5/91
 DATE _____



- GLYCOL IS DIVERTED TO THE FRESH AIR MAKE UP SYSTEM DURING THE HEATING SEASON
- ONE COOLING TOWER FAN OPERATES CONTINUOUSLY
- THE SECOND OPERATES ONLY WHEN THE RETURN GLYCOL TEMPERATURE EXCEEDS THE SETPOINT
- PIT EXHAUST AND FUME EXHAUST FAN MOTORS ARE 100 Hp each

Operation Hrs/Day = 24

5 PM - 1 AM 1

Operation Days Per Week	7

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Temp. Range	Hours of Occurrence			Total Hours	Percent Full Load		kW	kBtu/hr	MBtu	
	2-9	10-17	18-1		CFM Required	hp Required				
95	99	0	7	0	7	110	53.2	39.7	135.6	0.9
90	94	0	28	6	34	105	46.3	34.5	117.9	4.0
85	89	0	95	28	123	100	40.0	29.8	101.8	12.5
80	84	4	177	73	254	95	34.3	25.6	87.3	22.2
75	79	27	248	140	415	90	29.2	21.8	74.2	30.8
70	74	115	257	222	594	85	24.6	18.3	62.5	37.2
65	69	234	235	271	740	75	16.9	12.6	43.0	31.8
60	64	263	212	252	727	65	11.0	8.2	28.0	20.3
55	59	274	190	236	700	55	6.7	5.0	16.9	11.9
50	54	263	183	214	660	45	3.6	2.7	9.3	6.1
45	49	242	183	205	630	35	1.7	1.3	4.4	2.8
40	44	229	202	205	636	25	0.6	0.5	1.6	1.0
35	39	261	241	251	753	20	0.3	0.2	0.8	0.6
30	34	295	220	262	777	10	0.0	0.0	0.1	0.1
25	29	216	156	191	563	0	0.0	0.0	0.0	0.0
20	24	163	112	130	405	0	0.0	0.0	0.0	0.0
15	19	110	79	96	285	0	0.0	0.0	0.0	0.0
10	14	84	43	65	192	0	0.0	0.0	0.0	0.0
5	9	60	27	38	125	0	0.0	0.0	0.0	0.0
0	4	37	16	22	75	0	0.0	0.0	0.0	0.0
-5	-1	27	3	9	39	0	0.0	0.0	0.0	0.0
-10	-6	10	0	4	14	0	0.0	0.0	0.0	0.0
-15	-11	5	0	0	5	0	0.0	0.0	0.0	0.0
-20	-16	3	0	0	3	0	0.0	0.0	0.0	0.0
Totals		2922	2914	2920	8756					112

Total adjusted for work week	112



SUBJECT ECO #7
LEAD
DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

- Columns ① through ⑤ are weather data from Engineering Weather Data, TM 5-785 for Albany, N.Y.
- Column ⑥ = ③ + ④ + ⑤
- ⑦ is based on engineering judgment
- ⑧ = ⑦³ * 40 hp
- ⑨ = ⑧ * 0.746 kw/hp
- ⑩ = ⑨ * 3413 Btu/kw ÷ 1E6
- ⑪ = ⑩ * ⑥

$$\begin{array}{rcl} \text{Energy savings} & \Rightarrow & \frac{\text{MBtu/yr}}{519} \quad \text{Current method} \\ & & - \frac{112}{\text{New method}} \\ & & \hline & & 407 \text{ MBtu/yr electricity} \end{array}$$

There are three gun tube plating areas.
One is to be removed.

$$\text{Total savings} = 407 * 2 = \underline{814 \text{ MBtu/yr Elec.}}$$



SUBJECT ECO #7
QRIP calc's
DESIGNER Hutchins
CHECKER _____

AEP NO 290-0379-002
SHEET _____ OF _____
DATE 3/20/92
DATE _____

QRIP CALCULATIONS

PRESENT METHOD

$$519 \text{ MBTU/yr} \times 2 \text{ towers} \times \$20.35/\text{MBTU} = \$21,123$$

PROPOSED METHOD

$$112 \times 2 \times 20.35 = 4558$$

SAVINGS

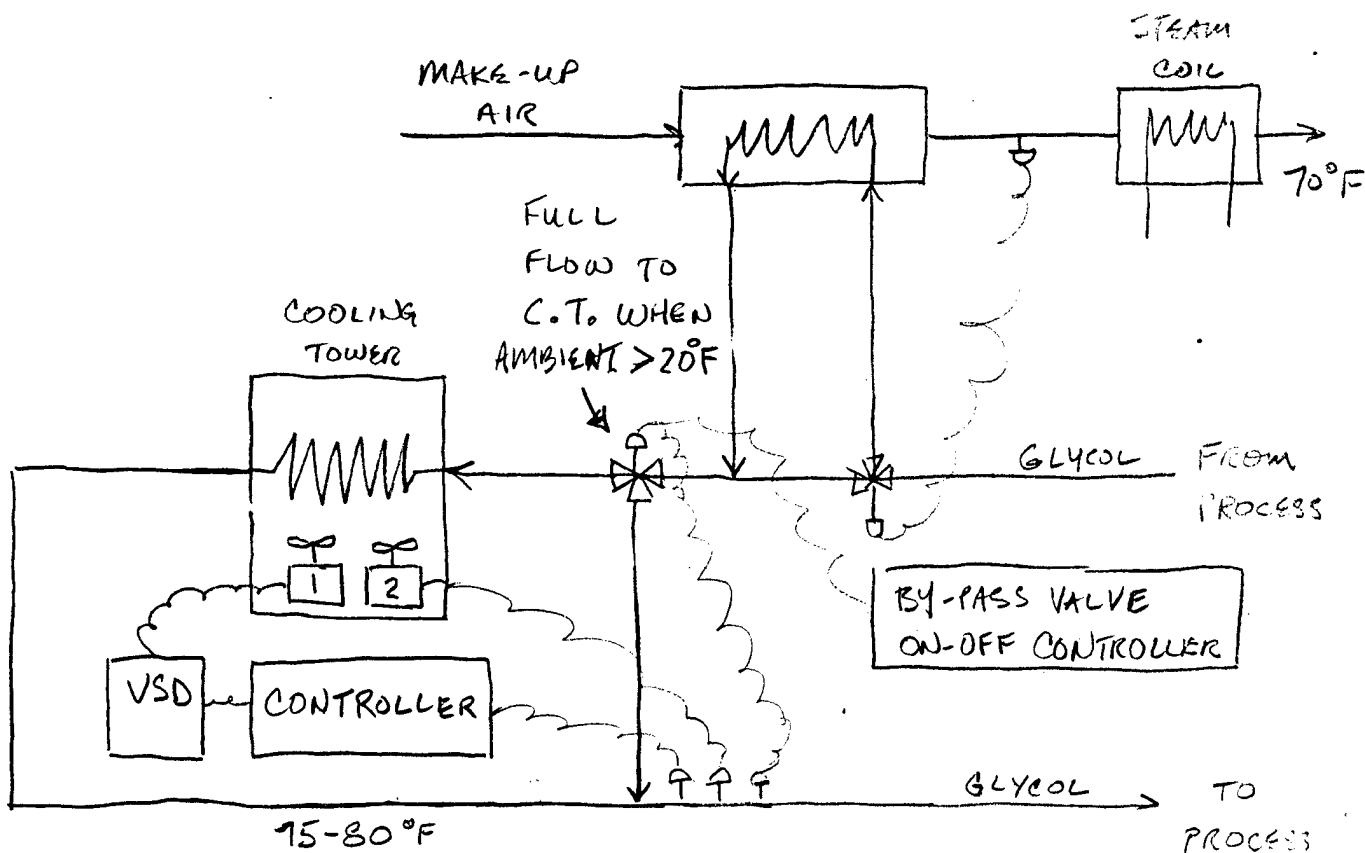
$$\underline{\$16,565}$$



SUBJECT ELD #7
LEAD
DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

PROPOSED ADDITION OF VARIABLE SPEED DRIVE



- FOR ALL EXCEPT THE COLDEST DAYS THE BY-PASS 3-WAY VALVE IS INOPERATIVE, ALLOWING FULL FLOW TO THE COOLING TOWER. IN THIS MODE THE VSD MODULATES THE FAN SPEED TO MAINTAIN THE LEAVING GLYCOL TEMPERATURE.
- WHEN THE AMBIENT TEMP. IS LESS THAN, SAY 20°F, OR OTHER VALUE DETERMINED IN ACTUAL OPERATION, THE GLYCOL LEAVING TEMPERATURE IS CONTROLLED BY THE BY-PASS VALVE. IN THIS MODE THE COOLING TOWER FANS ARE INOPERATIVE.

03/20/92

ECO Construction Cost Estimate Calculations

ECO Name: COOLING TOWER VARIABLE SPEED DRIVE

ECO #: 7

1991 ECO "bare" costs (from cost estimate sheet)

Material	\$15,300
Labor	\$1,650

Subtotal bare costs	\$16,950

FICA Insurance (20% of Labor)	\$330

Sales Tax (not applicable for GOGO)	\$0

Subtotal	\$17,280

Overhead (15%)	\$2,592

Subtotal	\$19,872

Profit (10%)	\$1,987

Subtotal	\$21,859

Bond (1%)	\$219

Subtotal	\$22,078

Contingency (10%)	\$2,208

Subtotal (Construction Cost Input For LCCID *)	\$24,286

SIOH (6.0% of Construction Cost)	\$1,457

Subtotal	\$25,743

Design (6% of Construction Cost)	\$1,457

Total Project Cost	\$27,200

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

CONSTRUCTION COST ESTIMATE

DATE PREPARED 8/9/91

SHEET OF

PROJECT

ENERGY ENGINEERING ANALYSIS

BASIS FOR ESTIMATE

- ☐ CODE A (No design completed)
☒ CODE B (Preliminary design)
☐ CODE C (Final design)
☐ OTHER (Specify) _____

LOCATION

WATERVLIET ARSENAL

ARCHITECT ENGINEER

REYNOLDS, SMITH AND HILLS A.E.P., INC.

DRAWING NO. COOLING TOWER FAN
MOTOR VSD

ESTIMATOR

P. HUTCHINS

CHECKED BY

ECO #7

SUMMARY

QUANTITY

NO.
UNITSUNIT
MEAS.PER
UNITLABOR
TOTAL

MATERIAL

PER
UNIT

TOTAL

TOTAL
COST

VAR. SPEED DRIVE - 40hp

1

ea

400

400

6400

6400

6800

PID CONTROLLER

1

ea

100

100

400

400

500

Type T Thermocouple

2

ea

25

50

50

100

150

Type T thermocouple

1

cf

25

25

50

50

75

wiring

ON-OFF CONTROLLER

1

ea

100

100

400

400

500

Solid State Relays

2

ea

25

50

50

100

150

Miscellaneous -

1

ea

100

100

200

200

300

wiring, connectors,

piping T's

BARRE LOGS TOTALS

825

7650

8475

FOR 2 UNITS

1650

15300

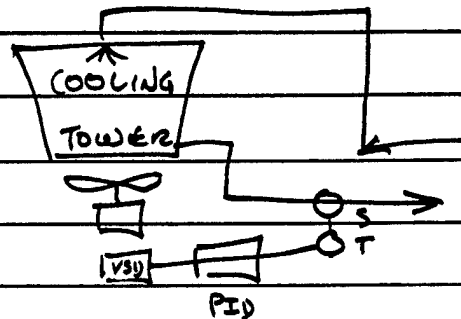
16960

Project No. 290-0379-002

Local ☒ L.D. ☐ Placed ☒ Rec'd. ☐ Date 7/8/91
P. Hutchins Conversed With Wes Shaver
 Of Shaver & Assoc. Regarding Cooling Tower Motor VSD
(Balt. Coil Rep.)

VSD requires

- sensor
- transmitter
- PID (Proportional Integral Derivative) Controller



Cost of VSD for 40 hp fan motor - \$6400
 includes bypass to use in conjunction with existing starter

Distribution:

Project No. 290-0379-002

Local _____ L.D. ✓ Placed ✓ Rec'd. _____ Date 8/14/91

P. Hutchins _____ Conversed With Tom _____

Of Omega _____ Regarding VSD Controller _____

Programmable

- Tom recommends the CN2001 T-F1 Controller - \$395
with a type T thermocouple, 4-20 ma output

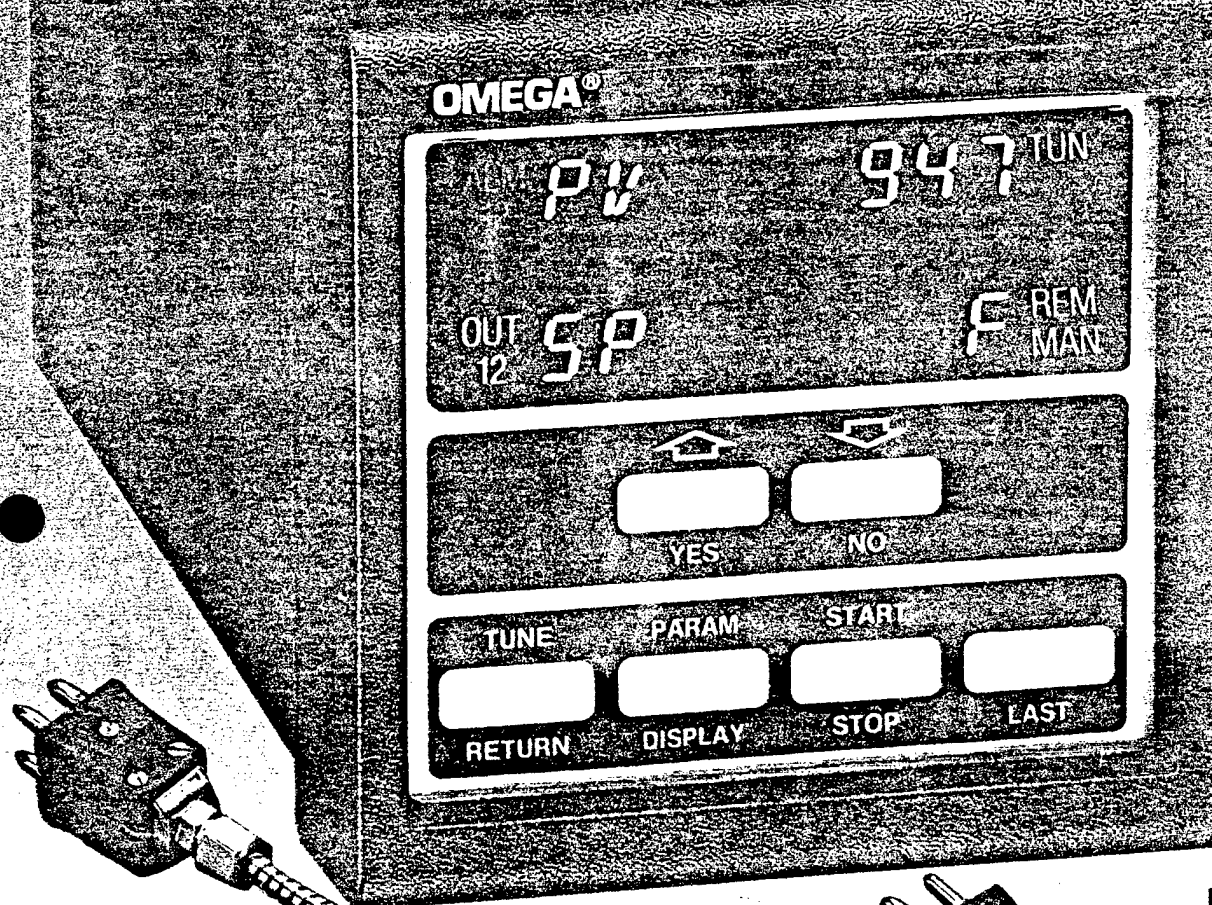
- Type T thermocouple - \$50

- Type T thermocouple wiring - \$50

Distribution:

Temperature/Process Controller

Model
CN 2000



Shown Larger than Actual Size

Model
CN2002A
Shown

Reliable and Accurate Microprocessor- Based Control

- For Thermocouple, RTD, Voltage and Current Inputs
- RS-232 and RS-422 Communication for Remote Control through a Computer System
- Wide Variety of Output and Alarm Options Available

For Use With

- ✓ Plastics Processing
- ✓ Heat Treating Furnaces
- ✓ Environmental Chambers
- ✓ Laboratories
- ✓ Food Processing
- ✓ Chemical Processing

See Section A
for Industrial
Thermocouple Probes

Microprocessor Accuracy

Prices Start At
\$470

Includes
Complete
Manual

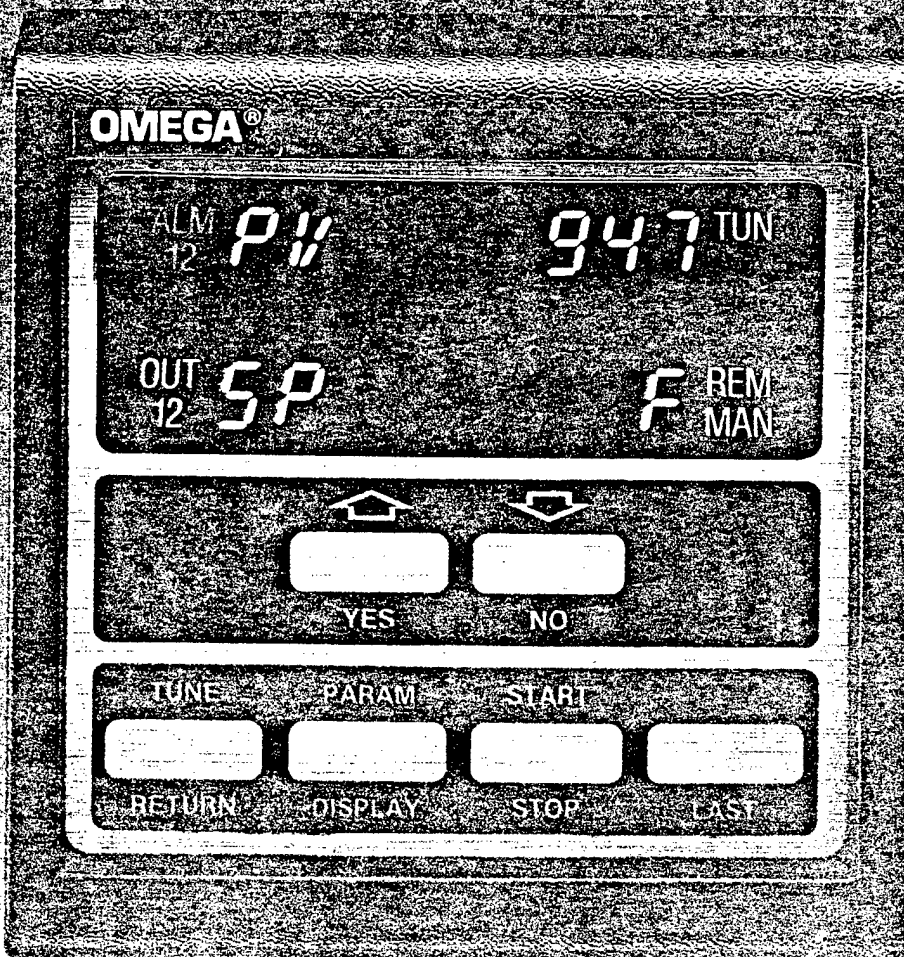
Shown Larger than Actual Size

Features

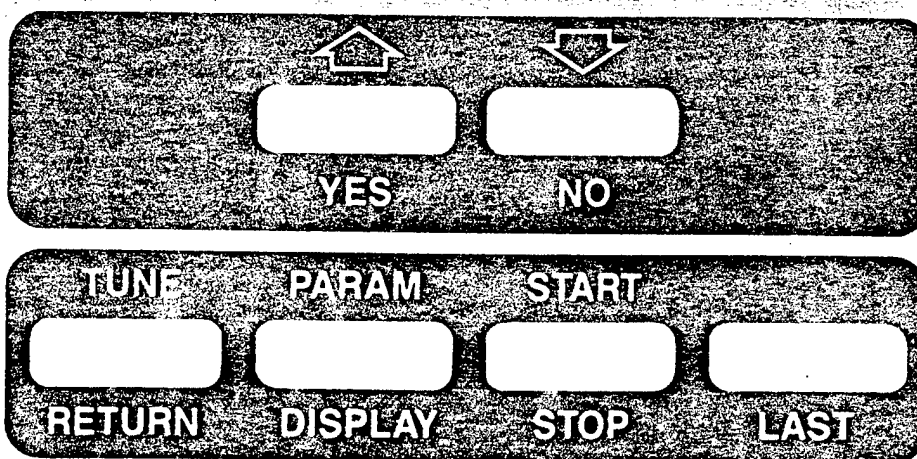
- PID Control
- User Friendly Tuning Via Front Keypad
- Continuous Indication of Output, Alarm, and Operating Status
- 0.1° Resolution for RTD Inputs

The OMEGA CN 2000 micro-processor based controllers utilize the latest technology to improve reliability, accuracy, and control. Inputs can be either thermocouple with 1° resolution, RTD with either 1° or 0.1° resolution, and current or voltage with a scalable display. For the analog inputs, the display is scalable for zero and span over the entire ± 3200 count range. CN 2000 controllers can be used with pressure and flow transducers, or with virtually any process transducer.

The CN 2000 controllers feature full 3-mode Proportioning, Integral (reset), Derivative (rate) control (PID). A unique multicolored display with vacuum fluorescent alpha-numeric characters allow for easy, user friendly tuning with continuous indication of output, alarm, and operating status. The environmentally sealed touch panel is the operator interface to the CN 2000 and the precision, fine tuning controls allow accurate adjustment of process parameters. The versatility of this controller makes it ideal for both laboratory and industrial uses.



Key Functions: Front Keypad is the operator interface. There are no internal pots, switches, or jumpers to set or adjust. Security key codes are required to access certain programs.



TUNE-RETURN

Calls up TUNE routine. Also RETURN program to normal operation

UP-YES

Drives set point to increase in value. Positive response to displayed question.

DISPLAY PARAM

Advances display in programmed sequence.

DOWN-NO

Drives set point to decrease in value. Negative response to displayed question.

START-STOP

Shuts off or turns on outputs. Not a power switch.

LAST

Recalls previous step to display. A backup key.



SUBJECT ENERGY-EFFICIENT
FLUORESCENT LAMPS/BALLASTS
DESIGNER C. WARREN
CHECKER _____

AEP NO 290-0379-002
SHEET 1 OF _____
DATE 3/26/92
DATE _____

EC08 -

REPLACEMENT OF STANDARD FLUORESCENT LAMPS AND/OR
BALLASTS WITH ENERGY-EFFICIENT TYPES

- 1/ SURVEY OF BUILDINGS ON WVA TABULATED IN TABLES B-1 and B-2, SHOWING TYPES OF FLUORESCENT LAMPS, NUMBERS OF LAMPS AND FIXTURES; WATTS AND KWH/YR, respectively.

ASSUMPTIONS - PRODUCTION AREAS ENERGIZE LIGHTS
24 HRS/DAY X 5 DAYS/WK X 50 WKS/YR
= 6000 HRS/YR

NON-PRODUCTION AREAS

11 HRS/DAY X 5 DAYS/WK X 50 WKS/YR
= 2,750 HRS/YR

STANDARD FIXTURE POWER DRAWS TAKEN FROM LIGHTING TEXTS - SURVEY NOTES CONTAIN DATA FOR EACH BUILDING THAT IS SUMMARIZED IN TABLES B-1, B-2.

2/ PREDOMINANT TYPES

F40 T12 = 1,134,612 / 6,140,625 KWH/YR = 18.5%

F96 T12 = 3,528,527 / 6,140,625 KWH/YR = 57.5%

F90 T12 = 1,156,800 / 6,140,625 KWH/YR = 18.8%



SUBJECT ENERGY LAMPS/BALLASTS
DESIGNER C. WARREN
CHECKER _____

AEP NO 290-0379-002
SHEET 2 OF _____
DATE 3/26/92
DATE _____

CONSIDER F40T12 & F96T12 FOR REPLACEMENT - F90T12 IS
REPLACEMENT FOR F90T17 AND IS ENERGY-EFFICIENT.

REPLACEMENTS FOR F40T12 LAMPS

- ① 34 W
- ② 32 W T-8 SYSTEM - REQUIRES ELECTRONIC BALLAST

BALLASTS FOR F40

- ① ENERGY ELECTROMAGNETIC
- ② ELECTRONIC

REPLACEMENTS FOR F96T12 LAMPS

- ① 60 W

BALLASTS - ELECTRONIC

SPECIFICATIONS AND PRICES TABLES B-3 AND B-4, resp.

3/ PERFORM CALCULATIONS TO DETERMINE INPUT DATA FOR LCCD CALCULATIONS

CASES CONSIDERED -

- 8 A. REPLACE 40-W LAMPS IN PRODUCTION AREAS WITH 34W LAMPS
LAMPS 300 (TABLE B-1) 300 IN 100 FIXTURES
8 IN 4 FIXTURES

EXISTING 3-TUBE FIXTURES DRAW 144 W / FIXTURE

" 2-TUBE FIXTURES DRAW 96 W / FIXTURE

REPLACING W/ 34 WATT TUBES

15.9% DROP IN LUMENS

144 W / FIX $\Rightarrow$ 120 W / FIX

96 W / FIX $\Rightarrow$ 80 W / FIX



SUBJECT ENERGY LAMPS/BALLASTS
DESIGNER C. WARREN
CHECKER _____

AEP NO 240-0379-002
SHEET 3 OF _____
DATE 3/26/92
DATE _____

8B. SAME AS A; REPLACE BALLASTS WITH ENERGY-EFFICIENT ELECTROMAGNETIC BALLASTS

1 BALLAST / 2 LAMPS (WVA ELECT. DEPT.)
152 BALLASTS

3-TUBE FIXTURES FROM 144 W/FIX $\Rightarrow$ 95 W/FIX

2-TUBE FIXTURES FROM 96 W/FIX $\Rightarrow$ 60 W/FIX

8C. REPLACE 40 W LAMPS & BALLASTS WITH F40T8 LAMPS (32 W) AND ELECTRONIC BALLASTS $\Rightarrow$ 7.9% DROP IN LUMENS FROM EXISTING

3 TUBE FIXTURES USE 1 BALLAST/FIXTURE

DRAW: 88 W/FIXTURE

2 TUBE FIXTURES / 1 BALLAST

DRAW 58 W/FIXTURE

8D. SAME AS A; MIXTURE OF 2, 3, 4 TUBE FIXTURES

ALL USE 1 BALLAST / 2 TUBES - NON PRODUCTION BLDGS

8E. SAME AS B₂ NON-PRODUCTION BLDGS

8F. SAME AS C, EXCEPT 1 BALLAST / 2 LAMPS;
NON-PRODUCTION BLDGS

8G. REPLACE 75 W F96T12 LAMPS WITH 60 W F96T12 LAMPS
PRODUCTION BUILDINGS $\Rightarrow$ 10.6% DROP IN LUMENS

175 W/FIXTURE $\Rightarrow$ 163 W/FIXTURE

8H. SAME AS G, WITH BALLAST REPLACEMENT (ELECTRONIC)
1 BALLAST / 2 LAMPS

175 W/FIXTURE $\Rightarrow$ 105 W/FIXTURE

(MAJORITY OF LAMPS IN BLDG 25 WITH 3.9 W/SF - LOSS OF LUMENS SHOULD NOT AFFECT WORK)



SUBJECT ENERGY LAMPS/BALLASTS AEP NO 290-0379-002
DESIGNER C. WARREN SHEET 4 OF
CHECKER DATE 3/26/92
DATE

8I. SAME AS G ; NON-PRODUCTION BLDGS

8J. SAME AS H ; NON-PRODUCTION BLDGS

LABOR AND MATERIAL COSTS / CONSTRUCTION COSTS

SITDOWN ON FOLLOWING COST ESTIMATE SHEETS

REPLACEMENT COSTS

ASSUMPTIONS - 20,000 HRS LIFETIME FOR ALL LAMPS
NO BALLAST REPLACEMENTS
25 YR PROJECT LIFETIME
LABOR COSTS ARE SAME FOR STD VS ENERGY LAMPS

AUG LAMP REPLACEMENTS PER YR

① PRODUCTION AREAS F40 LAMPS & F96

$$\frac{20,000 \text{ HRS/LAMP}}{6,000 \text{ HRS/YR}} = 3.33 \frac{\text{YRS}}{\text{LAMP}}$$

$$\frac{308 \text{ LAMPS}}{3.33 \text{ YRS}} = 92.4 \text{ REPLACEMENTS/YR}$$

② NON-PRODUCTION F40/F96

$$\frac{20,000}{2750} = 7.27 \text{ YRS/LAMP}$$

$$\frac{7845}{7.27} = 1079 \text{ LAMPS/YR REPLACED}$$



SUBJECT ENERGY LAMP/BALLASTS
DESIGNER C. WARREN
CHECKER _____

AEP NO 290-0379-002
SHEET 5 OF _____
DATE 3/26/92
DATE _____

③ PRODUCTION AREAS F96 LAMPS

$$\frac{6248 \text{ LAMPS}}{3.33 \text{ yrs}} = 1,876 \text{ REPL/YR}$$

④ NON-PRODUCTION F96

$$\frac{1032}{7.27} = 142 \text{ REPL/YR}$$

REPLACEMENT LAMP COSTS -

	# REPLACEMENTS/YR	LAMP PRICE (EA)	TOTAL
<u>PRODUCTION AREAS</u>			
F40T12 (STD)	92	1.05	97
F40T12/WM	92	1.80	166
F32TB	92	2.10	193
F96T12 (STD)	1876	2.60	4878
F96T12/WM	1876	3.95	7410
<u>NON-PRODUCTION AREAS</u>			
F40T12 (STD)	1079	1.05	1133
F40T12/WM	1079	1.80	1942
F32TB	1079	2.10	2266
F96T12 (STD)	142	2.60	369
F96T12/WM	142	3.95	560

SUMMARY OF SAVINGS FOR EACH ECD - PROJECT SUMMARY DATA
FOLLOW ON PAGES 8-10 thru 8-14

FLUORESCENT LIGHTING S
WATERLIET ARSENAL
DATES: 15 OCT 91 - 18
PROJECT # 290-0379-00

TABLE B-1 FLUORESCENT LIGHTING
INVENTORY

BLDG #	AREA	AVG W/SF	F40T12 # LTS	F40T12 # FXTRS	F96T12 # LTS	F96T12 # FXTRS	F96T12H0 # LTS	F96T12H0 # FXTRS	F90T12 # LTS	F90T12 # FXTRS	F72P617 # LTS	F72P617 # FXTRS	F96P617 # LTS	F96P617 # FXTRS	TOTAL LTS	TOTAL FXTRS	
20	MANUF	1.9							1,728	864					1,728	864	
25	MANUF	3.9			5,600	2,800									5,600	2,800	
35	MANUF	N/A													0	0	
110	MANUF	1.3	300	100	648	324			200	100					1,148	524	
125	MANUF	1.5	8	4			184	92							192	96	
135	MANUF	N/A													0	0	
TOTAL MANUF			308	104	6,248	3,124	184	92	1,928	964	0	0	0	0	8,668	4,284	
10	OFFICES	0.9	1,042	377	4	2									1,046	379	
15	MTR POOL	0.5	182	91	4	2									186	93	
15	OFFICES	0.5	62	31											62	31	
20	OFFICES	1.8	372	124											372	124	
21	CAFETERIA	0.4	124	62											124	62	
22	FIRE STA	N/A													0	0	
23	MANUF/SPLY	0.9	212	82	90	45									302	127	
24	OFFICES	1.2	114	57											114	57	
40	OFFICES/LABS	1.3	860	430	188	94									1,048	524	
44	OFFICES	1.4	1,512	454	166	83									1,678	537	
115	OFFICES	1.2	1,451	598	20	10									1,471	608	
120	STORAGE	0.6	104	52	158	79									262	131	
120	SHOPS	1.1							252	126					252	126	
120	OFFICES	1.2	352	176	10	5					60		30		362	181	
120	LABS	1.8	950	475											1,010	505	
123	CLEANING	1.3					42	21					24	12	66	33	
124	OFFICES/LABS	1.2	360	180											360	180	
130	WAREHOUSE	0.7	72	36	162	81			18	9					252	126	
145	WAREHOUSE	0.2	76	38	230	115			12	6					318	159	
TOTAL OTHER			7,845	3,263	1,032	516	42	21	0	282	141	60	30	24	12	9,285	3,983

FLUORESCENT LIGHTING SURVEY - SUMMARY

WATERVLIET ARSENAL

DATES: 15 OCT 91 - 18 OCT 91

PROJECT # 290-0379-002

TABLE B-2
FLUORESCENT LIGHTING
CURRENT ENERGY USE

BLDG #	AREA	AVG W/SF	F40T12 WATTS	F40T12 KWH/YR	F96T12 WATTS	F96T12 KWH/YR	F96T12H0 WATTS	F96T12H0 KWH/YR	F90T12 WATTS	F90T12 KWH/YR	F90T17 WATTS	F90T17 KWH/YR	F72P617 WATTS	F72P617 KWH/YR	F96P617 WATTS	F96P617 KWH/YR	TOTAL WATTS	TOTAL KWH/YR
20	MANUF	1.9							172,800	1,036,800					172,800	1,036,800	172,800	1,036,800
25	MANUF	3.9			490,000	2,940,000									490,000	2,940,000	490,000	2,940,000
35	MANUF	N/A															0	0
110	MANUF	1.3	14,400	86,400	56,700	340,200			20,000	120,000							91,100	546,600
125	MANUF	1.5	384	2,304			23,460	140,760									23,844	143,064
135	MANUF	N/A															0	0
TOTAL MANUF			14,784	88,704	546,700	3,280,200	23,460	140,760	192,800	1,156,800	0	0	0	0	0	0	777,744	4,666,464
10	OFFICES	0.9	50,016	137,544	350	963											50,366	138,507
15	NTR POOL	0.5	8,736	24,024	350	963											9,086	24,987
15	OFFICES	0.5	2,976	8,184													2,976	8,184
20	OFFICES	1.8	17,856	49,104													17,856	49,104
21	CAFETERIA	0.4	5,952	16,368													5,952	16,368
22	FIRE STA	N/A															0	0
23	MANUF/SPLY	0.9	10,176	38,352	7,875	21,656											18,051	60,008
24	OFFICES	1.2	5,472	15,048													5,472	15,048
40	OFFICES/LABS	1.3	41,280	113,520	16,450	45,238											57,730	158,758
44	OFFICES	1.4	72,576	199,584	14,525	39,944											87,101	239,528
115	OFFICES	1.2	69,648	191,532	1,750	4,813											71,398	196,345
120	STORAGE	0.6	4,992	13,728	13,825	38,019											18,817	51,747
120	SHOPS	1.1									27,090	74,498					27,090	74,498
120	OFFICES	1.2	16,896	46,464	875	2,406											17,771	48,870
120	LABS	1.8	45,600	125,400									11,385	31,309			56,985	156,709
123	CLEANING	1.3					5,355	32,130							5,520	33,120	10,875	65,250
124	OFFICES/LABS	1.2	17,280	47,520													17,280	47,520
130	WAREHOUSE	0.7	3,456	9,504	14,175	38,981					1,935	5,321					19,566	53,806
145	WAREHOUSE	0.2	3,648	10,032	20,125	55,344					1,290	3,548					25,063	68,924
TOTAL OTHER			376,560	1,045,908	90,300	248,327	5,355	32,130	0	0	30,315	83,367	11,385	31,309	5,520	33,120	519,435	1,474,161

TOTAL WVA 1.5 391,344 1,134,612 637,000 3,528,527 28,815 172,890 192,800 1,156,800 30,315 83,367 11,385 31,309 5,520 33,120 1,297,179 6,140,625

TABLE B-3

FLUORESCENT LAMP SPECIFICATIONS

WVA - #290-0379-002

10-Feb-92

LAMP(1)	BULB DIAM °		WATTS	BASE	LIFE (HRS) 12-HR START	LUMENS	CURRENT (MA)	PRICE (\$)
F40CW(GE)	1.5	STD	40	BIPIN	20000	3050	425	
F40CW(P)	1.5	STD	40	BIPIN	20000	3150	425	
F40CW/RS/WM(GE)	1.5	ENERGY	34	BIPIN	20000	2650	425	\$1.80
F40CW/RS/EW-II(P)	1.5	ENERGY	34	BIPIN	20000	2775	425	
F40/CW/EW-PH(P)	1.5	ENERGY	34	BIPIN	15000	2850	425	
F40CW/RS/WMP(GE)	1.5	ENERGY	32	BIPIN	15000	2525	425	\$2.10
F40T8(GE)	1.0	STD	40	BIPIN	20000	3600	265	
F40T8(P)	1.0	STD	40	BIPIN	20000	3650	265	
F32T8(P)	1.0	ENERGY	32	BIPIN	20000	2900	265	\$2.10
F040T8(S)	1.0	STD	40	BIPIN	20000	3650	265	
F032T8(S)	1.0	ENERGY	32	BIPIN	20000	2900	265	
F72P617(GE)	2.125	STD	165	RDC	15000	11000	1500	
F96T12/CW(GE)	1.5	STD	75	SINGLE	18000	6150	425	
F96T12/CW(P)	1.5	STD	75	SINGLE	12000	6300	425	
F96T12/CW/WM(GE)	1.5	ENERGY	60	SINGLE	18000	5500	425	\$3.95
F96T12/CW/EW(P)	1.5	ENERGY	60	SINGLE	12000	5600	425	
F96T12/CW/HO(GE)	1.5	STD	105	RDC	18000	8900	800	
F96T12/CW/HO(P)	1.5	STD	105	RDC	12000	9200	800	
F96T12/CW/HO/WM(GE)	1.5	ENERGY	95	RDC	18000	8000	800	\$5.30
F96T12/CW/HO/EW(P)	1.5	ENERGY	95	RDC	12000	8300	800	
F96P617/CW(GE)	2.125	STD	215	RDC	15000	15300	1500	
F96P617/CW/WM(GE)	2.125	ENERGY	185	RDC	15000	13500	1500	\$11.45
F90T17/CW(GE)	2.125	STD	90	MOG BIP	15000	6000	425	
F90T17/CW/WM(GE)	2.125	ENERGY	82	MOG BIP	15000	5750	425	\$9.00
F90T12/CW/60/EW(P)	1.5	ENERGY	84	MOG BIP	9000	6250	425	\$9.00
(REPLACES F90T17/CW)								

(1) GENERAL ELECTRIC (GE)
PHILIPS (P)
SYLVANIA (S)

SOURCES : SPECIFICATIONS FROM MANUF. CATALOGS
PRICE QUOTES FROM VENDORS

TABLE B-4

FLUORESCENT BALLAST SPECIFICATIONS

WVA - #290-0379-002

12-Feb-92

LAMPS	WATTS	BALLASTS	BALLAST INPUT (W)	PRICE (\$)
F40T12/RS STD	40	ADV MARK IV	80	\$20.00
		EBT ELECTRONIC	71	
		GE OPTIMISER	71	
		GE PERFORMANCE SS	70	
		STANDARD	96	
F40T12/RS ENERGY	34	ADV MARK IV	66	\$20.00
		EBT ELECTRONIC	59	\$25.20
		GE OPTIMISER	59	
F40T12/RS ENERGY	32	GE MAXI-MISER II	72	
F40T8/IS STD	40	EBT ELECTRONIC	70	
F32T8/IS ENERGY	32	EBT ELECTRONIC	58	\$26.90
		T8 MAGNETIC	66	
F96T12/IS STD	75	GE MAXI-MISER II	158	
		EBT ELECTRONIC	130	
		STANDARD	175	
F96T12/IS ENERGY	60	GE MAXI-MISER II	136	
		EBT ELECTRONIC	105	\$35.00
F96T12/HO STD	105	GE WATT-MISER	237	
		GE MAXI-MISER II	254	
		STANDARD	255	
		EBT ELECTRONIC	190	
F96T12/HO ENERGY	95	GE MAXI-MISER II	212	
		EBT ELECTRONIC	160	\$44.00
F96PG17 STD	215	STANDARD	460	
ENERGY	185	STANDARD	400	
F90T17 STD	90	STANDARD	215	
ENERGY	82	STANDARD	200	
F90T12	84	STANDARD	200	

SOURCES: SPECIFICATIONS FROM
MANUF. CATALOGS
PRICES FROM VENDORS

PROJECT SUMMARY DATA
WATERVLIET ARSENAL

PROJECT: ECO #8
ENERGY EFFICIENT FLUORESCENT LAMPS AND BALLASTS

8A

Replace 40-Watt Fluorescents with 34-Watt Lamps
Production Areas

	Existing F40T12 Std. Bal.	Proposed F40T12/WM Std. Bal.	Savings
Number Lamps	308.0	308.0	0.0
Number Fixtures	104.0	104.0	0.0
Number Ballasts	152.0	152.0	0.0
Load, kW	14.8	12.4	2.5
Use, Hrs/yr	6000.0	6000.0	0.0
Use MBtu/yr	303.7	253.1	50.6
Lamp Repl Cost, \$/yr	97.0	166.0	-69.0
Rebate Amt., \$	0.0	-123.2	123.2

8B

Replace 40-Watt Fluorescents with 34-Watt Lamps
Replace Standard Ballasts with Energy - Efficient Electromagnetic Ballasts
Production Areas

	Existing F40T12 Std. Bal.	Proposed F40T12/WM EM Bal.	Savings
Number Lamps	308.0	308.0	0.0
Number Fixtures	104.0	104.0	0.0
Number Ballasts	152.0	152.0	0.0
Load, kW	14.8	9.8	5.0
Use, Hrs/yr	6000.0	6000.0	0.0
Use MBtu/yr	302.7	200.4	102.4
Lamp Repl Cost, \$/yr	97.0	166.0	-69.0
Rebate Amt., \$	0.0	-3163.2	3163.2

PROJECT SUMMARY DATA
WATERVLIET ARSENAL

PROJECT: ECO #8
ENERGY EFFICIENT FLUORESCENT LAMPS AND BALLASTS

8C

Replace 40-Watt Lamps and Ballasts with T8 System
Production Areas

	Existing F40T12 Std. Bal.	Proposed F40T8 Elect. Bal.	Savings
Number Lamps	308.0	308.0	0.0
Number Fixtures	104.0	104.0	0.0
Number Ballasts	152.0	102.0	50.0
Load, kW	14.8	9.1	5.7
Use, Hrs/yr	6000.0	6000.0	0.0
Use MBtu/yr	302.7	185.6	117.1
Lamp Repl Cost, \$/yr	97.0	193.0	-96.0
Rebate Amt., \$	0.0	-2203.2	2203.2

8D

Replace 40-Watt Fluorescents with 34-Watt Lamps
Non-Production Areas

	Existing F40T12 Std. Bal.	Proposed F40T12/WM Std. Bal.	Savings
Number Lamps	7845.0	7845.0	0.0
Number Fixtures	3263.0	3263.0	0.0
Number Ballasts	3923.0	3923.0	0.0
Load, kW	376.6	313.8	62.7
Use, Hrs/yr	2750.0	2750.0	0.0
Use MBtu/yr	3534.3	2945.6	588.7
Lamp Repl Cost, \$/yr	1133.0	1942.0	-809.0
Rebate Amt., \$	0.0	-3138.0	3138.0

PROJECT SUMMARY DATA
WATERVLIET ARSENAL

PROJECT: ECO #8
ENERGY EFFICIENT FLUORESCENT LAMPS AND BALLASTS

8E

Replace 40-Watt Fluorescents with 34-Watt Lamps
Replace Standard Ballasts with Energy - Efficient Electromagnetic Ballasts
Non-Production Areas

	Existing F40T12 Std. Bal.	Proposed F40T12/WM EM Bal.	Savings
Number Lamps	7845.0	7845.0	0.0
Number Fixtures	3263.0	3263.0	0.0
Number Ballasts	3923.0	3923.0	0.0
Load, kW	376.6	258.9	117.6
Use, Hrs/yr	2750.0	2750.0	0.0
Use MBtu/yr	3534.3	2430.1	1104.2
Lamp Repl Cost, \$/yr	1133.0	1942.0	-809.0
Rebate Amt., \$	0.0	-81598.0	81598.0

8F

Replace 40-Watt Lamps and Ballasts with T8 System
Non-Production Areas

	Existing F40T12 Std. Bal.	Proposed F40T8 Elect. Bal.	Savings
Number Lamps	7845.0	7845.0	0.0
Number Fixtures	3263.0	3263.0	0.0
Number Ballasts	3923.0	3923.0	0.0
Load, kW	376.6	227.5	149.0
Use, Hrs/yr	2750.0	2750.0	0.0
Use MBtu/yr	3534.3	2135.6	1398.7
Lamp Repl Cost, \$/yr	1133.0	2266.0	-1133.0
Rebate Amt., \$	0.0	-81598.0	81598.0

PROJECT SUMMARY DATA
WATERVLIET ARSENAL

PROJECT: ECO #8
ENERGY EFFICIENT FLUORESCENT LAMPS AND BALLASTS

8G

Replace 75-Watt Fluorescents with 60-Watt Lamps
Production Areas

	Existing F96T12 Std. Bal.	Proposed F96T12/WM Std. Bal.	Savings
Number Lamps	6248.0	6248.0	0.0
Number Fixtures	3124.0	3124.0	0.0
Number Ballasts	3124.0	3124.0	0.0
Load, kW	546.7	509.2	37.5
Use, Hrs/yr	6000.0	6000.0	0.0
Use MBtu/yr	11195.3	10427.4	767.9
Lamp Repl Cost, \$/yr	4878.0	7410.0	-2532.0
Rebate Amt., \$	0.0	-2499.2	2499.2

8H

Replace 75-Watt Fluorescents with 60-Watt Lamps
Replace Standard Ballasts with Energy - Efficient Electronic Ballasts
Production Areas

	Existing F96T12 Std. Bal.	Proposed F96T12/WM Elect. Bal.	Savings
Number Lamps	6248.0	6248.0	0.0
Number Fixtures	3124.0	3124.0	0.0
Number Ballasts	3124.0	3124.0	0.0
Load, kW	546.7	328.0	218.7
Use, Hrs/yr	6000.0	6000.0	0.0
Use MBtu/yr	11195.3	6717.2	4478.1
Lamp Repl Cost, \$/yr	4878.0	7410.0	-2532.0
Rebate Amt., \$	0.0	-64979.2	64979.2

PROJECT SUMMARY DATA
WATERVLIET ARSENAL

PROJECT: ECO #8
ENERGY EFFICIENT FLUORESCENT LAMPS AND BALLASTS

8I

Replace 75-Watt Fluorescents with 60-Watt Lamps
Non-Production Areas

	Existing F96T12 Std. Bal.	Proposed F96T12/WM Std. Bal.	Savings
Number Lamps	1032.0	1032.0	0.0
Number Fixtures	516.0	516.0	0.0
Number Ballasts	516.0	516.0	0.0
Load, kW	90.3	84.1	6.2
Use, Hrs/yr	2750.0	2750.0	0.0
Use MBtu/yr	847.5	789.3	58.2
Lamp Repl Cost, \$/yr	369.0	560.0	-191.0
Rebate Amt., \$	0.0	-412.8	412.8

8J

Replace 75-Watt Fluorescents with 60-Watt Lamps
Replace Standard Ballasts with Energy - Efficient Electronic Ballasts
Non-Production Areas

	Existing F96T12 Std. Bal.	Proposed F96T12/WM Elect. Bal.	Savings
Number Lamps	1032.0	1032.0	0.0
Number Fixtures	516.0	516.0	0.0
Number Ballasts	516.0	516.0	0.0
Load, kW	90.3	54.2	36.1
Use, Hrs/yr	2750.0	2750.0	0.0
Use MBtu/yr	847.5	508.5	339.0
Lamp Repl Cost, \$/yr	369.0	560.0	-191.0
Rebate Amt., \$	0.0	-10732.8	10732.8

03/19/92

ECO Construction Cost Estimate
Calculations

ECO Name: Replace 40-Watt Fluorescents With 34-Watt Lamps
Production Areas

ECO #: 8A

1991 ECO "bare" costs (from cost estimate sheet)

Material	\$554
Labor	\$693

Subtotal bare costs	\$1,247

FICA Insurance (20% of Labor)	\$139

Sales Tax (not applicable for GOGO)	\$0

Subtotal	\$1,386

Overhead (15%)	\$208

Subtotal	\$1,594

Profit (10%)	\$159

Subtotal	\$1,753

Bond (1%)	\$18

Subtotal	\$1,771

Contingency (10%)	\$177

Subtotal (Construction Cost Input For LCCID *)	\$1,948

SIOH (6% of Construction Cost)	\$117

Subtotal	\$2,065

Design (6% of Construction Cost)	\$117

Total Project Cost	\$2,182

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically
added in the Life Cycle Cost In Design (LCCID) analysis program.

03/19/92

ECO Construction Cost Estimate
Calculations

ECO Name: Replace 40-Watt Fluorescents With 34-Watt Lamps
Replace Standard Ballasts With Energy EM Ballasts
Production Areas

ECO #: 8B

1991 ECO "bare" costs (from cost estimate sheet)

Material \$3,594

Labor \$3,885

Subtotal bare costs \$7,479

FICA Insurance (20% of Labor) \$777

Sales Tax (not applicable for GOGO) \$0

Subtotal \$8,256

Overhead (15%) \$1,238

Subtotal \$9,494

Profit (10%) \$949

Subtotal \$10,443

Bond (1%) \$104

Subtotal \$10,547

Contingency (10%) \$1,055

Subtotal (Construction Cost Input For LCCID *) \$11,602

SIOH (6% of Construction Cost) \$696

Subtotal \$12,298

Design (6% of Construction Cost) \$696

Total Project Cost \$12,994

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically
added in the Life Cycle Cost In Design (LCCID) analysis program.

03/19/92

ECO Construction Cost Estimate Calculations

ECO Name: Replace 40-Watt Fluorescents With 32-Watt Lamps
Replace Standard Ballasts With Electronic Ballasts
Production Areas

ECO #: 8C

1991 ECO "bare" costs (from cost estimate sheet)

Material	\$3,639
Labor	\$2,835

Subtotal bare costs	\$6,474

FICA Insurance (20% of Labor)	\$567

Sales Tax (not applicable for GOGO)	\$0

Subtotal	\$7,041

Overhead (15%)	\$1,056

Subtotal	\$8,097

Profit (10%)	\$810

Subtotal	\$8,907

Bond (1%)	\$89

Subtotal	\$8,996

Contingency (10%)	\$900

Subtotal (Construction Cost Input For LCCID *)	\$9,896

SIOH (6% of Construction Cost)	\$594

Subtotal	\$10,490

Design (6% of Construction Cost)	\$594

Total Project Cost	\$11,084

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

03/19/92

ECO Construction Cost Estimate
Calculations

ECO Name: Replace 40-Watt Fluorescents With 34-Watt Lamps
Non-Production Areas

ECO #: 8D

1991 ECO "bare" costs (from cost estimate sheet)

Material	\$14,121
Labor	\$17,651

Subtotal bare costs	\$31,772

FICA Insurance (20% of Labor)	\$3,530

Sales Tax (not applicable for GOGO)	\$0

Subtotal	\$35,302

Overhead (15%)	\$5,295

Subtotal	\$40,597

Profit (10%)	\$4,060

Subtotal	\$44,657

Bond (1%)	\$447

Subtotal	\$45,104

Contingency (10%)	\$4,510

Subtotal (Construction Cost Input For LCCID *)	\$49,614

SIOH (6% of Construction Cost)	\$2,977

Subtotal	\$52,591

Design (6% of Construction Cost)	\$2,977

Total Project Cost	\$55,568

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically
added in the Life Cycle Cost In Design (LCCID) analysis program.

03/19/92

ECO Construction Cost Estimate
Calculations

ECO Name: Replace 40-Watt Fluorescents With 34-Watt Lamps
Replace Standard Ballasts With Energy EM Ballasts
Non-Production Areas

ECO #: 8E

1991 ECO "bare" costs (from cost estimate sheet)

Material	\$92,581
Labor	\$100,034.

Subtotal bare costs	\$192,615
FICA Insurance (20% of Labor)	\$20,007
Sales Tax (not applicable for GOGO)	\$0

Subtotal	\$212,622
Overhead (15%)	\$31,893

Subtotal	\$244,515
Profit (10%)	\$24,452

Subtotal	\$268,967
Bond (1%)	\$2,690

Subtotal	\$271,657
Contingency (10%)	\$27,166

Subtotal (Construction Cost Input For LCCID *)	\$298,823

SIOH (6% of Construction Cost)	\$17,929

Subtotal	\$316,752
Design (6% of Construction Cost)	\$17,929

Total Project Cost	\$334,681

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

03/19/92

ECO Construction Cost Estimate Calculations

ECO Name: Replace 40-Watt Fluorescents With 32-Watt Lamps
Replace Standard Ballasts With Electronic Ballasts
Non-Production Areas

ECO #: 8F

1991 ECO "bare" costs (from cost estimate sheet)

Material	\$122,395
Labor	\$100,034

Subtotal bare costs	\$222,429
FICA Insurance (20% of Labor)	\$20,007
Sales Tax (not applicable for GOGO)	\$0

Subtotal	\$242,436
Overhead (15%)	\$36,365

Subtotal	\$278,801
Profit (10%)	\$27,880

Subtotal	\$306,681
Bond (1%)	\$3,067

Subtotal	\$309,748
Contingency (10%)	\$30,975

Subtotal (Construction Cost Input For LCCID *)	\$340,723

SIOH (6% of Construction Cost)	\$20,443

Subtotal	\$361,166
Design (6% of Construction Cost)	\$20,443

Total Project Cost	\$381,609

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

03/23/92

ECO Construction Cost Estimate
Calculations

ECO Name: Replace 75-Watt Fluorescents With 60-Watt Lamps
Production Areas

ECO #: 8G

1991 ECO "bare" costs (from cost estimate sheet)

Material	\$24,680
Labor	\$15,620

Subtotal bare costs	\$40,300

FICA Insurance (20% of Labor)	\$3,124

Sales Tax (not applicable for GOGO)	\$0

Subtotal	\$43,424

Overhead (15%)	\$6,514

Subtotal	\$49,938

Profit (10%)	\$4,994

Subtotal	\$54,932

Bond (1%)	\$549

Subtotal	\$55,481

Contingency (10%)	\$5,548

Subtotal (Construction Cost Input For LCCID *)	\$61,029

SIOH (6% of Construction Cost)	\$3,662

Subtotal	\$64,691

Design (6% of Construction Cost)	\$3,662

Total Project Cost	\$68,353

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically
added in the Life Cycle Cost In Design (LCCID) analysis program.

03/23/92

ECO Construction Cost Estimate
Calculations

ECO Name: Replace 75-Watt Fluorescents With 60-Watt Lamps
Replace Standard Ballasts With Electronic Ballasts
Production Areas

ECO #: 8H

1991 ECO "bare" costs (from cost estimate sheet)

Material	\$134,020
Labor	\$93,720

Subtotal bare costs	\$227,740

FICA Insurance (20% of Labor)	\$18,744

Sales Tax (not applicable for GOGO)	\$0

Subtotal	\$246,484

Overhead (15%)	\$36,973

Subtotal	\$283,457

Profit (10%)	\$28,346

Subtotal	\$311,803

Bond (1%)	\$3,118

Subtotal	\$314,921

Contingency (10%)	\$31,492

Subtotal (Construction Cost Input For LCCID *)	\$346,413

SIOH (6% of Construction Cost)	\$20,785

Subtotal	\$367,198

Design (6% of Construction Cost)	\$20,785

Total Project Cost	\$387,983

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

03/23/92

ECO Construction Cost Estimate
Calculations

ECO Name: Replace 75-Watt Fluorescents With 60-Watt Lamps
Non-Production Areas

ECO #: 8I

1991 ECO "bare" costs (from cost estimate sheet)

Material	\$4,076
Labor	\$2,580

Subtotal bare costs	\$6,656

FICA Insurance (20% of Labor)	\$516

Sales Tax (not applicable for GOGO)	\$0

Subtotal	\$7,172

Overhead (15%)	\$1,076

Subtotal	\$8,248

Profit (10%)	\$825

Subtotal	\$9,073

Bond (1%)	\$91

Subtotal	\$9,164

Contingency (10%)	\$916

Subtotal (Construction Cost Input For LCCID *)	\$10,080

SIOH (6% of Construction Cost)	\$605

Subtotal	\$10,685

Design (6% of Construction Cost)	\$605

Total Project Cost	\$11,290

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically
added in the Life Cycle Cost In Design (LCCID) analysis program.

03/23/92

ECO Construction Cost Estimate
Calculations

ECO Name: Replace 75-Watt Fluorescents With 60-Watt Lamps
Replace Standard Ballasts With Electronic Ballasts
Non-Production Areas

ECO #: 8J

1991 ECO "bare" costs (from cost estimate sheet)

Material	\$22,136
Labor	\$15,480

Subtotal bare costs	\$37,616

FICA Insurance (20% of Labor)	\$3,096

Sales Tax (not applicable for GOGO)	\$0

Subtotal	\$40,712

Overhead (15%)	\$6,107

Subtotal	\$46,819

Profit (10%)	\$4,682

Subtotal	\$51,501

Bond (1%)	\$515

Subtotal	\$52,016

Contingency (10%)	\$5,202

Subtotal (Construction Cost Input For LCCID *)	\$57,218

SIOH (6% of Construction Cost)	\$3,433

Subtotal	\$60,651

Design (6% of Construction Cost)	\$3,433

Total Project Cost	\$64,084

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

SHEET 1 OF 2

2 | 13 | 42

SHEET 1 OF 2

ENERGY ENGINEERING ANALYSIS

WVA

REYNOLDS, SMITH AND HILLS A.E.P., INC.

ESTIMATOR

C. WARREN

CHECKED BY

CREATED BY
P. Hutchins

☐ CODE A (No design completed)
☒ CODE B (Preliminary design)
☐ CODE C (Final design)
☐ OTHER (Specify)

ECO8 SUMMARY		QUANTITY		LABOR		MATERIAL		TOTAL COST
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
F40T12 LAMP REPLACEMENTS								
4 BALLAST REPLACEMENTS								
PRODUCTION AREAS								
3A	34 W LAMPS	308	EA	2.25	693	1.80	554	1,247
NO BALLAST REPLACEMENTS								
3B	34 W LAMPS	308	EA	2.25	693	1.80	554	1,247
	ENERGY EM BALLASTS	152	EA	21.00	3,192	20.00	3,040	6,232
					3,885		3,594	7,479
3C	32 W LAMPS (TB)	308	EA	2.25	693	2.10	647	1,340
	ELECTRONIC BALLASTS	102	EA	21.00	2,142	29.33	2,992	5,134
					2,835		3639	6,474
NON-PRODUCTION AREAS								
3D	34 W LAMPS	7845	EA	2.25	17,651	1.80	14,121	31,772
NO BALLAST REPLACEMENTS								
3E	34 W LAMPS	7845	EA	2.25	17,651	1.80	14,121	31,772
	ENERGY EM BALLASTS	3923	EA	21.00	82,383	20.00	78,460	160,843
					100,034		92,581	192,615
3F	32 W LAMPS (TB)	7845	EA	2.25	17,651	2.10	16,474	34,125
	ELECTRONIC BALLASTS	3923	EA	21.00	82,383	27.00	105,921	188,304
					100,034		122,395	222,429

02/10/92 18:33 2904 279 2491

RS&H

001

RS&H

Architecture, Engineering and Planning

Reynolds, Smith and Hills, Inc.
6651 Salisbury Road
Jacksonville, Florida 32256

FACSIMILE TRANSMITTAL LETTER

DATE 2/10/92

From TO: ELECTRONIC BALLAST TECHNOLOGY - Swanson & Co.
Tampa
TO FROM: DR CARLOS WARREN, PE (904) 279-2275

FAX NO. (213) 534-8214

PTAC NUMBER 599361

PROJECT NUMBER:

TASK NO:

SENDER'S DEPARTMENT NUMBER 2ASH

WE ARE TRANSMITTING 1 PAGES INCLUDING COVER

IF YOU DO NOT RECEIVE ALL PAGES PLEASE TELEPHONE:

904-296-2000

IF YOU WISH TO TRANSMIT FAX COPY TO US PLEASE TELEPHONE: 904-279-2491

COMMENTS: I NEED PRICE QUOTES FOR BULK PURCHASES
OF FOLLOWING BALLASTS

SSB1 - 120 - 2/40 LH	25.20 ea.
SSB1 - 277 - 2/96 HO LH	44.80 ea.
SSB2 - 120 - 2/96 IS LH	35.00 ea.
SSB1 - 120 - 2/96 HO LH	44.80 ea.
SSB2 - 120 - 2/32 IS LH	26.90 ea.

PLEASE QUOTE ASAP Thanks Ch

SSB2 - 120 - 3/32 IS LH 29.33

From ~~Jim~~ Jim REYNOLDS

to ~~From~~ Carlos Warren
RS&H

Quotes on the following (bulk quantities)

Lamps =

GE	F40CW/RS/wm	1.80 ea
	F40 ^{LH} ~~SW~~ /RS/wm plus	2.10 ea
	F96T12/cw/wm	3.95 ea
	F96T12/cw/HO/wm ^{5.30 ea}	or equivalent
	F96PG17/cw/wm 11.45 ea	Philips, Sylvania
	F96T17/cw/wm	9.00 ea

Philips	F96T12CW/60/EW	\$ 9.00
	FO32/35	\$ 2.10

Ballasts (2 lamp fixtures)

Advance Powerkut Mark IV	RK-2540-TP	20.00 ea
	VK-2540-TP	22.00 ea

~~GE Optimiser M28-120~~

~~Maxi-Miser II BG1028W, BG1148W, BG1144W,
BG1008W, BG1004W~~

~~EBT SSB1-120-2/40 LH SSB2-120-2/96 ES-LH
SSB1-120-2/40 LH SSB1-120-2/96 HO LH
SSB1-277-2/96 HO LH, SSB2-120-2/32 IS LH~~

1 MA

TIME 08:42

WATER
SELF-SERVICE SUPPLY CENTER
- MASTER LIST OF SUPPLIES -
REPAIR & UTILITY

STOCK NUMBER

NOMENCLATURE

MAT-CAT

UNIT
ISSUEUNIT
PRICE

> 6240007522001

LAMP, FLUORESCENT, POWER GROOVE
F96P617CW

T

EA

\$ 10.15

6240005190445

LAMP, FLUORESCENT, WATTS 32, BULB NO. T-10
BASE, 4-PIN, COOL WHITE, RAPID START, 12" DIA

T

EA

\$ 4.00

6240008200470

LAMP, FLUORESCENT, WATT 14, BULB T-12, MED.
BI-PIN BASE, WARM WHITE

T

EA

\$ 3.86

> 6240000671021

LAMP, FLUORESCENT, TUBE, 6 FOOT, POWER GROOVE
"POWER GROOVE" 1500M. A. 165 WATTS F72T1200
RAPID START

T

EA

\$ 4.92

6240006354480

LAMP, INCANDESCENT 60 WATT, 120 VOLTS MED.
SCREW BASE, INSIDE FROSTED, A-19 BULB

T

EA

\$.38

6240002239097

LAMP, INCANDESCENT CLEAR, 1/4 WATT, 105-125
VOLT CANDLE BASE

T

EA

\$ 4.67

6240001433049

LAMP, INDICATOR, 6 WATTS, 110 VOLTS, CLEAR
G.E. #6S6

T

EA

\$.16

6240001558001

LAMP, INDICATOR, CLEAR, CANDLEABRA BASE
10 WATTS 230 VOLTS, G.E. 1056-10

T

EA

\$ 2.26

6240007123090

LAMP, REFLECTOR, INFRE-RED, RED BOWL, 250
WATTS, 125 VOLTS, OR 120 VOLTS

T

EA

\$ 3.08

6240007818372

LAMP, STREET LIGHTING, 6000 LUMENARS
BULB 6.6, MOGUL BASE, CLEAR

T

EA

\$ 7.50

62400005003643

LAMP, TRAFFIC SIGNAL, CLEAR, 60 WATTS, 120
VOLTS, BULB A21

T

EA

\$.81

> 6240000X810003

LAMP, U SHAPED

T

EA

\$ 5.88

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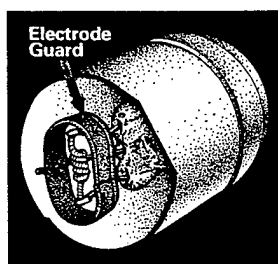
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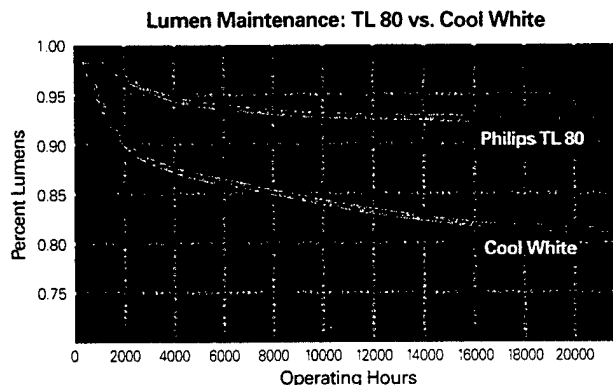
TL 80 Series Fluorescent Lamps
Electrical, Technical and Ordering Data (Subject to change without notice)

Product Number	Description	Nominal Watts	Bulb	Base	Std Pkg Qty	Lamp Current (Amps)	Color Temp (Kelvin)	Color Rendering (CRI)	Nominal Length (Feet)	Rated Average Life (Hrs) ⁽¹⁾	Approx. Initial Lumens	Design Lumens ⁽²⁾
31980-6	F17T8/TL830	17	T-8	Md. Bipin	25	0.265	3000	85	2	20,000	1400	1300
32304-8	F17T8/TL835	17	T-8	Md. Bipin	25	0.265	3500	85	2	20,000	1400	1300
31983-0	F17T8/TL841	17	T-8	Md. Bipin	25	0.265	4100	85	2	20,000	1400	1300
31984-8	F25T8/TL830	25	T-8	Md. Bipin	25	0.265	3000	85	3	20,000	2250	2100
25798-0	F25T8/TL835	25	T-8	Md. Bipin	25	0.265	3500	85	3	20,000	2250	2100
31989-7	F25T8/TL841	25	T-8	Md. Bipin	25	0.265	4100	85	3	20,000	2250	2100
31991-3	F32T8/TL830	32	T-8	Md. Bipin	25	0.265	3000	85	4	20,000	3050	2850
31993-9	F32T8/TL835	32	T-8	Md. Bipin	25	0.265	3500	85	4	20,000	3050	2850
31994-7	F32T8/TL841	32	T-8	Md. Bipin	25	0.265	4100	85	4	20,000	3050	2850
31996-2	F40T8/TL830	40	T-8	Md. Bipin	25	0.265	3000	85	5	20,000	3800	3550
25799-8	F40T8/TL835	40	T-8	Md. Bipin	25	0.265	3500	85	5	20,000	3800	3550
31998-8	F40T8/TL841	40	T-8	Md. Bipin	25	0.265	4100	85	5	20,000	3800	3550

(1) Average life under specified test conditions with lamps turned off and restarted no more than once every 3 operating hours.
(2) Approximate lumens at 40% of rated average life (8000 Hours).



For maximum lumen maintenance, TL 80 Series lamps feature an "electrode guard" around each electrode to effectively reduce lamp darkening and retain a clean appearance for thousands of hours.



Philips Lighting specialists are ready to help.

Philips Lighting has a team of specialists dedicated to commercial/office and retail lighting applications. They can provide a free lighting analysis which demonstrates how Philips TL 80 Series lamps can reduce energy costs in your building and improve the quality of light at the same time.

Call your Philips Lighting representative for a free fluorescent lighting analysis today:
1-800-631-1259.

TL 80 System – lamp specification

- "Lamps shall be Philips TL 80 Series lamps having:
- Color rendering index of 85
 - T-8 diameter bulb
 - Medium bi-pin bases
 - Color temperature of _____ K (3000, 3500 or 4100)
 - Initial lumens of _____ (1400, 2250, 3050 or 3800)
 - Nominal wattage of _____ (17, 25, 32, 40)
 - Powered by electronic ballasts designed for 265ma T-8 lamps
 - An electrode guard."

SYSTEM PERFORMANCE

Because the 32-watt, T8 lamp would not operate properly on existing forty-watt, 430 ma. ballasts, design of the Octron lamp system was accomplished without the constraints of existing fluorescent systems. The goal was to optimize total system performance to the F40T12 system in a luminaire while reducing wattage significantly. The result is the most efficient full light output energy-saving fluorescent lighting system.

In designing the Octron lamp system, a number of factors did have to be taken into consideration. One was the ballast factor (ratio of light output when operated on commercially-available ballasts as compared to a reference circuit.) The ballast factor of the Octron magnetic ballast was set at nominal .95; rated lumens and lamp wattage were then established.

Other factors considered were the thermal effects, i.e. 2900 rated lumens of the Octron lamp versus the 3050 lumen rating of F40CW lamps, versus the lumen output of the same lamps when operated in a stabilized condition in the luminaire. Then there were the optical effects to be considered, i.e. better lighting control, and the trapping of less light by the fixture walls and bulb itself.

The true metric for comparison of the fluorescent lamps is their actual performance in a lighting system. The data shown in Figure 7 are the result of the systems approach to lamp design taking into consideration all of the above mentioned factors. In these tests, each fluorescent system was operated in the same 4-lamp recessed lensed troffer, in a room ambient temperature of 77°F. The plenum was allowed to stabilize prior to collection of system wattage and relative lumen output data. The F40CW/standard magnetic ballast was used as the base system, and set at 100% Relative Light Output. As Figure 8 illustrates, data were collected concerning watts, Relative Light Output and RLO/watt for each lamp type and ballast tested.

Results show that Octron lamps operated on magnetic ballasts deliver system efficiency equal to T12 34-watt energy-saving lamps operated on electronic ballasts. Furthermore, the tests show that Octron lamps operated on T8 electronic ballasts provide the highest system efficiency — 166 RLO/watt.

(FIGURE 7)

FIXTURE COMPARISON DATA (77° TEST ROOM - 4-LAMP RECESSED TROFFER, PLASTIC LENS)

LAMP TYPE	BALLAST	BALLAST FACTOR ¹	WATTS	RELATIVE LIGHT OUTPUT (RLO) ²	RLO/W
SYLVANIA F40CW	STD. MAGNETIC	.95	174	100	100
SYLVANIA 34W					
SUPERSAVER® D841	STD. MAGNETIC	.90	155	95	107
SYLVANIA 32W					
SUPERSAVER PLUS D841	STD. MAGNETIC	.90	144	93	113
SYLVANIA F40CW	ENERGY SAVING MAGNETIC	.95	162	101	108
SYLVANIA 34W					
SUPERSAVER D841	ENERGY SAVING MAGNETIC	.88	139	93	116
SYLVANIA 32W					
SUPERSAVER PLUS D841	ENERGY SAVING MAGNETIC	.88	131	91	122
SYLVANIA 34W					
SUPERSAVER D841	ELECTRONIC	.75	119	93	136
SYLVANIA FO32 OCTRON®	T8 MAGNETIC	.95	132	104	137
SYLVANIA FO32 OCTRON® ³	T8 ELECTRONIC	.92	106	101	166

1 DATA IN TEST NORMALIZED TO BALLAST FACTORS SHOWN IN THIS COLUMN FOR MAGNETIC BALLASTS. FACTORS SHOWN FOR ELECTRONIC BALLASTS ARE MEASURED VALUES OF SAMPLE.

2 RELATIVE LIGHT OUTPUT BASED ON INITIAL (100 HOUR) RATED LAMP LUMEN OUTPUT AS OF 8/22/83.

3 LIFE RATED AT 15,000 HOURS. ALL OTHER SYSTEMS SHOWN ARE RATED AT 20,000 HOURS.

OCTRON CURVALUME LAMPS

An Octron Curvalume family has been introduced to provide greater lighting design, flexibility and higher efficiency than conventional U-lamp systems having T-12 bulbs. These lamps are available in 16-, 24- and 31-watt sizes and are designed to operate on Octron ballasts available for the 2-, 3-, and 4-foot straight lamps respectively. Their medium bipin bases will fit existing sockets designed for ordinary T-12 Curvalume lamps.

The new size of the Octron Curvalume family allows for the design of more compact luminaires for a wide variety of applications. The tight-bend U-lamps have a center to center leg spacing of

1 $\frac{5}{8}$ " and have overall lengths of 10 $\frac{1}{2}$ " for the 16-watt, 16 $\frac{1}{2}$ " for the 24-watt and 22 $\frac{1}{2}$ " for the 31-watt lamps. When operated on rapid start magnetic ballasts, the Octron Curvalume lamps have an average rated life of 20,000 hours.

Available in the three standard Octron colors of 3100K, 3500K and 4100K, these lamps may be used in conjunction with other members of the Octron family to fit the varied requirements of a lighting installation. Octron Curvalume lamps also have a color rendering index of 75, common to other Octron lamp types. Table 2, in this bulletin describes the physical, electrical, and photometric performance data for the Octron Curvalume family of lamps.

OCTRON CURVALUME LAMP COLOR & PERFORMANCE DATA

FB016 (16 watt)				FB024 (24 watt)		
Ordering Abbreviation	FB016/31K	FB016/35K	FB016/41K	FB024/31K	FB024/35K	FB024/41K
Sylvania Item Number	21801	21800	21802	21803	21810	21804
Correlated Color Temp.	3100K	3500K	4100K	3100K	3500K	4100K
Color Rendering Index	75	75	75	75	75	75
Initial Lumens	1250	1250	1250	2050	2050	2050

FB031 (31 watt)			
Ordering Abbreviation	FB031/31K	FB031/35K	FB031/41K
Sylvania Item Number	21805	21807	21806
Correlated Color Temp.	3100K	3500K	4100K
Color Rendering Index	75	75	75
Initial Lumens	2800	2800	2800

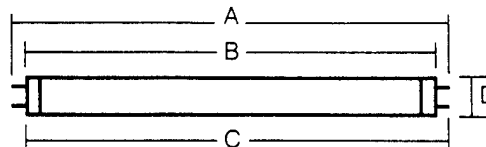
EFFECT OF BURNING PERIODS ON LAMP LIFE

Due to slight variations in the lamp making process, it is impossible to have each lamp operate for exactly the life for which it was designed. For this reason, lamp life is rated as the average life of a large group of lamps, operated under controlled laboratory conditions. Average rated life is the point at which approximately 50 percent of the lamps in a large test group have burned out and 50 percent remain burning as shown in Figure 8.

During the operation of a fluorescent lamp, the emissive material is gradually depleted from the cathodes. The normal end of life is reached when there is insufficient emissive material remaining

on either cathode to strike the arc. Since published average rated life figures are based on a three hour burning cycle, these ratings reflect the effects of both starting and operating. Changes in the burning cycle will affect life in service. Shorter burning cycles (more frequent starts) shorten lamp life and extended burning cycles (less frequent starts) increase lamp life. Figure 9 lists the average life in hours for Octron fluorescent lamps at various burning cycles. Data is provided for Octron lamps operated at 60Hz. in the rapid start mode as well as for high frequency operation in the instant start mode.

STRAIGHT OCTRON PERFORMANCE DATA



(TABLE I)

	F017		F025		F032		F040	
I. Physical Characteristics	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Overall Length (A)	23.67"	23.78"	35.67"	35.78"	47.67"	47.78"	59.50"	59.61"
Face to Face (B)		23.22"		35.22"		47.22"		59.05"
Face to End of Opposite Pin (C)	23.41"	23.50"	35.41"	35.50"	47.41"	47.50"	59.24"	59.33"
Bulb Diameter (D)	.94"	1.1"	.94"	1.10"	.94"	1.10"	.94"	1.10"
Base Type	medium bipin		medium bipin		medium bipin		medium bipin	
II. Electrical Characteristics								
60 Hz Rapid Start								
Lamp								
Rated Power	17 watts		25 watts		32 watts		40 watts	
Lumens per Watt	79 LPW		86 LPW		90.6 LPW		91.3 LPW	
Lamp Current	265 ma.		265 ma.		265 ma.		265 ma.	
Lamp Voltage	73 v.		106 v.		139 v.		172 v.	
Lamp Life (3 hrs./start)	20,000 hrs.		20,000 hrs.		20,000 hrs.		20,000 hrs.	
Ballast Requirements (2-lamp)								
Starting Time	0.75-2.0 sec.		0.75-2.0 sec.		0.75-2.0 sec.		0.75-2.0 sec.	
Open Circuit Voltage ¹	210		260		300		385	
Starting Aid Voltage ¹ (peak)	350		350		290		350	
Filament Voltage ¹								
Dummy Load (11 ohms)	3.4-4.5 v.		3.4-4.5 v.		3.4-4.5 v.		3.4-4.5 v.	
Operational	2.5-4.0 v.		2.5-4.0 v.		2.5-4.3 v.		2.5-4.0 v.	
Lamp Current Crest Factor	1.7 max.		1.7 max.		1.7 max.		1.7 max.	
III. Electrical Characteristics								
25 KHz Instant Start								
Lamp								
Rated Power	14 watts		21 watts		28 watts		35 watts	
Lumens per Watt	97 LPW		102 LPW		103.6 LPW		104 LPW	
Lamp Current	210 ma.		210 ma.		210 ma.		210 ma.	
Lamp Voltage	66 v.		101 v.		136 v.		172 v.	
Lamp Life (3 hrs./start)	15,000 hrs.		15,000 hrs.		15,000 hrs.		15,000 hrs.	
Ballast Requirements								
Open Circuit Voltage	425 v. min. ⁴		425 v. min. ⁴		500 v. min. ⁴		575 v. min. ⁴	
Starting Time	50 ms. max.		50 ms. max.		50 ms. max.		50 ms. max.	
Current Crest Factor	1.7 max.		1.7 max.		1.7 max.		1.7 max.	
IV. Photometric Characteristics								
Ordering Abbreviation	F017/31K F017/41K		F025/31K F025/41K		F032/31K F032/41K		F040/31K F040/41K	
Sylvania Item Number	21830 21831		21828 21829		21825 21824		21826 21827	
Correlated Color Temp.	3100K 4100K		3100K 4100K		3100K 4100K		3100K 4100K	
Color Rendering Index	75 75		75 75		75 75		75 75	
Initial Lumens	1350 1350		2150 2150		2900 2900		3650 3650	
Mean Lumens (8000 Hrs) ²	1215 1215		1935 1935		2600 2600		3285 3285	
Mean Lumens (6000 Hrs) ³	1235 1235		1965 1965		2650 2650		3335 3335	

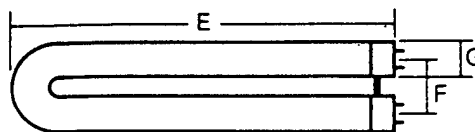
1. For Starting at 50° F and above

2. Mean Lumens at 40% of 20,000 Hr rated Life—Rapid Start Operation

3. Mean Lumens at 40% of 15,000 Hr rated Life—Instant Start Operation—High Frequency

Single lamp requirement

OCTRON CURVALUME PERFORMANCE DATA



(TABLE II)

	FB016		FB024		FB031	
I. Physical Characteristics	Min.	Max.	Min.	Max.	Min.	Max.
Base face to Outside of glass bend (E)	10.25"	10.60"	16.25"	16.60"	22.25"	22.60"
Center to Center of bases (F)	1.50"	1.75"	1.50"	1.75"	1.50"	1.75"
Bulb Diameter (G)	.94"	1.10"	.94"	1.10"	.94"	1.10"
Base Type	medium bipin		medium bipin		medium bipin	
II. Electrical Characteristics						
60 Hz Rapid Start						
Lamp						
Rated Power	16 watts		24 watts		31 watts	
Lumens per Watt	78 LPW		85 LPW		90 LPW	
Lamp Current	265 ma.		265 ma.		265 ma.	
Lamp Voltage	67 v.		100 v.		133 v.	
Lamp Life (3 hrs./start)	20,000 hrs.		20,000 hrs.		20,000 hrs.	
Ballast Requirements (2-lamp)						
Starting Time	.75-2.0 sec.		.75-2.0 sec.		.75-2.0 sec.	
Open Circuit Voltage ¹	210		260		300	
Starting Aid Voltage ¹ (peak)	350		350		290	
Filament Voltage ¹						
Dummy Load (11 ohms)	3.4-4.5 v.		3.4-4.5 v.		3.4-4.5 v.	
Operational	2.5-4.0 v.		2.5-4.0 v.		2.5-4.0 v.	
Lamp Current Crest Factor	1.7 max.		1.7 max.		1.7 max.	
III. Electrical Characteristics						
25 KHz Instant Start						
Lamp						
Rated Power	13 watts		20 watts		27 watts	
Lumens per Watt	97 LPW		102 LPW		104 LPW	
Lamp Current	210 ma.		210 ma.		210 ma.	
Lamp Voltage	61 v.		96 v.		131 v.	
Lamp Life (3 hrs./start)	15,000 hrs.		15,000 hrs.		15,000 hrs.	
Ballast Requirements						
Open Circuit Voltage	425 v. min. ⁴		500 v. min. ⁴		575 v. min. ⁴	
Starting Time	50 ms. max.		50 ms. max.		50 ms. max.	
Current Crest Factor	1.7 max.		1.7 max.		1.7 max.	
IV. Photometric Characteristics						
Ordering Abbreviation	FB016/31K	FB016/41K	FB024/31K	FB024/41K	FB031/31K	FB031/41K
Sylvania Item Number	21801	21802	21803	21804	21805	21806
Correlated Color Temp.	3100K	4100K	3100K	4100K	3100K	4100K
Color Rendering Index	75	75	75	75	75	75
Initial Lumens	1250	1250	2050	2050	2800	2800
Mean Lumens (8000 Hrs) ²	1125	1125	1845	1845	2520	2520
Mean Lumens (6000 Hrs) ³						

1. For Starting at 50° F and above

2. Mean Lumens at 40% of 20,000 Hr rated Life—Rapid Start Operation

3. Mean Lumens at 40% of 15,000 Hr rated Life—Instant Start Operation—High Frequency

4. Single lamp requirement

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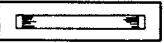
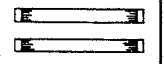
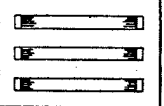
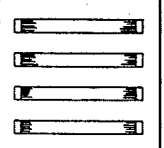
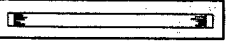
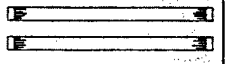
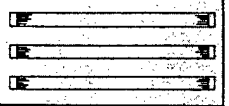
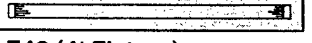
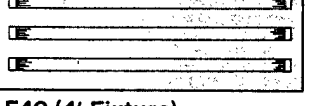
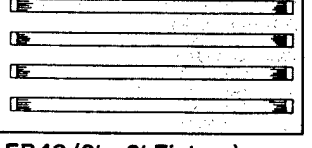
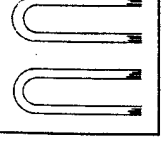
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Danvers, MA 01923 508-777-1900

O-362.0390

SYLVANIA LIGHTING SERVICES FIXTURE CONVERSION DATA

Fixtures that are "Convertible" to the Octron System	Typical Wattages after Conversion to Octron System	Typical Pre- Conversion T12 System Wattages ¹	Estimated Change in Fixture Wattage with Conversion ²	Estimated Change in Light Output with Conversion ³
1-F20 (2' Fixture) 	24 Watts w/Mag Ballast	32 Watts w/Std lamp	Down 25%	Up 7 - 10%
2-F20 (2' Fixture) 	43 Watts w/Mag Ballast	50 Watts w/Std lamps	Down 14%	Up 7 - 10%
3-F20 (2' Fixture) 	51 Watts w/Elec Ballasts (67 Watts w/Mag Ballast)	82 Watts w/Std lamps	Down 38%	Up 7 - 10%
4-F20 (2' Fixture) 	57 Watts w/Elec Ballast (86 Watts w/Mag Ballasts)	100 Watts w/Std lamps	Down 43%	Up 7 - 10%
1-F30 (3' Fixture) 	29 Watts w/Mag Ballast	43 Watts w/Std lamp 36 Watts w/SS lamp	Down 33% Down 20%	No Change Up 7 - 10%
2-F30 (3' Fixture) 	48 Watts w/Elec Ballast (55 Watts w/Mag Ballast)	75 Watts w/Std lamps 61 Watts w/SS lamps	Down 36% Down 21%	No Change Up 7 - 10%
3-F30 (3' Fixture) 	64 Watts w/Elec Ballast (84 Watts w/Mag Ballasts)	118 Watts w/Std lamps 97 Watts w/SS lamps	Down 46% Down 34%	No Change Up 7 - 10%
4-F30 (3' Fixture) 	84 Watts w/Elec Ballast (110 Watts w/Mag Ballasts)	150 Watts w/Std lamps 122 Watts w/SS lamps	Down 44% Down 31%	No Change Up 7 - 10%
1-F40 (4' Fixture) 	35 Watts w/Mag Ballast	55 Watts w/Std lamp 48 Watts w/SS lamp	Down 36% Down 27%	No Change Up 10 - 14%
2-F40 (4' Fixture) 	62 Watts w/Elec Ballast (67 Watts w/Mag Ballast)	92 Watts w/Std lamps 78 Watts w/SS lamps	Down 33% Down 21%	No Change Up 10 - 14%
3-F40 (4' Fixture) 	84 Watts w/Elec Ballast (102 Watts w/Mag Ballasts)	147 Watts w/Std lamps 126 Watts w/SS lamps	Down 43% Down 33%	No Change Up 10 - 14%
4-F40 (4' Fixture) 	106 Watts w/Elec Ballast (133 Watts w/Mag Ballasts)	174 Watts w/Std lamps 156 Watts w/SS lamps	Down 39% Down 32%	No Change Up 10 - 14%
2-FB40 (2' x 2' Fixture) 	60 Watts w/Elec Ballast (65 Watts w/Mag Ballast)	92 Watts w/Std lamps 78 Watts w/SS lamps	Down 35% Down 23%	No Change Up 10 - 14%

NOTES:

1. Estimate is based on fixtures with Standard Magnetic Ballasts
2. Compared to lowest wattage Octron system
3. Assumes same age of both old & new systems (4100K vs. CW). Does not consider immediate light level improvement provided by relamping.

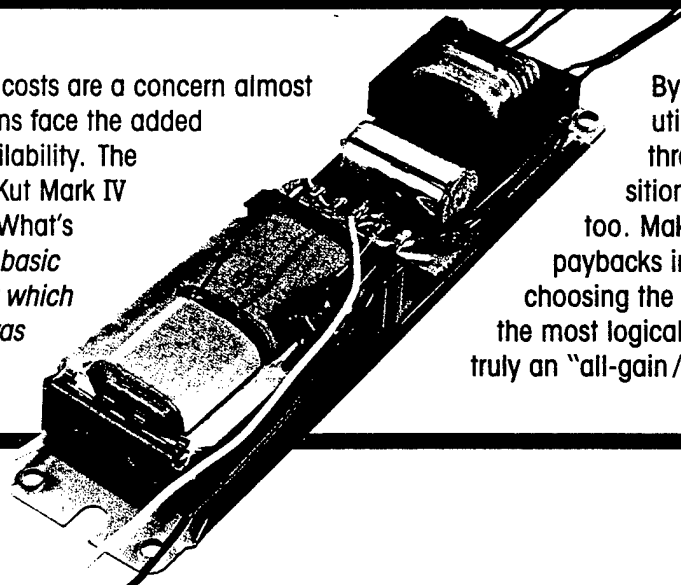
SYLVANIA

Lighting
Services

GTE

A Solid Choice for Many Applications

Rapidly rising electrical power costs are a concern almost everywhere. And some locations face the added problem of limited power availability. The energy-saving ADVANCE PowrKut Mark IV ballast is an answer for both. What's more, it lets you *maintain the basic lighting performance levels for which your present lighting system was originally designed.*



By taking advantage of the extensive utility rebate programs available throughout many areas, your acquisition cost may be greatly reduced, too. Making for one of the fastest overall paybacks in ballasting today. Indeed, choosing the new PowrKut Mark IV may be the most logical move you've ever made—it's truly an "all-gain / no-pain" proposition.

ADVANCE® PowrKut Mark IV™ Ballast for Two 4-ft. F-40 Rapid Start Lamps—60 Hz

Lamp Data		Min. Starting Temp. (°F)	Ballast Input Watts	Line Current (Amps)	Circuit (Volts)	Catalog Number (Class P)	Ballast Efficacy Factor	Sound Rating	Dimensions (Inches)				No. of Units Per Std. Ctn.	Wt. Std. Ctn. (Lbs.)
Description	Nom. Watts								Length	Width	Height	Mounting		
(2) F40 (2) F40/U Energy Savers	34	60°	66	.57 .26	120 277	RK-2S40-TP® VK-2S40-TP®	1.33	A	9 1/2	2 3/8	1 1/2	8 29/32	10	38.
(2) F40T12, (2) F40T10, (2) FB40T12	40	50°	80	.69 .31	120 277	RK-2S40-TP® VK-2S40-TP®	1.16							

ETL verification of performance to specifications in ETL Procedure B30.0
Test methods per ANSI Standard C82.2.

ADVANCE® POWRKUT MARK IV™ "THE SAVINGS WITHOUT THE SACRIFICE"

ADVANCE POWRKUT MARK IV

	Ballast Factor	Watts Input
Standard Lamps	.95	80
Energy Savings Lamps	.88	66

ADVANCE POWRKUT™

	Ballast Factor	Watts Input
Standard Lamps	.85	71
Energy Savings Lamps	.81	58

ADVANCE MARK III

	Ballast Factor	Watts Input
Standard Lamps	.95	86
Energy Savings Lamps	.88	72

ADVANCE RQM/VQM

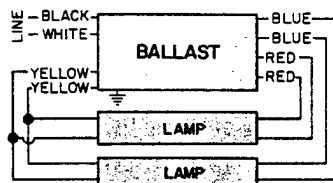
	Ballast Factor	Watts Input
Standard Lamps	.95	96
Energy Savings Lamps	.88	82

Specifications—ADVANCE PowrKut Mark IV Hybrid Electromagnetic Ballast

The ballast shall be ADVANCE PowrKut Mark IV hybrid electromagnetic design incorporating special circuitry to cut off cathode voltage to lamp filaments after the lamps are lit. It shall have an average input of 80 watts when operating 2, F40T12 (40W) rapid start lamps with ballast factor of .95 and average input of 66 watts when operating 2, F40T12 (34W) energy saving rapid start lamps with ballast factor of .88. Performance verified by ETL Laboratories to specifications in ETL Procedural Guide B30.0, using Test Methods of ANSI C82.2.

When operating 2, F40T12 (40W) rapid start lamps, Ballast Efficacy Factor (B.E.F.) shall meet or exceed 1.16; lamp current crest factor shall not exceed 1.6. Ballast shall have a 3-year warranty; design shall provide full rated 20,000 hour lamp life.

Wiring Diagram



ADVANCE TRANSFORMER CO.

O'HARE INTERNATIONAL CENTER
10275 WEST HIGGINS ROAD
ROSEMONT, ILLINOIS 60018
TELEPHONE: 708/390-5000
FAX: 708/390-5109 TELEX: 25-4305

A DIVISION OF NORTH AMERICAN PHILIPS CORPORATION

Specifications and data in this bulletin subject to change without notice.

EBT LOW HARMONIC BALLAST GUIDE

RAPID START BALLAST (SERIES CONNECTION)

LAMPS	LAMP TYPE	LAMP LENGTH	LAMP WATTS	INPUT VOLTAGE	LINE AMPS	INPUT WATTS	ORDERING CODE
1 ***	F40T12/RS	4'	34	120	0.27	31	SSB1-120-1/40 LH
			40		0.33	38	
			34	277	0.12	31	SSB1-277-1/40 LH
			40		0.14	38	
2 ***	F40T12/RS	4'	34	120	0.50	59	SSB1-120-2/40 LH
			40		0.60	71	
			34	277	0.22	59	SSB1-277-2/40 LH
			40		0.26	71	
3 ***	F40T12/RS	4'	34	120	0.77	90	SSB1-120-3/40 LH
			40		0.89	105	
			34	277	0.33	90	SSB1-277-3/40 LH
			40		0.39	105	
2 ****	F96T12/HO	8'	95	120	1.36	160	SSB1-120-2/96 HO LH
			110		1.62	190	
			95	277	0.59	160	SSB1-277-2/96 HO LH
			110		0.70	190	

INSTANT START BALLAST (PARALLEL CONNECTION)

1	FO32T8	4'	32	120	0.26	30	SSB2-120-1/32 IS LH
			32	277	0.11	30	SSB2-277-1/32 IS LH
2 *	FO32T8	4'	32	120	0.49	58	SSB2-120-2/32 IS LH
	FO40T8	5'	40		0.59	70	
	FO32T8	4'	32	277	0.21	58	SSB2-277-2/32 IS LH
	FO40T8	5'	40		0.26	70	
3 **	FO32T8	4'	32	120	0.75	88	SSB2-120-3/32 IS LH
	FO32T8	4'	32	277	0.32	88	SSB2-277-3/32 IS LH
4	FO32T8	4'	32	120	0.90	106	SSB2-120-4/32 IS LH
	FO32T8	4'	32	277	0.39	106	SSB2-277-4/32 IS LH
2 *****	F96T12/IS	8'	60	120	0.89	105	SSB2-120-2/96 IS LH
			75		1.11	130	
			60	277	0.39	105	SSB2-277-2/96 IS LH
			75		0.48	130	
2	40W (TWIN TUBE)	22.5"	40	120	0.55	65	SSB2-120-2/40 IS LH TT
		22.5"	40	277	0.24	65	SSB2-277-2/40 IS LH TT
3	40W (TWIN TUBE)	22.5"	40	120	0.86	101	SSB2-120-3/40 IS LH TT
		22.5"	40	277	0.37	101	SSB2-277-3/40 IS LH TT

- * ALSO COMPATIBLE WITH FO25T8 LAMPS
- ** ALSO COMPATIBLE WITH FO40T8 LAMPS
- *** ALSO COMPATIBLE WITH F30T12, OR F25T12 LAMPS
- **** ALSO COMPATIBLE WITH F72T12/HO OR F84T12/HO LAMPS
- ***** ALSO COMPATIBLE WITH F60T12, F70T12 OR F84T12 LAMPS



EBT SPECIAL PRODUCT GUIDE

LAMPS	LAMP TYPE	LAMP LENGTH	LAMP WATTS	INPUT VOLTAGE	LINE AMPS	INPUT WATTS	ORDERING CODE
2 *	F40T12/RS	4'	34	120	0.53	59	SSB1-120-2/40 MINI
			40		0.64	71	
			34	277	0.23	59	SSB1-277-2/40 MINI
			40		0.28	71	
2 **	F032T8/RS	4'	32	120	0.58	64	SSB1-120-2/32 MINI
			32	277	0.25	64	SSB1-277-2/32 MINI
2 **	F032T8/RS	4'	32	120	0.53	62	SSB1-120-2/32 LH
			32	277	0.23	62	SSB1-277-2/32 LH
3	F032T8/RS	4'	32	120	0.80	94	SSB1-120-3/32 LH
			32	277	0.35	94	SSB1-277-3/32 LH
2	F017T8/RS	2'	17	120	0.29	34	SSB2-120-2/17 IS
			17	277	0.12	34	SSB2-277-2/17 IS
2 *	F40T12/RS	4'	34	120	0.60	71	SSB1-120-2/40MPX LH
			40		0.73	86	
			34	277	0.26	71	SSB1-277-2/40MPX LH
			40		0.32	86	
2 *	F40T12/RS	4'	34	120	0.56	66	SSB1-120-2/40 LH 100%
			40		0.68	80	
			34	277	0.24	66	SSB1-277-2/40 LH 100%
			40		0.29	80	

* ALSO COMPATIBLE WITH F40T12/32W, F30T12, F25T12, 3" AND 6" "U" TUBE LAMPS

** ALSO COMPATIBLE WITH F025T8, F032T8 LAMPS

The ballast total harmonic distortion level may not be less than 20% when used with the above compatible lamps.



SUBJECT EC010
ENERGY EFFICIENT MOTORS
DESIGNER C. WARREN
CHECKER Z. H. Hines

AEP NO 290-0379-002
SHEET 1 OF 1
DATE 7/9/91
DATE

BUDG 35

Replace motors in small parts plating line and medium tube plating line w/ energy-efficient ones.

ASSUMPTIONS:

- ① Consider motors for fans, pumps, blowers > 3 HP
- ② Motors run 24 HR/DA, 7 DA/WK, 52 WK/YR, MED TUBE PLATING
 $\Rightarrow 8760$ HRS/YR

RUN 24 HR/DA, 5 DA, WK, 52 WK/YR, SMALL PARTS PLATING
 $\Rightarrow 6240$ HRS/YR

- ③ Labor charges are doubled to account for old motor removal time

CALCULATIONS

Preliminary screening calculation using spreadsheet on following page (10-2). Material costs from Reliance 1991 catalog - labor from 1991 Means

$\Rightarrow$ Consider motors ≤ 100 HP ONLY

ECO #10 - WATERVLIET ARSENAL
 INSTALL ENERGY EFFICIENT MOTORS
 FILENAME: REPEEM

DATE: 29 AUG 91 OPERATING HOURS = 6000

MOTOR SIZE (HP)	LIST PRICE	CONTRACTOR	LABOR	MAT'L & LABOR	EFFICIENCIES		ENERGY SAVINGS (KWH/YR)	COST SAVINGS (\$/YR)	SIMPLE PAYBACK (YRS)
	RELIANCE ENERGY-EFF. ENCLOSED (1991\$)	RELIANCE ENERGY-EFF. ENCLOSED (1991\$)	REMOVE OR INSTALL MOTOR (1991\$)	PRICE W/ MARKUPS (1991\$)	RELIANCE STD MOTOR NOM. EFF. (%)	RELIANCE ENERGY-EFF. ENCLOSED (%)			
3	395	296	45	609	77.0%	87.5%	2093	142	4.3
5	478	359	45	703	81.3%	88.5%	2256	153	4.6
8	636	477	48	892	82.0%	89.8%	3556	241	3.7
10	795	596	50	1079	84.0%	90.2%	3663	248	4.3
15	1042	782	63	1406	84.8%	90.9%	5360	363	3.9
20	1345	1009	77	1799	85.8%	91.7%	6774	459	3.9
25	1608	1206	80	2107	86.3%	92.3%	8504	576	3.7
30	1905	1429	84	2457	88.0%	92.7%	7737	524	4.7
40	2563	1922	100	3259	88.0%	93.3%	11557	783	4.2
50	3207	2405	125	4077	89.3%	93.3%	10745	728	5.6
60	4487	3365	145	5596	89.3%	93.1%	12444	843	6.6
75	5820	4365	170	7193	90.3%	94.0%	14839	1005	7.2
100	7140	5355	225	8884	90.6%	94.5%	20389	1382	6.4
125	9275	6956	285	11514	92.3%	94.9%	16608	1125	10.2
150	10942	8207	335	13579	91.7%	95.1%	26176	1774	7.7
200	12961	9721	400	16096	93.0%	95.1%	21256	1440	11.2
250	16652	12489	450	20448	93.6%	95.4%	22557	1528	13.4
300	17748	13311	500	21868	94.1%	95.6%	22390	1517	14.4

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT
 MOTORS ARE TOTALLY ENCLOSED, T-FRAME, 1800 RPM, 460 VOLT, 3 PHASE
 $SAVINGS = HP * 0.746 * [(1/ST\ EFF) - (1/EN\ EFF)] * HRS/YR * ELECCOST$
 OPERATING TIMES: 24 HR/DA
 5 DA/ 6000 HRS/YR
 ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES \$0.0678 /KWH



SUBJECT ECO 10
Energy Efficient Motors
DESIGNER J. Warren
CHECKER _____

AEP NO 090-0379-002
SHEET _____ OF _____
DATE 1/92
DATE _____

• Motor list taken from WVA Property Records

WV 12110 - Small pipe plating

WV 12050 - Medium tube plating

$$= \text{KW (SAVINGS)} = \text{HP} * 0.746 * (1/\text{STD EFFICIENCY} - 1/\text{ENERGY EFFICIENCY})$$

$$\bullet \text{ AUG ELECT COST} = \$20.35 / \text{MWh}$$

WATERVLIET ARSENAL
ECO#10 - INSTALL ENERGY EFFICIENT MOTORS

WV 12110 SMALL PARTS PLATING

NO.	HP	PRESENT METHOD				FUTURE METHOD				SAVINGS	
		ENERGY USE			ENERGY USE						
		HP	(KW)	(MBTU/YR)	(\$/YR)	(KW)	(MBTU/YR)	(\$/YR)	(MBTU/YR)	(\$/YR)	
3	3	9	8.7	186	\$3,779	7.7	163	\$3,326	22	\$453	
3	5	15	13.8	293	\$5,969	12.6	269	\$5,480	24	\$489	
3	7.5	22.5	20.5	436	\$8,871	18.7	398	\$8,101	38	\$771	
11	10	110	97.7	2,081	\$42,339	91.0	1,938	\$39,429	143	\$2,910	
1	15	15	13.2	281	\$5,722	12.3	262	\$5,335	19	\$387	
1	20	20	17.4	371	\$7,541	16.3	347	\$7,052	24	\$489	
4	25	100	86.5	1,842	\$37,486	80.8	1,721	\$35,029	121	\$2,457	
2	30	60	50.9	1,083	\$22,044	48.3	1,028	\$20,926	55	\$1,118	
5	40	200	169.5	3,611	\$73,480	159.9	3,406	\$69,306	205	\$4,174	
2	60	120	100.3	2,136	\$43,471	96.2	2,048	\$41,673	88	\$1,798	
35		672	578.5	12,320	\$250,702	543.7	11,580	\$235,656	739	\$15,046	

WV 12050 MEDIUM TUBE PLATING

			PRESENT METHOD			FUTURE METHOD				
TOTAL			ENERGY USE			ENERGY USE			SAVINGS	
NO.	HP	HP	(KW)	(MBTU/YR)	(\$/YR)	(KW)	(MBTU/YR)	(\$/YR)	(MBTU/YR)	(\$/YR)
4	3	12	8.7	261	\$5,305	7.7	229	\$4,669	31	\$637
6	5	30	27.5	824	\$16,759	25.3	756	\$15,386	67	\$1,373
4	7.5	30	27.3	816	\$16,605	24.9	745	\$15,163	71	\$1,442
2	15	30	26.4	790	\$16,067	24.6	736	\$14,980	53	\$1,087
12	20	240	208.8	5,242	\$127,034	195.2	5,837	\$118,792	405	\$8,243
3	40	120	101.7	3,041	\$61,893	95.9	2,869	\$58,377	173	\$3,516
1	60	60	50.2	1,499	\$30,513	48.1	1,437	\$29,251	62	\$1,262
32		522	450.6	13,473	\$274,176	421.8	12,610	\$256,617	863	\$17,559

TOTALS

67	1193.5	1,029	25,793	\$524,879	966	24,190	\$492,273	1,602	\$32,605

ELECTRICITY PRICE = \$20.35 /MBTU
OPERATING HOURS PER YEAR MEDIUM TUBE PLATING = 8760
SMALL PARTS PLATING = 6240

02/05/92

ECO Construction Cost Estimate Calculations

ECO Name: ENERGY EFFICIENT MOTORS

ECO #: 10

1991 ECO "bare" costs (from cost estimate sheet)

Material	\$63,817
Labor	\$9,038

Subtotal bare costs	\$72,855

FICA Insurance (20% of Labor)	\$1,808

Sales Tax (not applicable for GOGO)	\$0

Subtotal	\$74,663

Overhead (15%)	\$11,199

Subtotal	\$85,862

Profit (10%)	\$8,586

Subtotal	\$94,448

Bond (1%)	\$944

Subtotal	\$95,392

Contingency (10%)	\$9,539

Subtotal (Construction Cost Input For LCCID *)	\$104,931

SIDH (6% of Construction Cost)	\$6,296

Subtotal	\$111,227

Design (6% of Construction Cost)	\$6,296

Total Project Cost	\$117,523

* The SIDH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

CONSTRUCTION COST ESTIMATE

DATE PREPARED

9-6-91

SHEET 1 OF

PROJECT

ENERGY ENGINEERING ANALYSIS

LOCATION

WVA

ARCHITECT ENGINEER

REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE

- ☐ CODE A (No design completed)
☒ CODE B (Preliminary design)
☐ CODE C (Final design)
☐ OTHER (Specify) _____

DRAWING NO.

ESTIMATOR

C. WARREN

CHECKED BY

P. Hutchins

Motors WV12110 SUMMARY
 SMALL PARTS PLATING

QUANTITY		LABOR		MATERIAL		TOTAL COST
NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
3		90	270	296	889	1159
3		90	270	359	1076	1346
3		96	288	477	1431	1719
11		100	1100	596	6559	7659
1		126	126	782	782	908
1		154	154	1009	1009	1163
4		160	640	1206	4824	5464
2		168	336	1429	2858	3194
5		200	1000	1922	9611	10611
2		290	580	3365	6731	7311
35			4764		35768	210532

WV 12050

MED. TUBE PLATING

3	4		90	360	296	1184	1544
5	6		90	540	359	2154	2694
7.5	4		96	384	477	1908	2292
15	2		126	252	782	1564	1816
20	12		154	1848	1009	12108	13956
40	3		200	600	1922	5766	6366
60	1		290	290	3365	3365	3655
	32			4274		28049	32323

TOTALS —

67			9,038		63,817	72,855



SUBJECT WVA - Bldgs. 40, 44 & 125
Replace Electric Boilers
DESIGNER W.T. Todd
CHECKER _____

AEP NO 290-0379-002
SHEET 1 OF 6
DATE 1-31-92
DATE _____

ECO #12

Replace Electric Boilers with Natural Gas Boilers

The electric boilers located in Buildings 40, 44, 125N and 125S are used for humidification purposes. The boiler sizes are 90 kw, 210 kw, 58 kw and 58 kw, respectively.

By replacing these boilers with boilers that utilize natural gas the cost for energy to humidify this building will be reduced by over \$15 per MBtu.

The annual hours that humidification is required was calculated by a spreadsheet computer program. the results are shown on page 3. Assuming an operating diversity of 0.30, the boilers will operate:

$$5862 \text{ hrs/yr} \times 0.30 = 1759 \text{ hrs/year}$$

Current energy use (Electricity):

$$416 \text{ kw} \times 1759 \frac{\text{Hrs}}{\text{yr}} = 731,744 \text{ kWh/year}$$

$$731,744 \text{ kWh/yr} \times 3413 \frac{\text{Btu}}{\text{kWh}} \times \frac{1 \text{ MBtu}}{10^6 \text{ Btu}} = \underline{2497.4 \text{ MBtu/yr}}$$

Future energy use (Natural Gas):

$$2497.4 \text{ MBtu/yr} \div 0.80 \text{ (eff.)} = \underline{3121.8 \text{ MBtu/yr}}$$



SUBJECT WVA - Eldgs. 40, 44 & 125
Replace Electric Boilers
DESIGNER W.T. Todd
CHECKER _____

AEP NO 290-0379-002
SHEET 2 OF _____
DATE 1-31-92
DATE _____

The Future energy use calculation assumes the same output will be required and the efficiency of the N.G. boiler is 80%.

Energy Savings = Current energy use - Future energy use

$$\text{Electricity Savings} = 2497.4 \frac{\text{MBtu}}{\text{yr}} - 0 = \underline{2497.4 \frac{\text{MBtu}}{\text{yr}}}$$

$$\text{Natural Gas Savings} = 0 - 3121.8 \frac{\text{MBtu}}{\text{yr}} = \underline{(3121.8) \frac{\text{MBtu}}{\text{yr}}}$$

Total Savings:

$$\text{Energy: } 2497.4 \frac{\text{MBtu}}{\text{yr}} - 3121.8 \frac{\text{MBtu}}{\text{yr}} = \underline{(624.4) \frac{\text{MBtu}}{\text{yr}}}$$

Project Implementation Cost:

$$\text{Total Project Cost} = \underline{\$49,944}$$

See Cost Estimate Sheets for details

SUBJECT ECO #12

AEP NO _____

DESIGNER _____

SHEET _____ OF _____

CHECKER _____

DATE _____

DATE _____

QRIP Calculations

Present Method

$$\text{Elec} = 2497.4 \frac{\text{MBtu}}{\text{yr}} + \frac{\$20.35}{\text{MBtu}} = \$50,800$$

Proposed Method

$$\text{N. Gas} = 3121.8 \frac{\text{MBtu}}{\text{yr}} + \frac{\$4.16}{\text{MBtu}} = \$13,000$$

$$\text{Savings} = \underline{\underline{\$37,800}}$$

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY

01/31/92

INPUTS: 1) Days Per Week That HVAC Operates 7 Days/Week
 2) Summer Room Dry Bulb Temperature 75 °F (db)
 Room Wet Bulb Temperature 63 °F (wb)
 3) Winter Room Dry Bulb Temperature 68 °F (db)
 If RH Controlled, wb Temp. 57 °F (wb)
 and Ground Water Temperature 50 °F
 4) Outside Air Quantity (cfm) 1 cfm
 5) HVAC Oper. Hrs/Shift: 12 M -> 8 AM 8 Hrs/Shift
 8 AM -> 4 PM 8 Hrs/Shift
 4 PM -> 12 M 8 Hrs/Shift

Temperatures		Hours of Occurrence			Total Oper. Hours	Outside Air Load (MBtu/Yr)			
db-Range	wb	00-08	08-16	16-24		Cooling	Dehumid	Heating	Humid.
120	124				0	0.0000	0.0000	0.0000	0.0000
115	119				0	0.0000	0.0000	0.0000	0.0000
110	114				0	0.0000	0.0000	0.0000	0.0000
105	109				0	0.0000	0.0000	0.0000	0.0000
100	104				0	0.0000	0.0000	0.0000	0.0000
95	99	75	0	7	0	0.0002	0.0001	0.0000	0.0000
90	94	72	0	28	6	0.0006	0.0004	0.0000	0.0000
85	89	71	0	95	28	0.0016	0.0018	0.0000	0.0000
80	84	68	4	177	73	0.0020	0.0024	0.0000	0.0000
75	79	66	27	248	140	0.0009	0.0032	0.0000	0.0000
70	74	64	115	257	222	0.0000	0.0039	0.0000	0.0000
65	69	61	234	235	271	0.0000	0.0019	0.0000	0.0000
60	64	57	263	212	252	0.0000	0.0000	0.0048	0.0000
55	59	52	274	190	236	0.0000	0.0000	0.0085	0.0009
50	54	48	263	183	214	0.0000	0.0000	0.0116	0.0036
45	49	43	242	183	205	0.0000	0.0000	0.0146	0.0069
40	44	38	229	202	205	0.0000	0.0000	0.0182	0.0099
35	39	34	261	241	251	0.0000	0.0000	0.0257	0.0133
30	34	30	295	220	262	0.0000	0.0000	0.0308	0.0152
25	29	25	216	156	191	0.0000	0.0000	0.0254	0.0128
20	24	20	163	112	130	0.0000	0.0000	0.0205	0.0103
15	19	16	110	79	96	0.0000	0.0000	0.0160	0.0074
10	14	11	84	43	65	0.0000	0.0000	0.0118	0.0053
5	9	6	60	27	38	0.0000	0.0000	0.0084	0.0036
0	4	2	37	16	22	0.0000	0.0000	0.0054	0.0022
-5	-1	-3	27	3	9	0.0000	0.0000	0.0030	0.0012
-10	-6	-8	10	0	4	0.0000	0.0000	0.0012	0.0004
-15	-11	-13	5	0	0	0.0000	0.0000	0.0004	0.0002
-20	-16	-17	3	0	0	0.0000	0.0000	0.0003	0.0001
-25	-21				0	0.0000	0.0000	0.0000	0.0000
-30	-26				0	0.0000	0.0000	0.0000	0.0000
-35	-31				0	0.0000	0.0000	0.0000	0.0000
-40	-36				0	0.0000	0.0000	0.0000	0.0000
-45	-41				0	0.0000	0.0000	0.0000	0.0000
Totals		2922	2914	2920	8756	0.0053	0.0138	0.2066	0.0935
Total operating hours for each system						833	2167	6589	5862

02/05/92

ECO Construction Cost Estimate
Calculations

ECO Name: Replace Electric Boilers with Natural Gas Boilers

ECO #:

1991 ECO "bare" costs (from cost estimate sheet)		
Material		\$18,876
Labor		\$10,711
	Subtotal bare costs	\$29,587
FICA Insurance (20% of Labor)		\$2,142
Sales Tax (Not Applicable For GOGO)		\$0
	Subtotal	\$31,729
Overhead (15%)		\$4,759
	Subtotal	\$36,488
Profit (10%)		\$3,649
	Subtotal	\$40,137
Bond (1%)		\$401
	Subtotal	\$40,538
Contingency (10%)		\$4,054
		+-----+
Subtotal (Construction Cost Input For LCCID *)		\$44,592
		+-----+
SIOH (6.0% of Construction Cost)		\$2,676
	Subtotal	\$47,268
Design (6.0% of Construction Cost)		\$2,676
		+-----+
Total Project Cost		\$49,944

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.



SUBJECT WVA - Building 120
Reduce Air Flow - AHU 1
DESIGNER W. T. Todd
CHECKER _____

AEP NO 290-0379-002
SHEET 1 OF 8
DATE 12-24-91
DATE _____

ECO #13

Reduce Air Flow from AHU 1

The design air flow based on the "As Built" drawings is 6250 cfm, with a minimum of 930 cfm of outdoor air.

Measurements were taken on the supply air ducts. The calculations to determine the air flow were done on a spreadsheet and the results are displayed on page 13-4. The results indicate the total supply air flow for AHU 1 to be approximately 8230 cfm, an increase of 1980 cfm over the design value.

It is assumed that the minimum outdoor air flow is now higher than the design amount by the same percentage:

$$\frac{\text{Min. O.A.}}{8250 \text{ cfm}} = \frac{930 \text{ cfm}}{6250 \text{ cfm}} = 0.149$$

$$\text{Min. O.A.} = 1225 \text{ cfm}$$

The excess O.A. must be heated in the winter and cooled in the summer. The energy required to do this was calculated using a spreadsheet computer program with bin temperatures and the following equation:

$$Q_s (\text{MBtu/yr}) = \frac{\text{Hrs}}{\text{yr}} * 1.10 * \text{O.A. CFM} * \Delta T$$

$$Q_L (\text{MBtu/yr}) = \frac{\text{Hrs}}{\text{yr}} * 0.69 * \text{O.A. CFM} * \Delta W$$

113-11



SUBJECT WVA-Bldg. 120
Reduce Air Flow
DESIGNER W.T. Todd
CHECKER _____

AEP NO 290-0379-002
SHEET 2 OF _____
DATE _____
DATE _____

The results are shown on pages 13-5 and 13-6.

Current energy use (using COP = 3.23, Boiler eff = 0.80):

$$\text{Cooling} : 11.83 \frac{\text{MBtu}}{\text{yr}} \times 0.31 = \underline{3.7 \frac{\text{MBtu}}{\text{yr}}}, \text{Electricity}$$

$$\text{Heating} : 82.49 \frac{\text{MBtu}}{\text{yr}} \div 0.80 = \underline{103.1 \frac{\text{MBtu}}{\text{yr}}}, \text{Fuel Oil \#6}$$

$$\text{Fan} : 7.0 \text{ A} \times 480 \text{ V} \times 1.47 \times \frac{1 \text{ kW}}{1000 \text{ V}\cdot\text{A}} = 4.9 \text{ kW}$$

$$4.9 \text{ kW} \times 3125 \frac{\text{hr}}{\text{yr}} \times \frac{0.003413 \text{ MBtu}}{\text{KWH}} = \underline{52.3 \frac{\text{MBtu}}{\text{yr}}}, \text{Electricity}$$

Future energy use:

$$\text{Cooling} : 8.98 \frac{\text{MBtu}}{\text{yr}} \times 0.31 = \underline{2.8 \frac{\text{MBtu}}{\text{yr}}}, \text{Electricity}$$

$$\text{Heating} : 62.62 \frac{\text{MBtu}}{\text{yr}} \div 0.80 = \underline{78.3 \frac{\text{MBtu}}{\text{yr}}}, \text{Fuel Oil \#6}$$

$$\text{Fan} : \frac{\text{cfm}_1}{\text{cfm}_2} = \frac{\text{rpm}_1}{\text{rpm}_2} \Rightarrow \frac{6250}{8320} = \frac{\text{rpm}_1}{997} \Rightarrow \text{rpm}_1 = 749$$

$$\frac{P_1}{P_2} = \left(\frac{\text{rpm}_1}{\text{rpm}_2} \right)^3 \Rightarrow \frac{P_1}{7 \text{ A}} = \left(\frac{749}{997} \right)^3 \Rightarrow P_1 = 3.0 \text{ A}$$

$$3.0 \text{ A} \times 480 \text{ V} \times 1.47 \times \frac{1 \text{ kW}}{1000 \text{ V}\cdot\text{A}} = 2.1 \text{ kW}$$

$$2.1 \text{ kW} \times 3125 \frac{\text{hr}}{\text{yr}} \times \frac{0.003413 \text{ MBtu}}{\text{KWH}} = \underline{22.4 \frac{\text{MBtu}}{\text{yr}}}, \text{Electricity}$$

Energy Savings = Current energy use - Future energy use



SUBJECT ECO # 13

DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

QRIP Calculations

Present Method Cost

$$\text{Elec.} = (3.7 + 52.3) \text{ MBtu/yr} \times \frac{\$20.35}{\text{MBtu}} = \$1140$$

$$\#6 \text{ F.O.} = 103.1 \text{ MBtu/yr} \times \frac{\$4.40}{\text{MBtu}} = 454$$

$$\text{TOTAL} \quad \quad \quad \$ \underline{\underline{1600}}$$

Proposed Method Cost

$$\text{Elec} = (2.8 + 22.4) \times 20.35 = \$513$$

$$\#6 \text{ F.O.} = 783 \times 4.4 = \underline{345}$$

$$\text{TOTAL} \quad \quad \quad \$ \underline{\underline{860}}$$

$$\text{Savings} = 1600 - 860 = \$ \underline{\underline{740}} / \text{yr}$$



SUBJECT WVA - Bldg. 120
Reduce Air Flow
DESIGNER W. T. Todd
CHECKER _____

AEP NO 290-0379-002
SHEET 3 OF _____
DATE _____
DATE _____

Electricity Savings:

$$\text{Cooling} : 3.7 \text{ MBtu/yr} - 2.8 \text{ MBtu/yr} = 0.9 \text{ MBtu/yr}$$

$$\text{Fan} : 52.3 \text{ MBtu/yr} - 22.4 \text{ MBtu/yr} = 29.9 \text{ MBtu/yr}$$

$$\text{Total} : 0.9 \text{ MBtu/yr} + 29.9 \text{ MBtu/yr} = \underline{30.8 \text{ MBtu/yr}}$$

Fuel Oil #6 Savings

$$\text{Heating} : 103.1 \text{ MBtu/yr} - 78.3 \text{ MBtu/yr} = \underline{24.8 \text{ MBtu/yr}}$$

Total Savings:

$$\text{Energy} : 30.8 \text{ MBtu/yr} + 24.8 \text{ MBtu/yr} = \underline{55.6 \text{ MBtu/yr}}$$

Project Implementation Cost:

$$\text{Total Project Cost} = \underline{\$1,024}$$

See cost estimate sheets for details

Watervliet Arsenal - Energy Study
Filename: B120AHU1.WQ1

12/24/91

Building 120
AHU 1 Analysis

Zone	Measured P(v)	Velocity FPM	Duct Size in x in	Area SqFt	Measured CFM	Design CFM	CFM Diff.
1	0.1007	1271	14 14	1.36	1730	1240	490
2	0.0467	865	14 16	1.56	1346	1200	146
3	0.1039	1291	10 18	1.25	1614	1000	614
4	0.0162	510	10 14	0.97	496	600	-104
5	0.0294	687	10 14	0.97	668	700	-32
6	0.1167	1368	8 10	0.56	760	450	310
7	0.1542	1573	8 10	0.56	874	360	514
8	0.0343	742	12 12	1.00	742	700	42
Totals					8230	6250	1980

PROJECT: WATERVLIT ARSENAL LIMITED ENERGY STUDY

01/31/92

INPUTS: 1) Days Per Week That HVAC Operates 5 Days/Week
 2) Summer Room Dry Bulb Temperature 75 °F (db)
 Room Wet Bulb Temperature 63 °F (wb)
 3) Winter Room Dry Bulb Temperature 68 °F (db)
 If RH Controlled, wb Temp °F (wb)
 and Ground Water Temperature °F
 4) Outside Air Quantity (cfm) 1225 cfm
 5) HVAC Oper. Hrs/Shift: 12 M → 8 AM 2 Hrs/Shift
 8 AM → 4 PM 8 Hrs/Shift
 4 PM → 12 M 2 Hrs/Shift

Temperatures			Hours of Occurrence			Total Oper. Hours	Outside Air Load (MBtu/Yr)			
db-Range	wb		00-08	08-16	16-24		Cooling	Dehumid	Heating	Humid.
120	124					0	0.0000	0.0000	0.0000	0.0000
115	119					0	0.0000	0.0000	0.0000	0.0000
110	114					0	0.0000	0.0000	0.0000	0.0000
105	109					0	0.0000	0.0000	0.0000	0.0000
100	104					0	0.0000	0.0000	0.0000	0.0000
95	99	75	0	7	0	5	0.1482	0.1213	0.0000	0.0000
90	94	72	0	28	6	21	0.4827	0.3402	0.0000	0.0000
85	89	71	0	95	28	73	1.1781	1.3278	0.0000	0.0000
80	84	68	4	177	73	140	1.3222	1.5936	0.0000	0.0000
75	79	66	27	248	140	207	0.5578	1.9769	0.0000	0.0000
70	74	64	115	257	222	244	0.0000	1.9728	0.0000	0.0000
65	69	61	234	235	271	258	0.0000	0.8036	0.0000	0.0000
60	64	57	263	212	252	243	0.0000	0.0000	1.9678	0.0000
55	59	52	274	190	236	227	0.0000	0.0000	3.3615	0.0000
50	54	48	263	183	214	216	0.0000	0.0000	4.6547	0.0000
45	49	43	242	183	205	211	0.0000	0.0000	5.9576	0.0000
40	44	38	229	202	205	222	0.0000	0.0000	7.7703	0.0000
35	39	34	261	241	251	264	0.0000	0.0000	11.0100	0.0000
30	34	30	295	220	262	257	0.0000	0.0000	12.4480	0.0000
25	29	25	216	156	191	184	0.0000	0.0000	10.1715	0.0000
20	24	20	163	112	130	132	0.0000	0.0000	8.2019	0.0000
15	19	16	110	79	96	93	0.0000	0.0000	6.4059	0.0000
10	14	11	84	43	65	57	0.0000	0.0000	4.3255	0.0000
5	9	6	60	27	38	37	0.0000	0.0000	3.0237	0.0000
0	4	2	37	16	22	22	0.0000	0.0000	1.9534	0.0000
-5	-1	-3	27	3	9	9	0.0000	0.0000	0.8201	0.0000
-10	-6	-8	10	0	4	3	0.0000	0.0000	0.2560	0.0000
-15	-11	-13	5	0	0	1	0.0000	0.0000	0.0975	0.0000
-20	-16	-17	3	0	0	1	0.0000	0.0000	0.0621	0.0000
-25	-21					0	0.0000	0.0000	0.0000	0.0000
-30	-26					0	0.0000	0.0000	0.0000	0.0000
-35	-31					0	0.0000	0.0000	0.0000	0.0000
-40	-36					0	0.0000	0.0000	0.0000	0.0000
-45	-41					0	0.0000	0.0000	0.0000	0.0000
Totals			2922	2914	2920	3125	3.6890	8.1363	82.4875	0.0000

Total operating hours for each system 446 948 2177 0

PROJECT: WATERVLIT ARSENAL LIMITED ENERGY STUDY

01/31/92

INPUTS: 1) Days Per Week That HVAC Operates 5 Days/Week
 2) Summer Room Dry Bulb Temperature 75 °F (db)
 Room Wet Bulb Temperature 63 °F (wb)
 3) Winter Room Dry Bulb Temperature 68 °F (db)
 If RH Controlled, wb Temp °F (wb)
 and Ground Water Temperature °F
 4) Outside Air Quantity (cfm) 930 cfm
 5) HVAC Oper. Hrs/Shft: 12 M -> 8 AM 2 Hrs/Shift
 8 AM -> 4 PM 8 Hrs/Shift
 4 PM -> 12 M 2 Hrs/Shift

Temperatures			Hours of Occurrence			Total Oper. Hours	Outside Air Load (MBtu/Yr)			
db-Range	wb		00-08	08-16	16-24		Cooling	Dehumid	Heating	Humid.
120	124					0	0.0000	0.0000	0.0000	0.0000
115	119					0	0.0000	0.0000	0.0000	0.0000
110	114					0	0.0000	0.0000	0.0000	0.0000
105	109					0	0.0000	0.0000	0.0000	0.0000
100	104					0	0.0000	0.0000	0.0000	0.0000
95	99	75	0	7	0	5	0.1125	0.0921	0.0000	0.0000
90	94	72	0	28	6	21	0.3665	0.2583	0.0000	0.0000
85	89	71	0	95	28	73	0.8944	1.0080	0.0000	0.0000
80	84	68	4	177	73	140	1.0038	1.2099	0.0000	0.0000
75	79	66	27	248	140	207	0.4234	1.5008	0.0000	0.0000
70	74	64	115	257	222	244	0.0000	1.4977	0.0000	0.0000
65	69	61	234	235	271	258	0.0000	0.6101	0.0000	0.0000
60	64	57	263	212	252	243	0.0000	0.0000	1.4939	0.0000
55	59	52	274	190	236	227	0.0000	0.0000	2.5520	0.0000
50	54	48	263	183	214	216	0.0000	0.0000	3.5337	0.0000
45	49	43	242	183	205	211	0.0000	0.0000	4.5229	0.0000
40	44	38	229	202	205	222	0.0000	0.0000	5.8991	0.0000
35	39	34	261	241	251	264	0.0000	0.0000	8.3586	0.0000
30	34	30	295	220	262	257	0.0000	0.0000	9.4503	0.0000
25	29	25	216	156	191	184	0.0000	0.0000	7.7220	0.0000
20	24	20	163	112	130	132	0.0000	0.0000	6.2268	0.0000
15	19	16	110	79	96	93	0.0000	0.0000	4.8633	0.0000
10	14	11	84	43	65	57	0.0000	0.0000	3.2838	0.0000
5	9	6	60	27	38	37	0.0000	0.0000	2.2955	0.0000
0	4	2	37	16	22	22	0.0000	0.0000	1.4830	0.0000
-5	-1	-3	27	3	9	9	0.0000	0.0000	0.6226	0.0000
-10	-6	-8	10	0	4	3	0.0000	0.0000	0.1944	0.0000
-15	-11	-13	5	0	0	1	0.0000	0.0000	0.0740	0.0000
-20	-16	-17	3	0	0	1	0.0000	0.0000	0.0471	0.0000
-25	-21					0	0.0000	0.0000	0.0000	0.0000
-30	-26					0	0.0000	0.0000	0.0000	0.0000
-35	-31					0	0.0000	0.0000	0.0000	0.0000
-40	-36					0	0.0000	0.0000	0.0000	0.0000
-45	-41					0	0.0000	0.0000	0.0000	0.0000
Totals			2922	2914	2920	3125	2.8006	6.1769	62.6231	0.0000

Total operating hours for each system 446 948 2177 0

02/05/92

ECO Construction Cost Estimate Calculations

ECO Name: Reduce Air Flow, AHU 1, Building 120

ECO #: TBD

1991 ECO "bare" costs (from cost estimate sheet)		
Material		\$114
Labor		\$447
	Subtotal bare costs	\$561
FICA Insurance (20% of Labor)		\$89
Sales Tax (Not Applicable For GOGO)		\$0
	Subtotal	\$650
Overhead (15%)		\$98
	Subtotal	\$748
Profit (10%)		\$75
	Subtotal	\$823
Bond (1%)		\$8
	Subtotal	\$831
Contingency (10%)		\$83
	Subtotal (Construction Cost Input For LCCID *)	\$914
SIOH (6.0% of Construction Cost)		\$55
	Subtotal	\$969
Design (6.0% of Construction Cost)		\$55
Total Project Cost		\$1,024

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.



SUBJECT WVA - Building 115
Replace Old Cent. Chiller
DESIGNER W. T. Todd
CHECKER _____

AEP NO 290-0379-002
SHEET 1 OF 6
DATE 2-4-92
DATE _____

EEO #14

Replace Old Electric Centrifugal Chiller

The centrifugal chillers in Building 115 are about 20 years old. The efficiencies of chillers at that time was approximately 1.0 to 1.2 kW/ton. Through the years technology has improved the efficiency of centrifugal chillers to about 0.7 kW/ton.

By replacing the old chiller with a new one, the efficiency would increase by $(1.1 \text{ kW/ton} - 0.7 \text{ kW/ton}) = 0.4 \text{ kW/ton}$.

According to the Bin Temperature Data for Albany, NY, the outside air temperature is above 57°F for 3594 hours per year. Assuming an operating diversity of 0.40, the chiller will operate:

$$3594 \text{ hr/yr} \times 0.40 = 1438 \text{ hr/yr}$$

Current Energy use (Electricity):

$$185 \text{ tons} \times 1.1 \frac{\text{KW}}{\text{ton}} \times 1438 \frac{\text{hr}}{\text{yr}} = 292,633 \text{ KWH/yr}$$

$$292,633 \frac{\text{KWH}}{\text{yr}} \times 3413 \frac{\text{Btu}}{\text{KWH}} \times \frac{1 \text{ MBtu}}{10^6 \text{ Btu}} = \underline{998.8 \text{ MBtu/yr}}$$



SUBJECT WVA - Building 115
Replace old Cent. Chiller
DESIGNER W. T. Todd
CHECKER _____

AEP NO 290-0379-002
SHEET 2 OF _____
DATE 2-4-92
DATE _____

Future Energy Use (Electricity) :

$$185 \text{ ton} \times 0.7 \frac{\text{KW}}{\text{ton}} \times 1438 \frac{\text{hr}}{\text{yr}} = 186,221 \text{ KW/yr}$$

$$186,221 \frac{\text{KW}}{\text{yr}} \times 3413 \frac{\text{Btu}}{\text{KW}} \times \frac{1 \text{ MBtu}}{10^6 \text{ Btu}} = \underline{635.6 \text{ MBtu/yr}}$$

Electricity Savings :

$$\text{Energy} = 998.8 \text{ MBtu/yr} - 635.6 \frac{\text{MBtu}}{\text{yr}} = \underline{363.2 \frac{\text{MBtu}}{\text{yr}}}$$

Project Implementation Cost :

$$\text{Total Project Cost} = \underline{\$ 149,176}$$

See cost estimate sheets for details

02/05/92

ECO Construction Cost Estimate
Calculations

ECO Name: Replace Old Centrifugal Chiller

ECO #:

1991 ECO "bare" costs (from cost estimate sheet)		
Material		\$66,450
Labor		\$23,600
	Subtotal bare costs	\$90,050
FICA Insurance (20% of Labor)		\$4,720
Sales Tax (Not Applicable For GOGO)		\$0
	Subtotal	\$94,770
Overhead (15%)		\$14,216
	Subtotal	\$108,986
Profit (10%)		\$10,899
	Subtotal	\$119,885
Bond (1%)		\$1,199
	Subtotal	\$121,084
Contingency (10%)		\$12,108
		+-----+
Subtotal (Construction Cost Input For LCCID *)		\$133,192
		+-----+
SIOH (6.0% of Construction Cost)		\$7,992
	Subtotal	\$141,184
Design (6.0% of Construction Cost)		\$7,992

Total Project Cost		\$149,176

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

ALBANY NEW YORK

LAT 42 45N LONG 73 48W ELEV 275 FT

MEAN FREQUENCY OF OCCURRENCE OF DRY BULB TEMPERATURE (DEGREES F) WITH MEAN COINCIDENT WET BULB TEMPERATURE (DEGREES F) FOR EACH DRY BULB TEMPERATURE RANGE

Temperature Range	MAY				JUNE				JULY				AUGUST				SEPTEMBER				OCTOBER						
	Obsn		Total		M	Obsn		Total		M	Obsn		Total		M	Obsn		Total		M	Obsn		Total				
	Hour Gp		Obsn	Hour Gp		Obsn	Hour Gp		Obsn		Hour Gp		Obsn	Hour Gp		Obsn	Hour Gp		Obsn		Hour Gp		Obsn	Hour Gp			
	01	09		17			24	01			09	17		24			01	09			17	24		01	09	17	24
95/99																											
90/94																											
85/89																											
80/84																											
75/79																											
70/74																											
65/69																											
60/64																											
55/59																											
50/54																											
45/49																											
40/44																											
35/39																											
30/34																											
25/29																											
20/24																											

ALBANY NEW YORK

Temperature Range	NOVEMBER												DECEMBER												JANUARY												FEBRUARY												MARCH												APRIL												ANNUAL TOTAL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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SUBJECT ECO#15 EWCSAEP NO 290-0379-002

DESIGNER _____

SHEET _____ OF _____

CHECKER _____

DATE 3/25/92

DATE _____

ECO #15 - EWCS

DUE TO THE LARGE SIZE OF THE BACKUP DATA
FOR THE EWCS, A TABLE OF CONTENTS IS
SHOWN HERE

TABLE OF CONTENTS - ECO#15 - EWCS

ENERGY SAVINGS CALCULATIONS
COST ESTIMATE SHEETS
SYSTEM BLOCK DIAGRAM
COST ESTIMATE BACK UP DATA

15-1a thru 15-20
15-20 thru 15-37
15-38 thru 15-39
15-40 thru 15-70



SUBJECT WVA - 26 Buildings
Install EMCS
DESIGNER Todd / Hutchins
CHECKER _____

AEP NO 290-0379-002
SHEET _____ OF _____
DATE 3-18-92
DATE _____

ECO # 15

Install Energy Monitoring and Control Systems

The EMCS can be used control various functions of a buildings energy using equipment. Of the many software programs available, only Day/Night Setback and Ventilation & Recirculation were judged to be technically and economically feasible. A block diagram of the system is shown on p

Current Energy Use

Virtually all of the steam generated by the boilers in Building 136 is used for space heating applications. These boilers burn approximately 280,000 mbtu/year of fuel oil #6 to heat about 2.15 million square feet of building floor area. The 26 buildings that are included in this analysis have about 1.65 million square feet of floor area (see next page)

Using the square footage values to estimate the heating energy required for the 26 buildings that will utilize the EMCS:

$$\text{Total Heating Energy Use} = 280,000 \text{ mbtu/yr}$$

$$\text{Current Energy Use} = 280,000 \frac{\text{mbtu}}{\text{yr}} \times \frac{1.65 \times 10^6 \text{ ft}^2}{2.15 \times 10^6 \text{ ft}^2}$$

$$\text{Current Energy Use} = \underline{214,900 \frac{\text{mbtu}}{\text{yr}}} \text{ (F.O. \#6)}$$

Watervliet Arsenal EMCS
 Square Footage Calculation
 Filename: SQFHEAT.WQ1

03/20/92

Building Number	Floor Area (SqFt)	Heated Area (SqFt)
1	13666	
2	9828	
3	9740	
4	14000	
6	15970	
8	11173	
9	4338	
10	67790	67790
11	131	
12	1320	
15	22990	22990
16	219	
17	7714	7714
18	1764	
19	9208	
20	107157	107157
21	17121	17121
22	9955	
23	21527	21527
24	11876	11876
25	185886	185886
29	210	
35	372921	186461
36	6293	
38	29400	6100
40	192221	192221
41	5023	
42	218	
43	300	
44	61278	61278
46	405	
47	405	
48	1074	
49	221	
50	1213	
102	240	
Subtotal	1214795	888121

Building Number	Floor Area (SqFt)	Heated Area (SqFt)
107	289	
108	2988	
110	208574	208574
111	146	
112	2633	
113	108	
114	4597	4597
115	49926	49926
116	6082	6082
118	1536	
119	3765	
120	101975	101975
121	6445	6445
122	1552	
123	8262	8262
124	13199	13199
125	119200	119200
126	6614	6614
128	269	
129	3765	
130	30904	30904
132	2342	2342
133	7200	
134	324	
135	191964	191964
136	28608	
137	315	
138	600	
139	600	
140	600	
141	1708	
144	65	
145	126720	7600
146	655	
150	1840	
Subtotal	936370	757684
Subtotal	1214795	888121
Totals	2151165	1645805

SUBJECT ECO#15 EMCSAEP NO 290-0379-002DESIGNER P. HUTCHINS

SHEET _____ OF _____

CHECKER _____

DATE _____

DATE _____

EMCS FUNCTIONS SUMMARY

1. Scheduled Start/Stop	ALREADY EXISTS
2. DUTY CYCLING	LPS, IOM
3. DEMAND LIMITING	INCLUDED
4. OPTIMUM START/STOP	EVALUATED, LOW SAVINGS
5. OUTSIDE AIR LIMIT SHUTOFF	~~NA~~ LPS
6. VENTILATION & RECIRC.	INCLUDED
7. ECONOMIZER	ALREADY EXISTS
8. DAY/NIGHT SETBACK	INCLUDED
9. REHEAT COIL RESET	NA
10. HOT DECK/COLD DECK TEMP RESET	LPS
11. HW OSA RESET	LPS
12. BOILER OPTIMIZATION	NA - one boiler normally used
13. CHILLER OPTIMIZATION	NA
14. CHILLER WATER TEMP. RESET	EVALUATED, NOT RECOMMENDED
15. CONDENSER WATER TEMP. RESET	EVALUATED, NOT RECOMMENDED
16. CHILLER DEMAND LIMIT	NA, ONLY ONE CENTRIFUGAL CHILLER (1)
17. LIGHTING CONTROL	NO APPROPRIATE AREAS IDENTIFIED

NOTES: LPS - LOW POTENTIAL SAVINGS

IM - INCREASED MAINTENANCE

NA - not applicable

(1) - Not recommended for recip's



SUBJECT Ed #15- EMCS
DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

ENERGY SAVINGS SUMMARY SHEET

EMCS FUNCTION

SAVINGS

DEMAND LIMITING

\$ 5124/yr demand reduction

DAY/NIGHT SETBACK

9164 MBTU/yr (#6 Fuel Oil)

VENTILATION & RECIRCULATION

637 MBTU/yr (#6 Fuel Oil)

MAINTENANCE

\$ 1100/yr

TOTALS

#6 Fuel oil

9851 MBTU/yr.

Other Dollars

\$ 6224 /yr



SUBJECT ECO #15 - EMCS
DESIGNER Hurt Lewis
CHECKER _____

AEP NO 290-0379-002
SHEET _____ OF _____
DATE 3/21/92
DATE _____

EMCS - Demand Limiting

- Evaluate savings due to Demand Limiting

The following chillers can be de-energized for short periods of time to reduce peak demand. They serve administrative areas.

<u>Blng #</u>	<u>SIZE (tons)</u>	<u>OPERATION</u>
10	44	year round
20	30	
25 (1)	60	
25 (2)	60	
40	90	
44	90	Summer only
115	185	
120	150	
TOTAL	709	

$$\text{KW SAVINGS} = \text{HP} \times \text{L} \times (0.746 \text{ kw/hp}) \times 0.25$$

Assume approximately 1 Kw/ton for chillers and auxiliaries

HP = motor nameplate horsepower
L = load factor = 0.8 (p. 35, CR 32-030)
ratio of motor partial loading and efficiency
Varies from 0.25 in winter
to 0.50 in fall/spring
to 0.80 in summer

SUBJECT ECO#16

AEP NO _____

DESIGNER JH

SHEET _____ OF _____

CHECKER _____

DATE _____

DATE _____

Year round capacity = 284 tons = 234 kw

Summer only cap. = 425 tons

kw savings = $425 \times 0.25 \times 0.25 = 27 \text{ kw}$
 $425 \times 0.50 \times 0.25 = 53 \text{ kw}$
 $709 \times 0.80 \times 0.25 = 142 \text{ kw}$

Annual dollar savings =

$27 \text{ kw} \times 5.77 \text{ \$/kw/mon} \times 4 \text{ mos} +$
 $53 \text{ kw} \times 5.77 \text{ \$/kw/mon} \times 4 \text{ mos} +$
 $142 \text{ kw} \times 5.77 \text{ \$/kw/mon} \times 4 \text{ mos} =$

\$5124 / yr.

WATERVLIET ARSENAL

BLDG #	CHILLER		HVAC SYSTEM TYPE		SUP FAN (HP)	EXH FAN (HP)
	TYPE	SIZE (TONS)	AHU	PERIM		
10 (adm)	RC/DX/AC	44	VAV	HW/PR	15	-
(cmp)	RC/DX/AC	25	SZ	-	7.5	-
(rep)	RC/DX/AC	5	SZ	HW/PR	1	-
(cmp)	RC/DX/AC	5	SZ	-	1	-
15 (adm)	RC/DX/AC	8	SZ	ST/PR+UH	1	-
20 (adm)	RC/DX/AC	30	VVT	ST/PR	7.5	-
21 (caf)	-	-	SZ	ST/PR	-	-
23 (adm)	-	-	-	ST/PR	-	0.5
24 (adm)	RC/DX/AC	5.5	SZ	ST/PR	0.75	-
25 (adm)	RC/DX/AC	60,60	VAV	HW/PR	30,30	10,10
(cmp)	RC/DX/AC	10,10	SZ	-	2	-
35 (cls)	RC/DX/AC	25	VAV	ST/PR	2	-
40 (mf)	RC/DX/AC	25	SZ	HW/PR	7.5	-
(cd)	RC/DX/AC	30	SZ	HW/PR	7.5	-
(adm)	RC/CW/AC	-	FC	HW/PR	-	-
(dft)	RC/DX/AC	5	SZ	HW/PR	1	-
(ncf)	RC/DX/AC	11	SZ	HW/PR	2	-
(scf)	RC/DX/AC	10	SZ	HW/PR	2	-
44 (adm)	RC/CW/AC	90	SZ	ST/PR	25,5	-
(lab)	RC/CW/AC	75	SZ	-	20	-
(cmp)	RC/DX/AC	90	SZ	-	-	-
(bsm)	-	-	SZ	ST/UH	30	-
115 (adm)	CC/CW/WC	185,185(bu)	RH	FC	7.5,5,2,FC	-
(cmp)	RC/DX/AC	28	SZ	-	7.5	-
120 (adm)	RC/CW/AC	150	MZ	PR+FC	7.5	-
(cwl)	RC/CW/AC	150	SZ	PR+FC	7.5,FC	-
(el)	RC/CW/AC	40	-	PR+FC	FC	-

CHILLER TYPES

RC = reciprocating chiller
 CC = centrifugal chiller
 DX = direct expansion
 CW = chilled water
 AC = air cooled
 WC = water cooled

HVAC TYPES

VAV = variable air volume
 VVT = variable volume, temperature control
 SZ = single zone
 MZ = multi zone
 RH = terminal reheat

AREAS

mf = microfilm
 adm = administrative areas
 lab = laboratory areas
 bsm = basement areas
 cd = CADD
 dft = drafting room
 ncf = north conference room
 scf = south conference room
 cmp = computer room
 cwl = central and west labs
 el = east labs
 rep = reproduction

PERIMETER SYSTEMS

PR = perimeter radiation
 UH = unit heater
 FC = fan coils

15-3d

8/92

CONSTRUCTION COST ESTIMATE

DATE PREPARED
8/21/92

SHEET OF

PROJECT

ENERGY ENGINEERING ANALYSIS

LOCATION

WATERLIET ARSENAL

ARCHITECT ENGINEER

REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE

☐ CODE A (No design completed)

☒ CODE B (Preliminary design)

☐ CODE C (Final design)

☐ OTHER (Specify)

DRAWING NO.

ECO#15 - EMCS

ESTIMATOR

P. HUTCHINS

CHECKED BY

DEMAND LIMITING

SUMMARY

QUANTITY

NO.
UNITS

UNIT
MEAS.

PER
UNIT

LABOR
TOTAL

MATERIAL

PER
UNIT

TOTAL

TOTAL
COST

CONTROL RELAY

8

ea

25

200

37

696

396

AUXILIARY CONTACT

8

ea

25

200

15

120

320

WATT TRANS DUCCN SET

3-PHASE

1

ea

23

23

425

425

448

120 Volt AC Power

8

ea

75

600

39

312

912

Wiring - indoor

400'

1000'

450

180

510

204

384

Computer program

1

ea

2370

\$ 5330

SUBJECT ECO#15 - EMCS

AEP NO. _____

DESIGNER _____

SHEET _____ OF _____

CHECKER _____

DATE _____

DATE _____

Day / Night Setback

Calculate savings due to Day / Night Setback

Ref: User Guide for Single Bldg Controllers (CR32.030 p. 51)

$$\text{Heat Savings} = \frac{\text{BTT} \times \text{AZ} \times \text{SD} \times (168 - \text{H}) \times \text{WKW}}{\text{HEFF} \div 1e6}$$

where

- AZ = area of zone being served (ft²)
BTT = building thermal transmission
(BTU / hr °F - ft²)
SD = thermostat setback for unoccupied
periods during heating season = 10°F
H = hours of operation during week
during which the normal setpoint applies
WKW = length of winter heating season
HEFF = heating efficiency of system = 0.80

The heating energy savings due to day/night setback were calculated using a spreadsheet computer program and the equation shown above.

The spreadsheet and all assumptions are given on the next 3 pages. The results are:

$$\text{Setback Energy Savings} = \underline{\underline{9,164 \frac{\text{MBtu}}{\text{yr}}}} \quad (\text{F.O. \#6})$$

ECO #15 - EMCS

WATERVLIET ARSENAL EMCS
SETBACK CALCULATION
Filename: SETBK.WQ1
03/20/92

#	BLDG #	WALL AREA (SF)	WINDOW AREA (%)	WINDOW TYPE	ROOF AREA (SF)	Uo*Aw	Uo	HEATED FL AREA (SF)	VOLUME (CF)	INFIL. (CFM)	S/B ?	BTT	H (HR/WK)	HEATING SAVINGS (MBTU)
1	10	17,850	20	2	21,750	9,310	0.24	67,790	610,110	2,542	1	0.18	50	481
2	15	6,350	10	1	23,000	3,676	0.13	22,990	206,910	862	1	0.20	50	184
3	17	3,952	15	1	7,714	1,788	0.15	7,714	69,426	289	1	0.27	50	84
4	20(adm)	3,200	10	2	9,600	1,869	0.15	9,600	86,400	360	1	0.24	120	37
	20(shops)	7,200	15	1	48,779	6,209	0.11	97,557	878,013	3,658	1	0.59	120	940
5	21	5,120	30	2	17,100	4,049	0.18	17,121	154,089	642	1	0.28	120	77
6	22	4,490	15	2	9,955	2,523	0.17	9,955	89,595	373	0	0.00	168	0
7	23	9,240	25	1	4,940	3,354	0.24	21,527	193,743	807	1	0.20	50	169
8	24	5,170	30	1	3,670	2,034	0.23	11,876	106,884	445	1	0.21	50	100
9	25(adm)	12,070	10	2	66,100	9,590	0.12	66,100	594,900	2,479	1	0.19	50	490
10	25(shops)	24,140	15	1	0	6,916	0.29	119,786	1,078,074	4,492	1	0.10	120	191
11	35	43,968	15	1	372,921	44,295	0.11	186,461	1,678,145	6,992	1	0.28	120	842
12	38	6,440	25	1	6,100	2,563	0.20	6,100	54,900	229	1	0.46	50	112
13	40	51,700	25	2	88,900	31,468	0.22	192,221	1,729,989	7,208	1	0.20	50	1,567
14	44	8,040	15	2	61,300	8,213	0.12	61,278	551,502	2,298	1	0.17	50	427
15	110	71,488	25	1	208,574	40,426	0.14	208,574	1,877,166	7,822	1	0.23	120	793
16	114	2,589	15	2	4,597	1,358	0.19	4,597	41,373	172	1	0.34	50	62
17	115	16,960	10	2	32,840	8,371	0.17	49,926	449,334	1,872	1	0.21	50	415
18	116	2,978	15	1	6,082	1,370	0.15	6,082	54,738	228	1	0.27	50	65
19	120	24,240	10	1	30,800	9,187	0.17	101,975	917,775	3,824	1	0.13	50	532
20	121	3,065	15	1	6,445	1,426	0.15	6,445	58,005	242	1	0.26	50	67
21	123	3,471	15	1	8,262	1,697	0.14	8,262	74,358	310	1	0.25	50	81
22	124	4,387	15	1	13,199	2,379	0.14	13,199	118,791	495	1	0.22	50	116
23	125	13,183	15	1	119,200	13,909	0.11	119,200	1,072,800	4,470	1	0.16	120	304
24	126	3,105	15	1	6,614	1,452	0.15	6,614	59,526	248	1	0.26	50	69
25	130	13,600	25	1	30,900	6,945	0.16	30,904	278,136	1,159	1	0.27	50	327
26	132	1,742	10	1	2342	671	0.16	2,342	21,078	88	1	0.33	50	31
27	135	16,730	20	1	191,964	21,369	0.10	191,964	1,727,676	7,199	1	0.15	120	473
28	145	9,600	0	1	7,600	2,950	0.17	7,600	68,400	285	1	0.43	50	130
Totals						251,366		1,655,760	14,901,836	62,091	28			9,164

ASSUMPTIONS:

Wall U-value : 0.24 Btu/sf-F-hr
Window U-value (1-pane) 1.13 Btu/sf-F-hr
Window U-value (2-pane) 0.55 Btu/sf-F-hr
Roof U-value : 0.085 Btu/sf-F-hr
Average infiltration : 0.25 volumes/hour

Heating savings = $\frac{BTT \times AZ \times SD \times (168-H) \times WKW}{HEFF / 1e6}$

where:

BTT = $[(U_o \times A_w) + (I \times 1.08 \text{ Btu/cfm-F-hr})] / AF$
Uo = overall wall U-value
Aw = wall area (sf)
I = infiltration (cfm)
AF, AZ = floor area (sf)
SD = thermostat set-down during heating season (10°F)
H = hours per week building is occupied
WKW = weeks of winter (see calcs on next page)
HEFF = 0.80

WATERVLIET ARSENAL EMCS
 WEEKS OF WINTER CALCULATION
 Filename: SETBK.WQ1

Outside Temperature Range		Hours of Occurrence			Total Hours
		2-9	10-17	18-1	
50	54	221	193	202	616
45	49	218	193	206	617
40	44	237	236	239	712
35	39	289	246	286	821
30	34	304	194	258	756
25	29	184	106	152	442
20	24	124	65	90	279
15	19	75	32	57	164
10	14	54	13	26	93
5	9	18	3	9	30
0	4	9	0	2	11
-5	-1	3	0	1	4
-10	-6	1	0	0	1
-15	-11	0	0	0	0

Totals	1737	1281	1528	4546

Total weeks of winter (WKW) = $4546 / 24 / 7 = 27$

Data source : TM 5-785

SUBJECT ECO #15 - EMCSAEP NO. DESIGNER SHEET OF CHECKER DATE DATE

Assumptions for Day/Night Setback Calculation:

$$BTI = [(U_o * A_w) + (I * 1.08 \text{ Btu/ft}^2 \cdot \text{hr}^\circ \text{F})] / AF$$

U_o = combined U-factor for all exterior surfaces ($\text{Btu/ft}^2 \cdot \text{hr}^\circ \text{F}$)

A_w = total area of exterior surfaces (ft^2)

I = total infiltration for building (cfm)

AF = total floor area of building (ft^2)

From ASHRAE Handbook, 1977 Fundamentals,
Chapter 25.

Wall U-value for 4 in face brick, 8 in common
brick with air space is 0.24

$$U_w = 0.24$$

Roof U-value for roof made of 4 in wood and
1" insulation is 0.085

$$U_r = 0.085$$

U-value for single-pane windows is 1.13, double
or storm is 0.55

$$U_{w1} = 1.13 \quad U_{w2} = 0.55$$

Infiltration is very difficult to calculate
but it is known to range from about 0.3 to 1.0
air changes per hour for residential buildings
(ASHRAE 1981 Fundamentals, p. 22-8). Commercial
buildings tend to be tighter than residential, so a
value of 0.25 air changes per hour is assumed.



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Ventilation & Recirculation

The heating energy savings for this program were calculated using a spreadsheet computer program and the following equation:

$$\text{Savings} = \frac{\text{CFM} \times \text{POA} \times (\text{WSP} - \text{AWT}) \times 1.08 \times \text{AND} \times (\text{WH} - 0.25)}{\text{HEFF} \times 10^6 \left(\frac{\text{Btu}}{\text{m Btu}} \right)}$$

The assumptions and results of the calculations are shown on the following 2 pages.

The air handling unit cfm was obtained from shop drawings or estimated using the following equation:

$$\text{CFM} = \frac{\text{Motor HP} \times 6356 \times \text{Efficiency}}{\text{Static Pressure (in. H}_2\text{O)}}$$

The results of the savings calculations are:

$$\text{V\&R Energy Savings} = \underline{\underline{687 \text{ MBtu/yr}}} \quad (\text{F.O. \#6})$$

Total Energy Savings

$$\text{Total Energy Savings} = \text{Setback Savings} + \text{V\&R Savings}$$

$$\text{Total Energy Savings} = 9,164 \frac{\text{MBtu}}{\text{yr}} + 687 \frac{\text{MBtu}}{\text{yr}} = \underline{\underline{9,851 \text{ MBtu/yr}}}$$

WATERVLIET ARSENAL EMCS
 VENTILATION & RECIRCULATION SAVINGS CALCULATION
 Filename: V&REC.WQ1

03/20/92

#	BLDG # (Area)		AHU Fan		VENT. CFM (1)	WARM-UP VENT. SAVINGS (MBTU)
			HP	#		
1	10	(adm)	15.0	1	18,000	53
2		(cmp)				
3		(rep)				
4		(cmp)				
5	15	(adm)				
6	20	(adm)	7.5	1	12,000	35
7	21	(caf)				
8	23	(adm)				
9	24	(adm)				
10	25	(adm)	60.0	2	96,000	281
11		(cmp)				
12	35	(cls)				
13	40	(mf)	7.5	1	12,000	35
14		(cd)	7.5	1	12,000	35
15		(adm)	15.0	2	24,000	70
16		(dft)				
17		(ncf)				
18		(scf)				
19	44	(adm)	25.0	1	20,000	59
20		(lab)				
21		(cmp)				
22		(bsm)	30.0	1	34,400	101
23	115	(adm)				
24		(cmp)				
25	120	(adm)	7.5	1	6,250	18
26		(cwl)				
27		(el)				
Totals			175.0	11	234,650	687

(1) Ventilation CFM estimated based on motor horsepower

$$\text{SAVINGS} = \frac{\text{CFM} \times \text{POA} \times (\text{WSP} - \text{AWT}) \times (1.08 \text{ BTU/CFM-F-HR}) \times \text{AND} \times (\text{WH} - 0.25)}{\text{HEFF} \times 1\text{E}6 (\text{BTU/MBTU})}$$

Where:

CFM = Varies = air handler capacity, in Cubic Feet per Minute
 POA = 0.25 = minimum outside air (% of CFM)
 WSP = 70 = winter thermostat setpoint (°F)
 AWT = 42 = average winter OA temp. (°F, see App. B, p. I-8)
 AND = 248 = annual days requiring warm-up (see next page)
 WH = 1.5 = present warm-up hours (Hours/Day)
 HEFF = 0.8 = boiler efficiency

ECO #15 - EMCS

WATERVLIET ARSENAL EMCS
ANNUAL DAYS REQUIRING WARM-UP CALCULATION
Filename: V&REC.WQ1

Outside Temperature Range		Hours of Occurrence			Total Hours
		1-8	9-16	17-24	
50	54	221	193	202	616
45	49	218	193	206	617
40	44	237	236	239	712
35	39	289	246	286	821
30	34	304	194	258	756
25	29	184	106	152	442
20	24	124	65	90	279
15	19	75	32	57	164
10	14	54	13	26	93
5	9	18	3	9	30
0	4	9	0	2	11
-5	-1	3	0	1	4
-10	-6	1	0	0	1
-15	-11	0	0	0	0
Totals		1737	1281	1528	4546

Total days requiring warm-up = $1737 / 7 =$ 248

Data source : TM 5-785

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Optimum Start / Stop Evaluation

- Calculate energy savings

Currently air handlers in administrative areas ~~are~~ operate from 0600-1800 and are energized and de-energized by a time clock controller. The Optimum Start/Stop function would reduce the present warm-up time from 1.5 hours to a shorter time period based on the thermal characteristics of the building and its location geographically.

The calculations were made based on CR 82.030 methods and are shown in the table on the following page. Savings are too small (\$~\$200/yr) warrant implementing this function.

WATERVLIT ARSENAL
OPTIMUM START/STOP SAVINGS CALCULATION

#	BLDG #	WARM-UP AUXILIARIES (HP)	COOL-DOWN AUXILIARIES (HP)	Uo	ERT	WARM-UP SAVINGS (MBTU)	COOL-DOWN SAVINGS (MBTU)	TOTAL SAVINGS (MBTU)
1	10	15	15	0.24	370	0	2	2
2	15			0.13	250			
3	17			0.15	290			
4	20(adm)	7.5	7.5	0.15	275	1	1	2
5	20(shops)			0.11	230			
6	21			0.18	320			
7	22			0.17	310			
8	23			0.24	370			
9	24			0.23	370			
10	25(adm)	60	60	0.12	250	11	8	18
11	25(shops)			0.29	390			
12	35			0.11	215			
13	38			0.20	340			
14	40	7.5	7.5	0.22	350	0	1	1
15	44	60	60	0.12	230	12	8	20
16	110			0.14	275			
17	114			0.19	320			
18	115	14.5	14.5	0.17	300	2	2	3
19	116			0.15	290			
20	120	15	15	0.17	300	2	2	3
21	121			0.15	275			
22	123			0.14	275			
23	124			0.14	260			
24	125			0.11	215			
25	126			0.15	275			
26	130			0.16	290			
27	132			0.16	300			
28	135			0.10	215			
						27	23	50

WARM-UP SAVINGS =

$$\text{HP} \times \text{L} \times (0.746 \text{ KW/HP}) \times ((\text{WH} \times \text{AND}) - \text{ERT}) \times (\text{DAY}/7 \text{ DY/WK}) \\ \times 0.003413 \text{ (MBTU/KWH)}$$

where

- HP = motor horsepower
- L = motor efficiency load factor (0.8)
- WH = present warm-up time (estimate 1.5 hrs)
- AND = annual number of days total that warmup is required (243 da/yr)
- ERT = equipment run time total required for warm-up (hrs/yr)
- DAY = equipment operation (dy/wk)

COOL-DOWN SAVINGS =

$$\text{HP} \times \text{L} \times (0.746 \text{ KW/HP}) \times ((\text{CH} - 0.75 \text{ HR/DA}) \times (365 \text{ DY/YR} - \text{AND}) \\ \times (\text{DAY} / 7 \text{ DY/WK}) \times 0.003413 \text{ (MBTU/KWH)})$$

where

- CH = present cool-down time (estimate 1.5 hrs)



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CHILLED WATER RESET FUNCTION

- Calculate energy savings (ref. CR 82.030 p. 53)

$$SAV = TON * CPT * CFLH * 2^{\circ}F * REI$$

where

TON = chiller capacity
CPT = energy use per ton (kw/ton)
CFLH = equivalent full-load hours for cooling (hrs/yr)
REI = efficiency increase per $^{\circ}F$ increase in
chilled water temp.
= 0.012 / $^{\circ}F$ for reciprocal
= 0.017 / $^{\circ}F$ for centrifugal

Mean $^{\circ}F$	09 to 16 Hours of Occurrence	DEGREE Hours C (H-65)
97	7	224
92	28	756
87	95	2090
82	177	3009
77	248	2976
72	257	1799
67	235	470
		<u>11,324 $^{\circ}F$-hr</u>

$$CFLH = 11,324 \div (\text{Cooling design temp.} - 65^{\circ}F)$$

$$= 11324 \div (88 - 65) = \underline{492} \text{ hr/yr.}$$



SUBJECT ECO #15 EURS

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Chiller efficiencies: (Ref.: DOE-2)

	<u>COP</u>	<u>CPT (kw/ton)</u>
Centrifugal	4.8	0.73
reciprocal	3.6	0.98

$$\frac{\text{kw}}{\text{ton}} = \frac{\text{kW}_{\text{in}}}{3413 \text{ Btu/h}_{\text{in}}} * \frac{\text{Btu/h}_{\text{in}}}{\text{Btu/h}_{\text{out}}} * \frac{12,000 \text{ Btu/h}_{\text{out}}}{\text{ton}}$$

← $\frac{1}{\text{COP}}$

$$\frac{\text{kw}}{\text{ton}} = \frac{12,000}{3413 * \text{COP}}$$

$$\text{SAVINGS} = \text{TON} * \text{CPT} * \text{CFLH} * 2 * \text{REI}$$

$$\text{RECIP} = \text{TON} * 0.98 * 492 * 2 * 0.012$$

$$\text{RECIP} = 11.57 * \text{TON} \text{ (kwh)}$$

$$\text{CENTRIF} = \text{TON} * 0.73 * 492 * 2 * 0.017$$

$$\text{CENTRIF} = 12.21 * \text{TON} \text{ (kwh)}$$

SAVINGS CALCULATION

LOCATION	SIZE (TONS)	TYPE $T_{\text{PE}}^{(1)}$	SAVINGS PER YEAR		
			kW	MBTU	\$
44 ADM	90	R	1041	3.6	\$ 72
115 ADM	185	C	2257	7.7	\$ 157
120 ADM	150	R	1736	5.9	\$ 120
120 LAB(W)	150	R	1736	5.9	\$ 120
120 LAB(E)	40	R	463	1.6	\$ 33
40 ADM	100	R	1157	4.0	\$ 80

} \$ 580/yr

WATERVLIET ARSENAL
OPTIMUM START/STOP CALCULATION

BLDG #	CHILLER		HVAC SYSTEM TYPE		SUP FAN (HP)	EXH FAN (HP)	OPERATING SCHEDULE					ST	DP	CR	WT	TOT
	TYPE	SIZE (TONS)	AHU	PERIM			ON	OFF	DA/WK							
10	(adm)	RC/DX/AC	44	VAV	HW/PR	15	-	0600	1800	5	1	1	1	1	4	
	(cmp)	RC/DX/AC	25	SZ	-	7.5	-	0000	2400	7	0				0	
	(rep)	RC/DX/AC	5	SZ	HW/PR	1	-	0600	1800	5	1	1	1	0	3	
	(cmp)	RC/DX/AC	5	SZ	-	1	-	0000	2400	7	0				0	
15	(adm)	RC/DX/AC	8	SZ	ST/PR+UH	1	-	0600	1800	5	1	1	1		3	
20	(adm)	RC/DX/AC	30	VVT	ST/PR	7.5	-	0600	1800	5	1	1	1		3	
21	(caf)	-	-	SZ	ST/PR	-	-	0600	1800	5	0				0	
23	(adm)	-	-	-	ST/PR	-	0.5	0600	1800	5	0				0	
24	(adm)	RC/DX/AC	5,5	SZ	ST/PR	0.75	-	0600	1800	5	0				0	
25	(adm)	RC/DX/AC	60,60	VAV	HW/PR	30,30	10,10	0600	1800	5	2	2	2		6	
	(cmp)	RC/DX/AC	10,10	SZ	-	2	-	0000	2400	7	0				0	
35	(cls)	RC/DX/AC	25	VAV	ST/PR	2	-	as needed			0				0	
40	(mf)	RC/DX/AC	25	SZ	HW/PR	7.5	-	0600	1800	5	1	1	1		3	
	(cd)	RC/DX/AC	30	SZ	HW/PR	7.5	-	0600	1800	5	1	1	1		3	
	(adm)	RC/CW/AC		FC	HW/PR	-	-	0600	1800	5	1	1	1		3	
	(dft)	RC/DX/AC	5	SZ	HW/PR	1	-	0600	1800	5	1	1	1		3	
	(ncf)	RC/DX/AC	11	SZ	HW/PR	2	-	as needed			0				0	
	(scf)	RC/DX/AC	10	SZ	HW/PR	2	-	as needed			0				0	
44	(adm)	RC/CW/AC	90	SZ	ST/PR	25,5	-	0600	1800	5	1	1	1		3	
	(lab)	RC/CW/AC	75	SZ	-	20	-	0000	2400	7	0				0	
	(cmp)	RC/DX/AC		SZ	-		-	0000	2400	7	0				0	
	(bsm)	-	-	SZ	ST/UH	30	-	0000	2400	7	1	1	1		3	
115	(adm)	CC/CW/WC	185,185(bu)	RH	FC	7.5,5,2,FC	-	0600	1800	5	3	3	3		9	
	(cmp)	RC/DX/AC	28	SZ	-	7.5	-	0000	2400	7	0				0	
120	(adm)	RC/CW/AC	150	MZ	PR+FC	7.5	-	0600	1800	5	1	1	1		3	
	(cwl)	RC/CW/AC	150	SZ	PR+FC	7.5,FC	-	0600	1800	5	1	1	1		3	
	(el)	RC/CW/AC	40	-	PR+FC	FC	-	0600	1800	5	1	1	1		3	

CHILLER TYPES

RC = reciprocating chiller
CC = centrifugal chiller
DX = direct expansion
CW = chilled water
AC = air cooled
WC = water cooled

HVAC TYPES

VAV = variable air volume
VVT = variable volume, temperature control
SZ = single zone
MZ = multi zone
RH = terminal reheat

AREAS

mf = microfilm
adm = administrative areas
lab = laboratory areas
bsm = basement areas
cd = CADD
dft = drafting room
ncf = north conference room
scf = south conference room
cmp = computer room
cwl = central and west labs
el = east labs
rep = reproduction

PERIMETER SYSTEMS

PR = perimeter radiation
UH = unit heater
FC = fan coils



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ESTIMATE PAYBACK - CHILLED WATER RESET

COST ESTIMATE

		UNIT	COST ⁽¹⁾
• CHILLED WATER TEMP. SENSOR	(6)	\$143	858
• CHILLED WATER TEMP. CONTROL POINT ADJ.	(6)	200	1200
• OSA	-		
• WIRING (~\$450/pt) 2pts/CHILLER	(6)	900	5400
• Computer program	(1)	1500	1500
			\$8958
Mark-ups (~58%)			\$5196
			\$14,154

$$\text{Payback} = \frac{14,154}{580} = \underline{\underline{24 \text{ yrs.}}}$$

Not Recommended.

⁽¹⁾ See detailed cost estimate sheets in this section

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CONDENSER WATER RESET

- CALCULATE ENERGY SAVINGS (Ref. CR 82.030)

$$\text{COOLING SAVINGS} = \text{TON} \times \text{CPT} \times \text{CFLH} \times \text{AEI}$$

where TON = chiller capacity (tons)
CPT = efficiency (kW/ton)
CFLH = equivalent full-load cooling hrs (hrs/yr)
AEI = adjusted eff. increase due to cond. reset

$$\text{AEI} = \frac{\text{PEI} + 5.5}{100} \quad \text{from Fig. 12 p. 61 and RCWT}$$

$$\text{RCWT} = \text{PCWT} - \text{ACWT}$$

where ACWT = achievable condenser water temp.
PCWT = present " " " (85°F)
RCWT = reduction in " " "
PEI = percent eff. increase

$$\text{PEI} = 6\% \quad \text{from Fig 12, p61 for RCWT} = 12.6^\circ\text{F} \text{ and centrifugal chiller}$$

$$\text{AEI} = \frac{6 - 5.5}{100} = 0.01$$

$$\begin{aligned} \text{SAVINGS} &= 185 \text{ tons} \times 0.73 \text{ kW/ton} \times 492 \text{ hrs/yr} \times 0.01 \\ &= 664 \text{ kWh/yr} = 2.27 \text{ MBTU/yr} \Rightarrow \$46/\text{yr} \end{aligned}$$

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ACWT CALCULATION

A	B	C	D
MEAN COINCIDENT WET BULB (°F)	COND. WATER TEMP (A + 10°)	09 TO 16 HOURS OF OCCURRENCE	TEMP. HRS (B x C)
75	85	7	595
73	83	28	2324
71	81	95	7695
68	78	177	13,806
66	76	248	18,848
64	74	257	19,018
61	71	235	16,685
57	67	212	14,204
52	62	<u>190</u>	<u>11,780</u>
		1449	104,955

$$ACWT = \text{TOTAL of D} \div \text{TOTAL OF C}$$

$$104,955 \div 1449 = 72.4^{\circ}\text{F}$$

$$RCWT = 85 - 72.4 = 12.6^{\circ}\text{F}$$

SUBJECT ECO #15 - EMCS

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- ESTIMATE PAYBACK - CONDENSER WATER RESET

TO Implement this function requires:

- Chilled water temp. sensor
- Chiller water temp. control point adj.
- OSA temp. sensor
- Wiring (~\$450/pt)
- Computer program

MARK-UP

Installed Cost ⁽¹⁾
\$ 143
200
-
900
<u>1500</u>
\$ 2743
<u>1590</u>
\$ 4334

EST. Payback $\frac{4333}{46} = 94 \text{ yr}$

Not Recommended

⁽¹⁾ See detailed cost estimate sheets in this section

SUBJECT ECO #15 - EMCS

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Maintenance Savings

These calculations are based on DD Report Number CR 82.030, Standardized EMCS Energy Savings Calculations.

Run Time Recording (RTR) =

By scheduling maintenance based on actual operation, assume the EMCS will save one man-visit per year to the system being monitored. Also assume each man-visit lasts 2 hours and a labor rate of \$25 per hour.

There are 11 AHU's that will be monitored.

$$\text{RTR Labor Savings} = 11 \frac{\text{visits}}{\text{yr}} \times 2 \frac{\text{Hr}}{\text{visit}} \times \$25/\text{hr} = \$550/\text{yr}$$

Safety Alarm (SA) :

The EMCS can save time spent conveying alarm information and diagnosing problems. Assume a total of 2 hours per system per year.

$$\text{SA Labor Savings} = 11 \text{ syst.} \times 2 \frac{\text{Hr}}{\text{syst. yr}} \times 25 \frac{\$}{\text{hr}} = \$550/\text{yr}$$

$$\text{Total Labor Savings} = \text{RTR Savings} + \text{SA Savings}$$

$$\text{Total Labor Savings} = \$550/\text{yr} + \$550/\text{yr} = \underline{\underline{\$1,100/\text{yr}}}$$

08/24/92

ECO Construction Cost Estimate Calculations

ECO Name: ENERGY MONITORING AND CONTROL SYSTEM

ECO #: 15

1991 ECO "bare" costs (from cost estimate sheet)

Material	\$209,300
Labor	\$118,100

Subtotal bare costs	\$327,400
FICA Insurance (20% of Labor)	\$23,620
Sales Tax (not applicable for GOGO)	\$0

Subtotal	\$351,020
Overhead (15%)	\$52,653

Subtotal	\$403,673
Profit (10%)	\$40,367

Subtotal	\$444,040
Bond (1%)	\$4,440

Subtotal	\$448,480
Contingency (10%)	\$44,848

Subtotal (Construction Cost Input For LCCID *)	\$493,328

SIOH (6% of Construction Cost)	\$29,600

Subtotal	\$522,928
Design (6% of Construction Cost)	\$29,600

Total Project Cost	\$552,528

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

Energy Monitoring and Control Systems

Construction Cost Estimate

District		Date Prepared <u>2/18/92</u>		Sheet <u>1</u> of <u>15</u>		
Project <u>EMCS</u>		Basis for Estimate				
Location <u>WATERVLIET ARSENAL</u>		☒ Schematic Design ☐ Preliminary Design ☐ Final Design ☐ Other (Specify) _____				
Note: Labor values shown are based on \$25.00/hour incl. fringes		Estimator <u>W. Todd</u>		Checked by		
Systems Equipment, FIDs MUX's and Enclosures Summary		Quantity		Material (\$)		
		No. Units	Unit Meas.	Per Unit	Labor (\$)	
				Total	Per Unit Total	
1. System Equipment Hardware - Complete** (For dual processor systems)*		1	PC LS (LS)	3,950 75,120 (102,215)	100 2250 (4212)	100 4050
2. Command Software		1	LS	37,400	XX	37,400
3. Data Base Generation (Cost per Point)		151	POINT	XX	18.50	2793
4. Graphic Displays (per Diagram)		3	DIAG.	XX	120	360
5. Applications Programs (From Work Sheet Table 2.11)		1	LS	5120	XX	5120
6. FID Hardware - Complete**		3	EA	5,450	213	639
7. FID Software (One Time Charge)		1	LS	5,750	XX	5750
8. MUX Hardware Complete**		7	EA	3,725	113	791
9. 120 Vac Power Circuit		41	EA	39	88	3608
10. Data Terminal Cabinet		7	EA	450	25	175
11. Remote Terminal Systems***		1	EA	3000	50	50
12. Large NEMA 1 I&C Enclosures		-	EA	150	23	-0-
13. Large NEMA 12 I&C Enclosures		3	EA	200	23	69
14. Small NEMA 4 & 13 I&C Enclosures		-	EA	50	13	-0-
15. FID Test Set		1	EA	18,718	200	200
16. FID Portable Tester		1	EA	7,500	XX	7500
PAGE TOTAL				129,212	8785	137,997

- * Use the cost in parenthesis for larger systems requiring dual processing with failover. The single processor figure is less one processor unit and the failover controller.
- ** The cost listed for the System Equipment includes all hardware, accessories, and power line conditioning, plus system software supplied by the computer manufacturer. The cost listed for FIDs and MUXs includes a power line conditioner. The FID cost does not include a separate MUX (see Figures 1-1 and 1-2).
- *** The cost of remote CRTs and/or printers is the same as for those listed in Table 2.10. Assume a \$50 (2 manhours) installation and set-up for each remote terminal. Material and labor costs must also be added for one Modem at the printer and one at the CLT, and for wireline DTM to connect between the CLT and the printer. These costs should be added on Sheet 2 of these cost estimating forms.

Remote Terminal	CRT	\$1300	} \$3000
	Printer	700	
	Modem(2)	1000	
Programs	Demand Limiting	\$ 2370	
	Ventilation & Recirculation	1350	
	Day/Night Setback	<u>1400</u>	
	TOTAL	\$ 5120	

Energy Monitoring and Control Systems

Construction Cost Estimate

Date Prepared

Sheet 2 of 15

District

Basis for Estimate

Project

EMCS

- ☐ Schematic Design
☐ Preliminary Design
☐ Final Design
☐ Other (Specify) _____

Location

WVA

Note: Labor values shown are based on \$25.00/hour incl. fringes

Estimator

W. Todd

Checked by

Fiber Optic DTM* Summary	Quantity		Material (\$)		Labor (\$)	
	No. Units	Unit Meas.	Per Unit	Total	Per Unit	Total
Fiber Optic Cable - Aerial		1000'	910		1024	
Fiber Optic Cable - Direct Burial**		1000'	910		2081	
Fiber Optic Cable - Direct Burial (Chain Trencher)**		1000'	910		601	
Fiber Optic Cable - Existing Duct Bank		1000'	910		600	
Fiber Optic Cable - Indoor		1000'	910		450	
Subtotals for Cables	XX	LS	XX	-0-	XX	-0-
Fiber Optic Modem - (Receive and Transmit)		EA	300		100	
Fiber Optic Repeater		EA	250		50	
Transmitter Module		EA	125		25	
Receiver Module		EA	170		25	
Subtotals for Hardware	XX	LS	XX	-0-	XX	-0-
Page Totals	XX	XX	XX	-0-	XX	-0-
PAGE COST SUM						

Notes: *The Fiber Optic Cable is 4-fiber loose tube construction.

**This cable installation is not tamped for vibratory plate compaction add \$253 per thousand linear feet (e.g. for direct burial w/chain trencher the total cost will be \$854 per thousand linear feet)

Energy Monitoring and Control Systems

Construction Cost Estimate

Date Prepared

Sheet 3 of 15

District

Basis for Estimate

Project

EMCS

- ☐ Schematic Design
☐ Preliminary Design
☐ Final Design
☐ Other (Specify) _____

Location

NVA

Note: Labor values shown are based on \$25.00/hour incl. fringes

Estimator

W. Todd

Checked by

Wireline DTM Summary	Quantity		Material (\$)		Labor (\$)	
	No. Units	Unit Meas.	Per Unit	Total	Per Unit	Total
Wireline Cable - Aerial	-	1000'	630	-0-	1024	-0-
Wireline Cable - Direct Burial	-	1000'	650	-0-	2413	-0-
Wireline Cable - Direct Burial (Chain Trencher)* MAT LAB	3.8 0.8	1000'	650	2470	601	481
Wireline Cable - Existing Duct Bank MAT LAB	37.0 20.4	1000'	510	18870	600	12240
Wireline Cable - Indoor MAT LAB	37.2 8.9	1000'	510	18,972	450	4005
Subtotal for Cables	XX	LS	XX	40108	XX	16546
Modem	7	EA	500	3500	45	315
Line Driver	-	EA	225	-0-	40	-0-
Subtotal for Hardware	XX	LS	XX	3500	XX	315
Page Totals	XX	XX	XX	43612	XX	17041
PAGE COST SUM						60,853

Note: *This cable installation is not tamped; for vibratory plate compaction add \$253 per thousand linear feet (e.g. for direct burial w/chain trencher the total cost will be \$854 per thousand linear feet).

Energy Monitoring and Control Systems

Construction Cost Estimate

Date Prepared

Sheet 4 of 15

District

Basis for Estimate

Project

EMCS

- ☐ Schematic Design
- ☐ Preliminary Design
- ☐ Final Design
- ☐ Other (Specify) _____

Location

WVA

Note: Labor values shown are based on \$25.00/hour incl. fringes

Estimator

W. Todd

Checked by

Coaxial Cable DTM Summary	Quantity		Material (\$)		Labor (\$)	
	No. Units	Unit Meas.	Per Unit	Total	Per Unit	Total
Coaxial Cable - Aerial		1000'	490		1024	
Coaxial Cable - Direct Burial*		1000'	490		2413	
Coaxial Cable - Direct Burial (Chain Trencher)*		1000'	490		601	
Coaxial Cable - Existing Duct Bank		1000'	230		600	
Coaxial Cable - Indoor		1000'	230		450	
Subtotal for Cables	XX	LS	XX	-0-	XX	-0-
Coaxial Cable Modem		EA	610		150	
Coaxial Amplifier		EA	650		100	
Subtotal for Hardware	XX	LS	XX	-0-	XX	-0-
Page Totals	XX	XX	XX	-0-	XX	-0-

PAGE COST SUM

Note: *This cable installation is not tamped; for vibratory plate compaction add \$253 per thousand linear feet (e.g., for direct burial w/chain trencher the total cost will be \$854 per thousand linear feet).

Energy Monitoring and Control Systems

Construction Cost Estimate

Date Prepared

Sheet 5 of 15

District

Project

EMCS

Location

WVA

Basis for Estimate

- ☐ Schematic Design
- ☐ Preliminary Design
- ☐ Final Design
- ☐ Other (Specify) _____

Note: Labor values shown are based on \$25.00/hour incl. fringes

Estimator

W. Todd

Checked by

Two-Way Radio DTM Summary	Quantity		Material (\$)		Labor (\$)		Total Cost
	No. Units	Unit Meas.	Per Unit	Total	Per Unit	Total	
Headend Transceiver	—	EA	5.145		13		
Headend Antenna	—	EA	585		25		
Radio Tower	—	EA	1.220		1.050		
Repeater	—	EA	6.930		38		
Duplexer	—	EA	775		38		
9.5 dB Remote Antenna	—	EA	225		25		
2.5 dB Remote Antenna	—	EA	65		25		
Remote Transceiver	—	EA	725		13		
Page Total (Hardware)	XX	XX	XX	—	XX	—	—0—

NOTE:

Modems and Coaxial Cable will be required for a two-way radio system as illustrated in Figure 2-2. Add the Modems and the Coaxial Cable (for long runs) on Sheet 3 of these cost estimating forms.

If the antenna or towers are located within 100 feet of the headend transceiver, the cost of the coaxial cable may be ignored.

Energy Monitoring and Control Systems

Construction Cost Estimate

Date Prepared

Sheet 6 of 15

District

Basis for Estimate

Project

EMCS

- ☐ Schematic Design
- ☐ Preliminary Design
- ☐ Final Design
- ☐ Other (Specify) _____

Location

WVA

Note: Labor values shown are based on \$25.00/hour incl. fringes

Estimator

W. Todd

Checked by

Analog Inputs Summary	Quantity		Material (\$)		Labor (\$)		Total Cost
	No. Units	Unit Meas.	Per Unit	Total	Per Unit	Total	
1. Space Temperature: RTD and Transmitter	30	EA	125	3750	35	1050	4800
2. Outside Air Temperature: RTD and Transmitter	3	EA	130	390	55	165	555
Instrument Shelter	3	EA	350	1050	45	135	1185
3. Duct (Point) Temperature: RTD and Transmitter	-	EA	130		55		-0-
4. Liquid Temperature: RTD and Transmitter (Cu Thermowell: Add \$20 for Stainless Steel Thermowell)	-	EA	210		38		-0-
5. Liquid Level Sensor	-	EA	1,037		80		-0-
6. Pos. Displacement Flowmeter	-	EA	2,353		245		-0-
7. Duct Average Temperature: RTD and Transmitter	-	EA	200		105		-0-
8. Space or OA Relative Humidity: Sensor and Transmitter	-	EA	450		35		-0-
9. Duct Relative Humidity: Sensor and Transmitter	-	EA	450		55		-0-
10. Gauge Pressure Transmitter (Liquid) (W/Pressure Tap)	-	EA	465		147		-0-
Page Total				5190		1350	6540

NOTE:

Each item cost includes the sensor, transmitter along with associated common costs (e.g., conduit, wiring, terminations) as stated previously in Paragraphs 3.1, 3.2, and 3.3.

Energy Monitoring and Control Systems

Construction Cost Estimate

Date Prepared

Sheet 7 of 15

District		Basis for Estimate						
Project		☐ Schematic Design ☐ Preliminary Design ☐ Final Design ☐ Other (Specify) _____						
Location								
Note: Labor values shown are based on \$25.00/hour incl. fringes		Estimator W. Todd		Checked by				
Analog Inputs Summary		Quantity		Material (\$)		Labor (\$)		Total Cost
		No. Units	Unit Meas.	Per Unit	Total	Per Unit	Total	
11. Differential Pressure Transmitter (Liquid) (incl. 2 Pressure Taps)		-	EA	670		260		-0-
12. 1-Phase Electric Power: (incl. CT, PT, Watt Transducer Set) with Split-Coil CT*		-	EA	480		93		-0-
			EA	510		84		-0-
13. 3-Phase Electric Power: (CT, PT, Watt Transducer Set) with Split Coil CT's*		1	3-EA	750		197		
				1,170	1170	170	170	1340
14. Current Transducer		-	3-EA	458		231		-0-
15. Voltage Transducer		-	2-EA	538		231		-0-
16. VAR Transducer (1 Phase)		-	EA	818		231		-0-
17. VAR Transducer (3 Phase)		-	EA	1,048		283		-0-
18. PF Transducer		-	EA	665		244		-0-
19. Valve Position: Linear Potentiometer		-	EA	210		73		-0-
20. Damper Position: Rotary Potentiometer		11	EA	210	2310	73	303	3113
Page Total			XXX	XXX	3480	XXX	973	4453

NOTE:

Each item accounts for the sensor, transmitter/transducer and common costs (general costs are estimated on Sheets 12 and 13 of these cost estimating forms). See also paragraphs 3.1, 3.2, 3.3, and Appendix C.

* Use one case or the other as applicable; do not add.

Energy Monitoring and Control Systems

Construction Cost Estimate

Date Prepared

Sheet 8 of 15

District

Basis for Estimate

Project

EMCS

☐ Schematic Design
☐ Preliminary Design
☐ Final Design
☐ Other (Specify) _____

Location

WVA

Note: Labor values shown are based on \$25.00/hour incl. fringes

Estimator

W. Todd

Checked by

Digital Inputs Summary

1. Space Temperature Switch

2. Liquid Temperature Switch
 (Copper Thermowell: Add \$20 for
 Stainless Steel Thermowell)

3. Gauge Pressure Switch (Liquid)
 (W/Pressure Tap)

4. Differential Pressure (DP) Switch
 (Liquid) (W/Pressure Taps)

5. Differential Pressure DP Switch
 (Air)

6. Liquid Flow Switch
 (W/Pipe Fittings)

7. Liquid Level Switch

8. 1-Phase Electric Power
 (incl. CT, PT, Meter Socket)
 W/Split Coil CT*
 Meter W/Pulse Initiator. Add

9. 3-Phase Electric Power
 (CT, PT, Meter Socket)
 W/Split Coil CT's*
 Meter W/Pulse Initiator. Add

10. Motor Current Status
 (CT, Sensing Relay)
 W/Split Coil CT*

Page Total

Quantity		Material (\$)		Labor (\$)		Total Cost
No. Units	Unit Meas.	Per Unit	Total	Per Unit	Total	
-	EA	105		38		-0-
-	EA	155		143		-0-
2	EA	155	310	147	294	604
-	EA	225		260		-0-
2	EA	70	140	48	96	236
-	EA	145		113		-0-
-		636		80		-0-
-	EA	560		118		-0-
	EA	700		109		
		375		13		
-		400		210		-0-
		820		183		
		575		13		
		85		58		
-		225		49		-0-
			450		390	840

* Use one case or the other as applicable; do not add.

Energy Monitoring and Control Systems

Construction Cost Estimate

Date Prepared

Sheet 9 of 15

District

Basis for Estimate

Project

LANC

- ☐ Schematic Design
- ☐ Preliminary Design
- ☐ Final Design
- ☐ Other (Specify) _____

Location

WVA

Note: Labor values shown are based on \$25.00/hour incl. fringes

Estimator

W. Todd

Checked by

Digital Inputs	Summary	Quantity		Material (\$)		Labor (\$)		Total Cost
		No. Units	Unit Meas.	Per Unit	Total	Per Unit	Total	
11. Status Monitoring	(Limit)	38	EA	15	570	25	950	1520
Auxiliary Contacts	(Switch)							
12. 3-Phase Electric Metering		-	EA	2,745		200		-0-
12 KV Installation								
13. Adjust Material Cost For		-	KV					-0-
Actual Voltage (KV Difference)			EA	110		--		
14. 3-Phase Electric Metering		-	EA	4,360		367		-0-
34.5 KV Installation								
15. Adjust Material Cost for		-	KV					-0-
Actual Voltage (KV Difference)			EA	275		---		
Page Total					570		950	1520

Construction Cost Estimate

Sheet 10 of 15

Basis for Estimate

EMCS

WVA

Estimator

W. Todd

Checked by

Quantity

Material (\$)

Labor (\$)

No.	Units
1	100
2	100
3	100
4	100
5	100
6	100
7	100
8	100
9	100
10	100
11	100
12	100
13	100
14	100
15	100
16	100
17	100
18	100
19	100
20	100
21	100
22	100
23	100
24	100
25	100
26	100
27	100
28	100
29	100
30	100
31	100
32	100
33	100
34	100
35	100
36	100
37	100
38	100
39	100
40	100
41	100
42	100
43	100
44	100
45	100
46	100
47	100
48	100
49	100
50	100
51	100
52	100
53	100
54	100
55	100
56	100
57	100
58	100
59	100
60	100
61	100
62	100
63	100
64	100
65	100
66	100
67	100
68	100
69	100
70	100
71	100
72	100
73	100
74	100
75	100
76	100
77	100
78	100
79	100
80	100
81	100
82	100
83	100
84	100
85	100
86	100
87	100
88	100
89	100
90	100
91	100
92	100
93	100
94	100
95	100
96	100
97	100
98	100
99	100
100	100

Unit
Meas.Per
Unit

	Total

Per
Unit

Total
Cost

EA

130
335

70

2

—

205

25

—

1

EA

182

2002

25

2277

1

 $E A$

400

4400

100

550

Page Total

6402

1370

777

- A-12

Energy Monitoring and Control Systems

Construction Cost Estimate

		Date Prepared		Sheet 11 of 15				
District		Basis for Estimate ☐ Schematic Design ☐ Preliminary Design ☐ Final Design ☐ Other (Specify) _____						
Project <u>EMCS</u>								
Location <u>NVA</u>								
Note: Labor values shown are based on \$25.00/hour incl. fringes		Estimator <u>W. Todd</u>		Checked by				
Digital Outputs Summary 1. Control Relay Output (CR) 2. Solenoid (EP Valve) Control (CR, EP Valve, Pr. Reg.) 3. Contactor Control 60 Amp (Control Relay) W/100 Amps Contactor** 4. Control Point Adjustment (Fail to last command)* (CR, Motorized Pot., Current Transducer, CPA Controller, and I-P Converter incl.)*** 5. Steam Control Valve, 4" Flanged, Iron Body, Pneumatic Operated. Page Total		Quantity No. Units Unit Meas.		Material (\$) Per Unit Total		Labor (\$) Per Unit Total		Total Cost
		12	EA	87	1044	25	300	1344
								-0-
		30	EA	302	9060	75	2250	11,310
		-	EA	412		75		-0-
			EA	557		60		
		-		930		183		-0-
		4	EA	2530	10120	120	480	10600
					20,224		3030	23,254

* Although the CPA with "fail to last command" is listed on the I/O summary sheet as an analog output, it is often implemented by two (raise, lower) digital outputs. For this special case, the quantity must be multiplied by two.

** Use one or the other as appropriate; do not add.

*** See the note on Sheet 7 of these cost estimating forms in reference to the addition of common costs.

Energy Monitoring and Control Systems

Construction Cost Estimate

Date Prepared		Sheet 12 or 15	
District		Basis for Estimate	
Project <u>EMCS</u>		☐ Schematic Design ☐ Preliminary Design ☐ Final Design ☐ Other (Specify) _____	
Location <u>WVA</u>			
Estimator <u>W. Todd</u>		Checked by	
General Costs and Sales Taxes Summary		Mat'L Total	Labor Total
1. Equipment Cost Summary (Maintenance Cost)			
System Equipment Hardware (Sheet 1 Item 1)		3950	100
FID Hardware (Sheet 1, Items 6, 15, & 16)		42568	839
MUX Hardware (Sheet 1 Items 8 & 10)		29225	966
Data Transmission H/W (Sheets 2, 3, 4, & 5)		3500	315
Total Equipment Cost		79,243	2,220
2. First Year Maintenance: 11% of Item 1 Total Cost (Material plus Labor)		(\$ 8961) Do not add this cost to the total construction cost. This information shall be given to the installation for O&M funds planning.	
3. Total Material Cost Summary (Sales Taxes)			
Total Equipment Material Cost (From Item 1 Above)		79,243	2,220
I&C Enclosures (Sheet 1 Items ~~16~~ thru 14)		600	69
Data Transmission Cables (Sheets 2, 3, & 4)		40312	16,726
120 Vac Power Circuits (Sheet 1, Item 9)		1599	3608
Total Material Cost		121,754	22,623
4. Sales Taxes on Materials: (0)% of Item 3 Mat'l Total			-0-
5. Employer's Burden: (20)% of Item 3 Labor Total			4525
Page Total		148,902	

Energy Monitoring and Control Systems

Construction Cost Estimate

		Date Prepared		Sheet 13 of 15	
District		Basis for Estimate ☐ Schematic Design ☐ Preliminary Design ☐ Final Design ☐ Other (Specify) _____			
Project <u>EMCS</u>					
Location <u>WVA</u>					
		Estimator <u>W. Todd</u>		Checked by	
<u>General Costs and Sales Taxes Summary</u>		Mat'L Total	Labor Total	Total Cost	
6. Technical Data Packages (From Table 2.1) 151 pts		—	26,205	26,205	
7. Testing* (From Table 2.2) 58 Analog Pts. 93 Digital Pts.		—	33,263	33,263	
8. Training (From Table 2.3) 10 students		—	20250	20250	
Page Total		-0-	79,718	79,718	

* The estimator should determine the point mix (analog and digital) and make any necessary adjustments to the cost of the Contractor's Field Testing.

Energy Monitoring and Control Systems

Construction Cost Estimate

District		Date Prepared		Sheet 14 of 15	
Project <u>EMCS</u>		Basis for Estimate			
Location <u>WVA</u>		☐ Schematic Design ☐ Preliminary Design ☐ Final Design ☐ Other (Specify) _____			
Estimator <u>W. Todd</u>		Checked by <u>P. Hutchins</u>			
Cost Summary		Mat'L Total	Labor Total	Total Cost	
1. Total Installed Direct Cost of EMCS (Sum of page totals, sheets 1-11; sheets 12 & 13 Items 4-8)		209,340	118,137	327,477	
1A. Correction of EMCS Labor Costs for Project Location: Multiply Labor Cost by (1.0).*		209,340	118,137	327,477	
2. Contractor's Overhead at (15)()% of Item 1A.					
3. Contractor's Profit at (10) ()% of Item 1A.					
4. Performance Bond at (1) ()% of Item 1A.					
5. S & A Allowance at (5.5) (6.0)% of Item 1A.					
6. Contingencies at (10) ()% of Item 1A.					
7. Design at 6.0% of Item 1A					
SEE PAGE 15-21 for mark-ups					
EMCS Total Construction Cost					

* To determine this factor, the estimator must first determine the prevailing local labor rate (whether Union or Davis-Bacon). If, for instance, the local rate is \$32, this factor is $(\$32/\$25) = (1.28)$.

Construction Cost Estimate

Sheet 15 of 15

Project

EMCS

Location

WVA

☐ Schematic Design
☐ Preliminary Design
☐ Final Design
☐ Other (Specify) _____

Estimator
W. Todd

Checked by

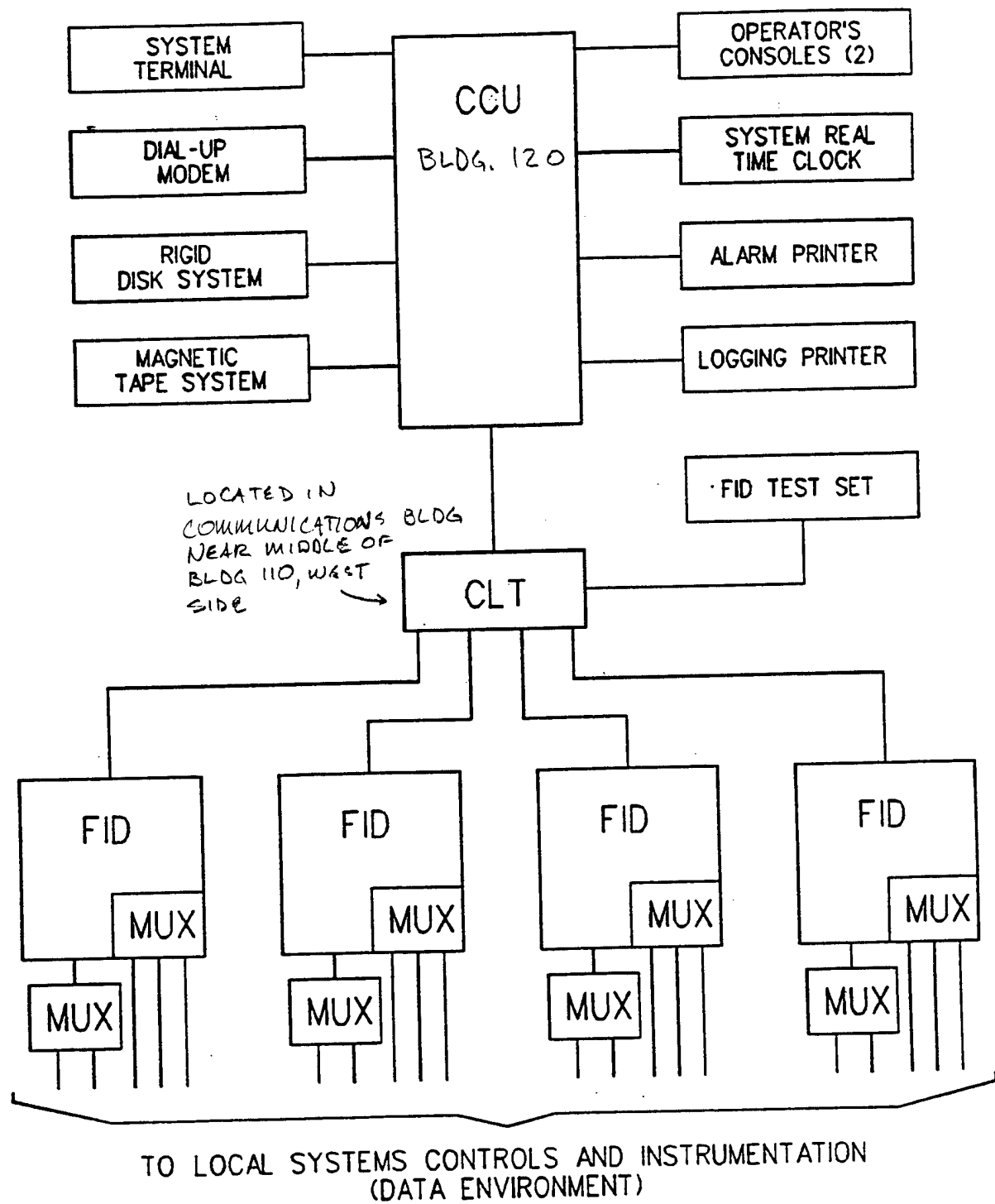
<u>Related Cost Summary</u>	<u>Mat'L Total</u>	<u>Labor Total</u>	<u>Total Cost</u>
1. Associated General Construction Lump Sum Cost (Sheet 14 total)			
2. Electrical Equipment Modifications Lump Sum Cost*			
3. Mechanical Equipment Modifications Lump Sum Cost*			
4. Existing Controls Repair Lump Sum Cost			
Total Costs			

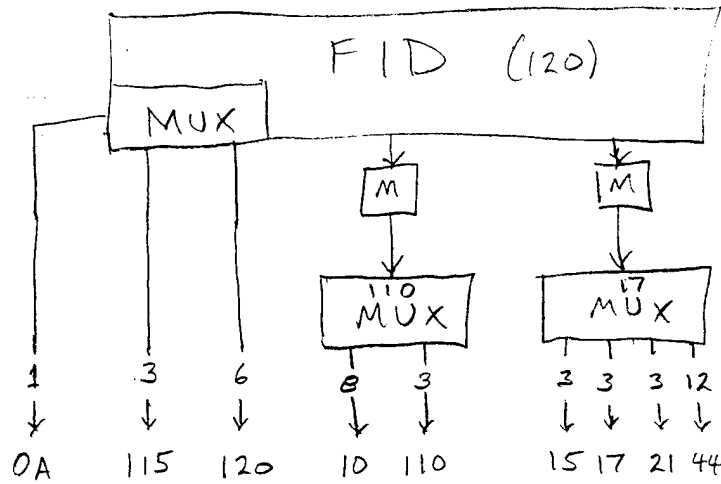
A-17

15-37

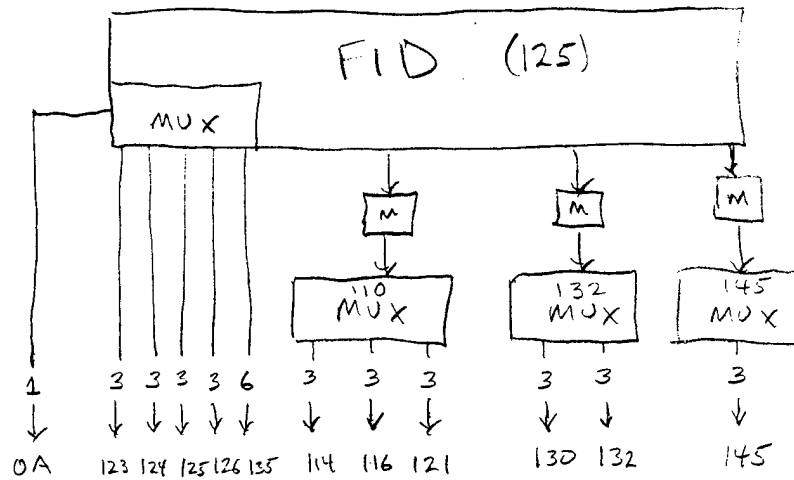
FIGURE 1-1

MEDIUM EMCS BLOCK DIAGRAM

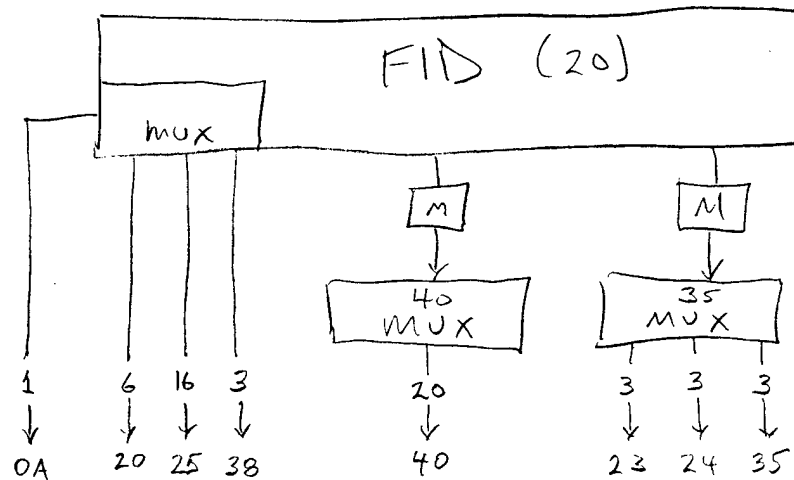




1 FID
2 MODEM
2 MUX
42 Points
8 Edges



1 FID
3 MODEM
3 MUX
37 Points
11 Edges



1 FID
2 MODEM
2 MUX
55 Points
7 Edges

SUBJECT ECO #15 - EMCS

AEP NO. _____

SHEET _____ OF _____

DESIGNER _____

DATE _____

CHECKER _____

DATE _____

Project Implementation Costs

The following sources were used to estimate the EMCS acquisition and installation costs:

1. EMCS, Large and Medium Configurations, Cost Estimating Guidelines, US Army Corps of Engineers, Huntsville Division, 12/90.
2. Means Mechanical Cost Data, 1991
3. Omega Engineering Catalog

All necessary control points are listed on the next 2 pages. The cost summary for these control points by function is contained on p. 15-43 and individually on p. 15-29 through 15-34.

Pages 15 through 30 contain the construction cost estimate worksheets.

ECO #15 - EMCS

Watervliet Arsenal - EMCS System & Points Schedule

File Name: EMSLIST.W01

Date: 03/02/92

Bldg	Area	System	Control	OUTPUT										Control Valve	120 VAC Power
				Total Pts	CRO	SOL	DMA	PID	GPS	DPS	LIM	STS	POS	OAT	
10	Repro	AHU-SZ,DX		0											
	ADPS	AHU-SZ,DX		0											
	Compu	AHU-SZ,DX		0											
	Admin N	AHU-VAV	VR	3	0	0	1	1	0	0	0	0	1	0	
	Admin S	Convert-HW	SBV&SBP	5	1	1	0	0	1	0	1	1	0	0	1
15	Admin	AHU-SZ,DX		0											
	Shop	UnitHt-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1
17	Grounds	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1
20	Admin	AHU-VAV	VR	4	0	0	1	1	0	0	0	0	1	1	
	Admin	Radiat-Stm		0											
	Shop	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1
21	Cafe	AHU-HV		0											
	Cafe	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1
22	Fire Sta	Radiat-Stm		0											
23	Admin 1st	Radiat-Stm	SBV	3	0	1	0	0	0	0	1	1	0	0	1
24	Admin	AHU-SZ,DX		0											
	Admin	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1
	Compu	AHU-SZ,DX		0											
25	Admin	AHU-VAV	VRF	5	1	0	1	1	0	1	0	0	1	0	
	Admin	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1
	Admin	AHU-VAV	VRF	5	1	0	1	1	0	1	0	0	1	0	
	Shop	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1
	Compu	AHU-SZ,DX		0											
35	Shop	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1
	Class Rm	AHU-SZ,DX		0											
38	Museum	Radiat-Stm	SBV	3	0	1	0	0	0	0	1	1	0	0	1
	Museum	AHU-SZ,DX		0											
40	MicroFilm	AHU-SZ,DX	VR	3	0	0	1	1	0	0	0	0	1	0	
	CADD	AHU-SZ,DX	VR	3	0	0	1	1	0	0	0	0	1	0	
	Admin	Chiller-AC		0											
	Admin 1	AHU-SZ	VR	3	0	0	1	1	0	0	0	0	1	0	
	Admin 1	Convert-HW	SBP	2	1	0	0	0	1	0	0	0	0	0	
	Admin 2	AHU-SZ	VR	3	0	0	1	1	0	0	0	0	1	0	
	Draft	AHU-SZ,DX		0											
	N-Conf	AHU-SZ,DX		0											
	S-Conf	AHU-SZ,DX		0											
	Clinic	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1
	Employ	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1
44	Admin	AHU-SZ	VR	3	0	0	1	1	0	0	0	0	1	0	
	Admin	Chiller-AC		0											
	Admin E	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1
	Admin W	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1
	Labs	AHU-SZ		0											
	Labs	Chiller-AC		0											
	Compu	AHU-SZ,DX		0											
	Basmt	AHU-HV	VR	3	0	0	1	1	0	0	0	0	1	0	

ECO #15 - EMCS

110	Shop	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1	
114	Lab	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1	
115	Admin	AHU-SZ		0												
	Admin	AHU-HV		0												
	Admin	AHU-HV		0												
	Admin	Radiat-Stm	SBV	3	0	1	0	0	0	0	1	1	0	0	1	1
	Compu	AHU-SZ,DX		0												
116	POL	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1	
120	Admin	AHU-MZ	VR	4	0	0	1	1	0	0	0	0	1	1		
	Admin	Chiller-AC		0												
	Shop	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1	
	C&W Labs	AHU-SZ		0												
	C&W Labs	Chiller-AC		0												
	E Labs	AHU-HV		0												
	E Labs	Chiller-AC		0												
121	Lab	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1	
123	Lab	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1	
124	Lab	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1	
125	Shop	Radiat-Stm	SB	4	0	1	0	0	0	0	1	1	0	1	1	
126	Storage	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1	
130	Storage	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1	
132	Pest	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1	
135	Shop	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1	
	Office	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1	
145	Storage	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0	1	
Totals				134	4	30	11	11	2	2	30	30	11	3	4	30

Control Point Legend:

CRO - Control Relay Output
 SOL - Solenoid
 DMA - Damper Motor Actuator
 PID - PID Controller
 GPS - Gage Pressure Switch
 DPS - Differential Pressure Switch
 LIM - End Limit Switch
 STS - Space Temperature Sensor ('F)
 POS - Damper Position Indicator
 OAT - Outside Air Temp. Sensor ('F)

Controlled System Legend:

AHU - Air Handling Unit
 AHU-HV - AHU, Heating & Ventilating
 AHU-MZ - AHU, Multi-Zone
 AHU-SZ - AHU, Single Zone
 AHU-SZ,DX - AHU, Single Zone, Direct Exp.
 AHU-VAV - AHU, Variable Air Volume
 Chiller-AC - Chiller, Air Cooled
 Convert-HW - Converter, Steam to Hot Water
 Radiat-Stm - Radiators, Steam
 UnitHt-Stm - Unit Heater, Steam

EMCS Function Legend:

SB - Day/Night Setback of Steam Valve
 SBV - SB With New Control Valve
 SBP - Setback Pump
 VR - Ventilation/Recirculation
 VRF - V/R With Exhaust Fan Control

CONSTRUCTION COST ESTIMATE				DATE PREPARED 3-20-92		SHEET OF	
PROJECT ENERGY ENGINEERING ANALYSIS					BASIS FOR ESTIMATE ☐ CODE A (No design completed) ☒ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____		
LOCATION WATERVLIET ARSENAL							
ARCHITECT ENGINEER REYNOLDS, SMITH AND HILLS A.E.P., INC.							
DRAWING NO. N/A			ESTIMATOR W.T. Todd		CHECKED BY		

EMCS SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
SETBACK - STEAM INPUT							
Space Temp. Sensor (A)	30	Ea.	35	1050	125	3750	4800
End limit Switch (D)	30	Ea.	25	750	15	450	1200
OUTPUT							
Solenoid (D)	30	Ea.	75	2250	302	9060	11310
120 Volt AC Power	30	Ea.	88	2640	39	1170	3810
Pneumatic Steam Valve, 4"	4	Ea.	120	480	2530	10120	10600
				7170		24550	31720
VENTIL. & RECIRC. INPUT							
Differential Press. Switch (D)	2	Ea.	48	96	70	140	236
Damper Pos. Ind. (A)	11	Ea.	73	803	210	2310	3113
OUTPUT							
Damper Motor Actuator (A)	11	Ea.	25	275	182	2002	2277
Control Relay (D)	2	Ea.	25	50	87	174	224
PID Controller	11	Ea.	100	1100	400	4400	5500
				2324		9026	11350
SETBACK - PUMP INPUT							
Gage Pressure Switch (D)	2	Ea.	147	294	155	310	604
OUTPUT							
Control Relay (D)	2	Ea.	25	50	87	174	224
				344		484	828

WVA - EMS Wire Line Distances (In Feet)

Filename: EMSCABL2.W01

		CLT-FID			FID-MUX			MUX-PTS				MUX-PTS TOTAL			
		Bldg	Duct	Bury	Bldg	Duct	Bury	Bldg	Duct	Bury	Bldg	Points	Duct	Bury	Bldg
FID 1	20	2600	0	200	0	0	0	0	0	0	300	7	0	0	2100
	25	0	0	0	0	0	0	300	0	0	300	16	4800	0	4800
	38	0	0	0	0	0	0	225	100	150		3	675	300	450
MUX 1	35	0	0	0	1000	0	400	0	0	0	400	3	0	0	1200
	23	0	0	0	0	0	0	0	0	0	400	3	0	0	1200
	24	0	0	0	0	0	0	0	0	0	300	3	0	0	900
MUX 2	40	0	0	0	875	0	400	0	0	0	400	20	0	0	8000
Subtotal		2600	0	200	1875	0	800	525	100	2250		55	5475	300	18650
FID 2	120	5300	0	250	0	0	0	0	0	0	200	7	0	0	1400
	115	0	0	0	0	0	0	50	50	200		3	150	150	600
MUX 1	17	0	0	0	1150	0	250	0	0	0	100	3	0	0	300
	15	0	0	0	0	0	0	275	50	150		3	825	150	450
	21	0	0	0	0	0	0	50	50	150		3	150	150	450
	44	0	0	0	0	0	0	300	0	200		12	3600	0	2400
MUX 2	110	0	0	0	375	0	300	0	0	0	400	3	0	0	1200
	10	0	0	0	0	0	0	50	300	200		8	400	2400	1600
Subtotal		5300	0	250	1525	0	550	725	450	1600		42	5125	2850	8400
FID 3	125	875	0	300	0	0	0	0	0	0	350	4	0	0	1400
	123	0	0	0	0	0	0	500	0	150		3	1500	0	450
	124	0	0	0	0	0	0	325	0	150		3	975	0	450
	126	0	0	0	0	0	0	325	0	150		3	975	0	450
	135	0	0	0	0	0	0	625	0	300		6	3750	0	1800
MUX 1	110	0	0	0	875	0	300	0	0	0		0	0	0	0
	114	0	0	0	0	0	0	75	0	100		3	225	0	300
	116	0	0	0	0	0	0	300	50	100		3	900	150	300
	121	0	0	0	0	0	0	250	50	100		3	750	150	300
MUX 2	132	0	0	0	1350	0	150	0	0	50		3	0	0	150
	130	0	0	0	0	0	0	300	100	150		3	900	300	450
MUX 3	145	0	0	0	2050	0	200	0	0	300		3	0	0	900
Subtotal		875	0	300	4275	0	650	2700	200	1900		37	9975	600	6950
TOTAL		8775	0	750	7675	0	2000	3950	750	5750		134	20575	3750	34000

Existing Duct Bank
Direct Burial
Indoor

Material
37025 Feet
3750 Feet
36750 Feet

Labor
20400 Feet
750 Feet
8500 Feet

WVA - EMCS Cable Distances
Existing Duct Banks
Filename: EMSCABL2.WQ1

Run Number	Manhole No.s From #	To #	Plan Inches	Act. Feet
1	2	1	1.125	225
2	3	2	0.875	175
3	4	3	0.750	150
4	5	4	0.750	150
5	5	5 A	0.500	100
6	5 A	38	1.000	200
7	6	5	1.125	225
8	7	6	0.875	175
9	8	7	1.375	275
10	9	8	1.125	225
11	10	9	0.750	150
12	11	10	0.375	75
13	12	11	0.375	75
14	12	14	1.250	250
15	14	15	0.750	150
16	15	16	1.000	200
17	16	17	1.000	200
18	17	18	0.375	75
19	18	19	0.875	175
20	19	19 A	1.000	200
21	19	20	1.500	300
22	19 A	19 B	1.000	200
23	19 B	19 C	0.875	175
24	19 C	60	1.375	275
25	20	22	0.750	150
26	20	32	2.000	400
27	22	23	1.125	225
28	32	33	1.500	300
29	33	34	0.750	150
30	34	5	0.125	25
31	42	41	1.625	325
32	43	42	1.250	250
33	44	43	1.125	225
34	44	46	1.500	300
35	46	47	1.375	275
36	52	44	2.000	400
37	53	52	0.500	100
38	54	53	1.250	250
39	55	54	1.250	250
40	55	55 A	1.375	275
41	56	55	1.375	275
42	57	56	1.625	325
43	57	57 A	1.125	225
44	58	57	1.500	300
45	59	58	1.750	350
46	60	59	1.750	350

[illegible]

Table 4-20. I/O summary table for steam/HW converter.

* ONE MEASUREMENT FOR ENTIRE SYSTEM
* C - LAST COMMAND O - ON (OPEN)
* H - HIGH VALUE F - OFF (CLOSED)
* L - LOW VALUE N - LOCAL LOOP

• ONE MEASUREMENT FOR ENTIRE SYSTEM
• C - LAST COMMAND O - ON (OPEN)
• H - HIGH VALUE F - OFF (CLOSED)
• L - LOW VALUE N - LOCAL LOOP

Note (1) - Outside Air temp. sensor is for Bldg. 20 only.

Table 4-3. I/O summary table for variable air volume AHU.

[illegible]

• ONE MEASUREMENT FOR ENTIRE SYSTEM
• C - LAST COMMAND O - ON (OPEN)
 H - HIGH VALUE F - OFF (CLOSED)
 L - LOW VALUE N - LOCAL LOOP

Table 4-10. I/O summary table for steam unit heater.

BUILDING NO'S See list below	HARDWARE														SOFTWARE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
	OUTPUT				INPUT				ALARMS		APPLICATION PROGRAMS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL

- ONE MEASUREMENT FOR ENTIRE SYSTEM
- C - LAST COMMAND O - ON (OPEN)
- H - HIGH VALUE F - OFF (CLOSED)
- L - LOW VALUE N - LOCAL LOOP

Table 4-13. I/O summary table for steam radiation.

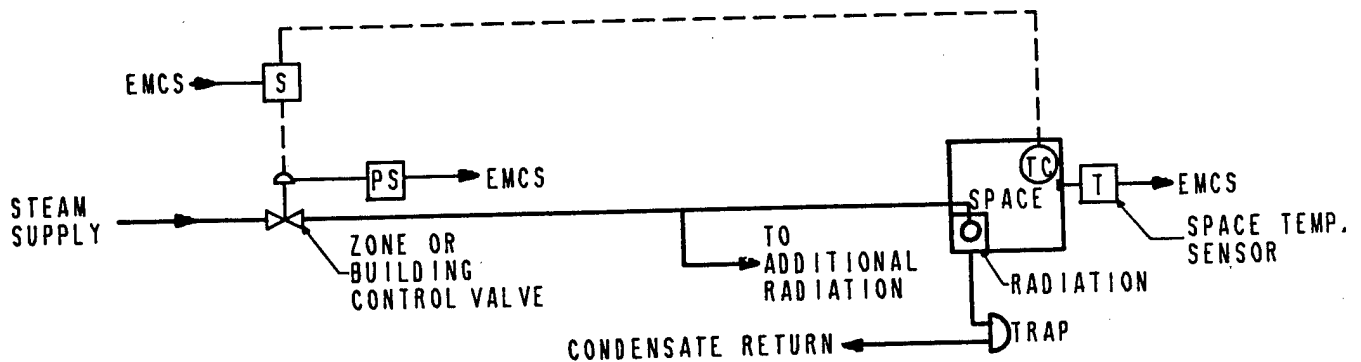


Figure 4-13. Steam radiation schematic.

Applies to the following Buildings:

20	~~17~~	35	121	126	40	135
23	17	110	123	130	44	
25	21	114	124	132	115	
38	24	116	125	145	120	

Note (1) - Outside air temp. sensor is for Bldg. 125 only

• ONE MEASUREMENT FOR ENTIRE SYSTEM
• C - LAST COMMAND O - ON (OPEN)
• H - HIGH VALUE F - OFF (CLOSED)
• L - LOW VALUE N - LOCAL LOOP

Table 4-3. I/O summary table for variable air volume AHU.

[illegible]

Table 4-20. I/O summary table for steam/HW converter.

* ONE MEASUREMENT FOR ENTIRE SYSTEM
* C - LAST COMMAND O - ON (OPEN)
* H - HIGH VALUE F - OFF (CLOSED)
* L - LOW VALUE N - LOCAL LOOP

* ONE MEASUREMENT FOR ENTIRE SYSTEM
 * C - LAST COMMAND O - ON (OPEN)
 * H - HIGH VALUE F - OFF (CLOSED)
 * L - LOW VALUE N - LOCAL LOOP

Table 4-5. I/O summary table for single zone DX-AC unit.

BUILDING NO'S 40 & 44	HARDWARE										SOFTWARE									
	OUTPUT					INPUT					ALARMS					APPLICATION PROGRAMS				
	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG	DIGITAL	ANALOG
SYSTEM(S)																				
SINGLE ZONE AHU																				
OCCUPANCY TIME																				
GRAPHIC DISPLAY																				
POINT DESCRIPTION																				
SINGLE ZONE AHU																				
SUPPLY FAN																				
RETURN FAN																				
O. A. DAMPER																				
MIXED AIR																				
SUPPLY AIR																				
RETURN AIR																				
SPACE																				
FILTER																				
OUTSIDE AIR																				

* ONE MEASUREMENT FOR ENTIRE SYSTEM
 * C - LAST COMMAND
 * H - HIGH VALUE
 * L - LOW VALUE
 * N - LOCAL LOOP
 * F - OFF (CLOSED)
 * O - ON (OPEN)

Table 4-1. I/O summary table for single zone AHU.

[illegible]

ONE MEASUREMENT FOR ENTIRE SYSTEM

C - LAST COMMAND	O - ON (OPEN)
H - HIGH VALUE	F - OFF (CLOSED)
L - LOW VALUE	N - LOCAL LOOP

Table 4-9. I/O summary table for heating and ventilating unit.

[illegible]

ONE MEASUREMENT FOR ENTIRE SYSTEM

C - LAST COMMAND	O - ON (OPEN)
H - HIGH VALUE	F - OFF (CLOSED)
L - LOW VALUE	N - LOCAL LOOP

multi-zone
Table 4-2. I/O summary table for ~~multi-zone~~ AHU.

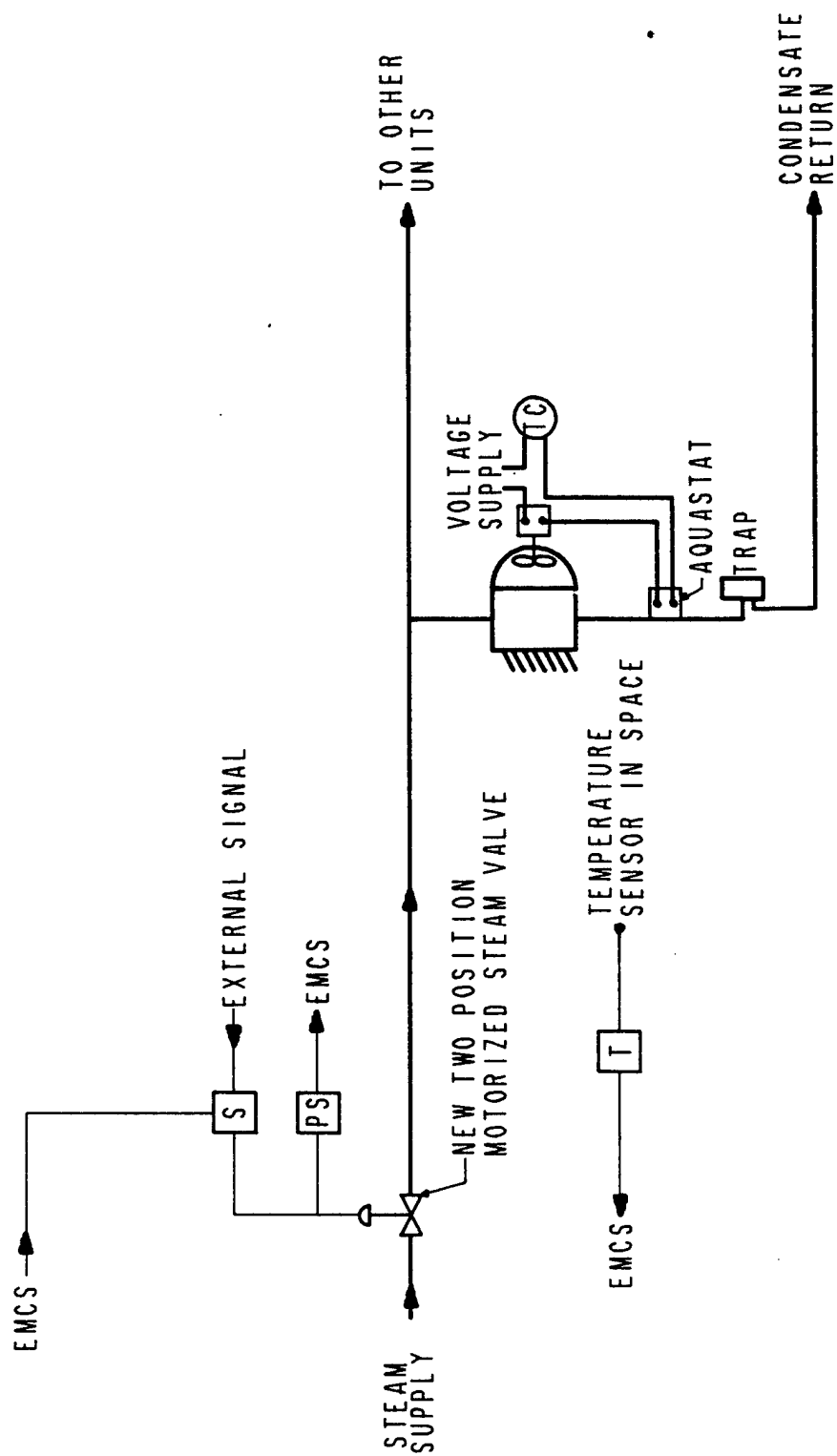


Figure 4-10. Steam unit heater schematic.

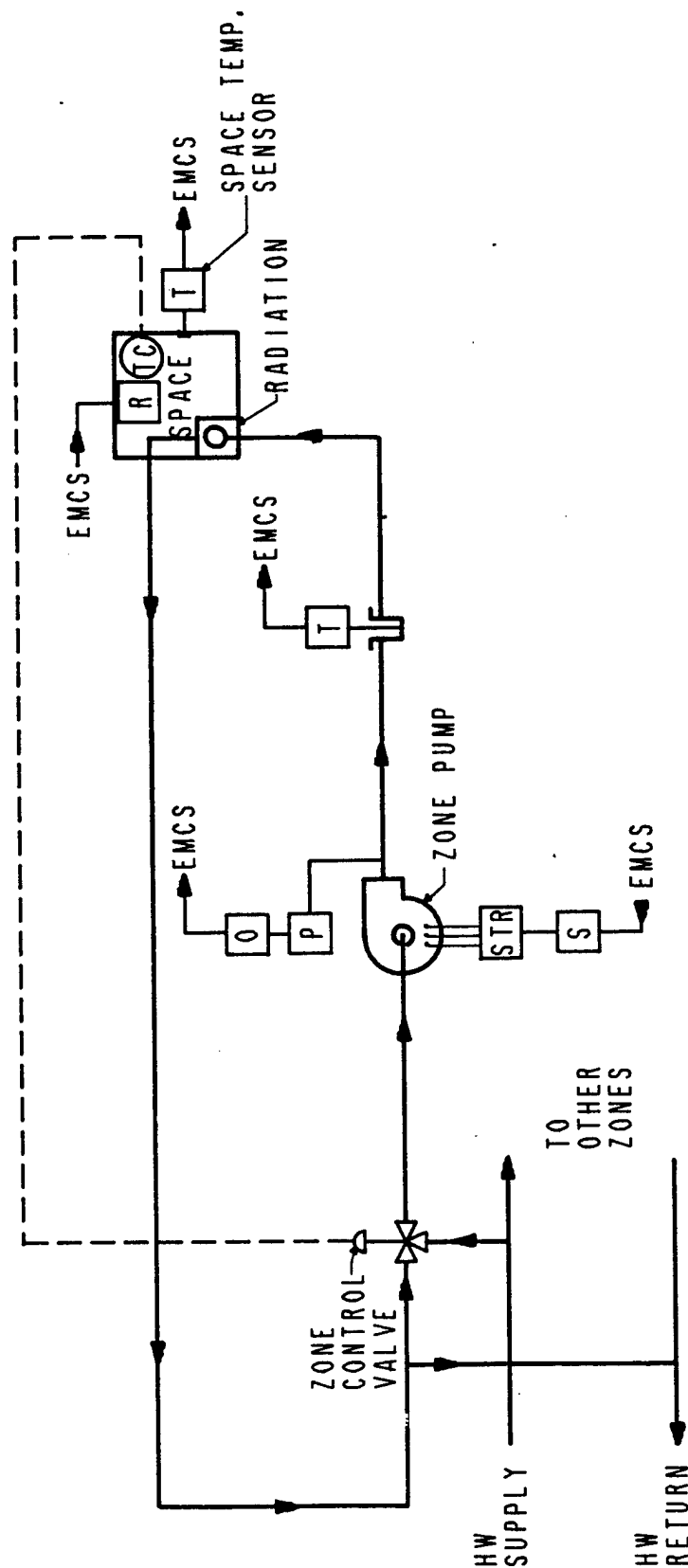


Figure 4-15. Hot water radiation schematic.

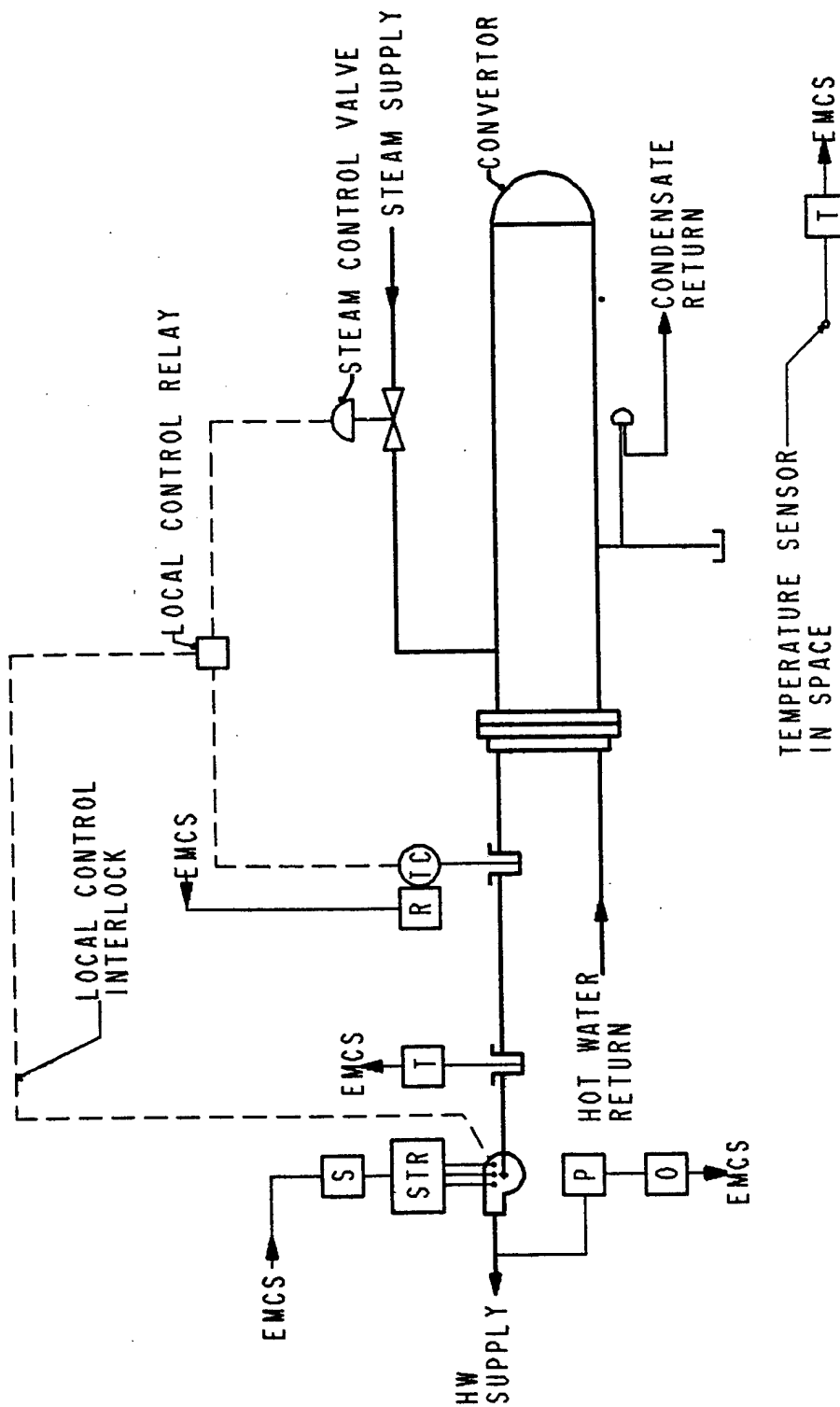


Figure 4-20. Steam/HW converter schematic.

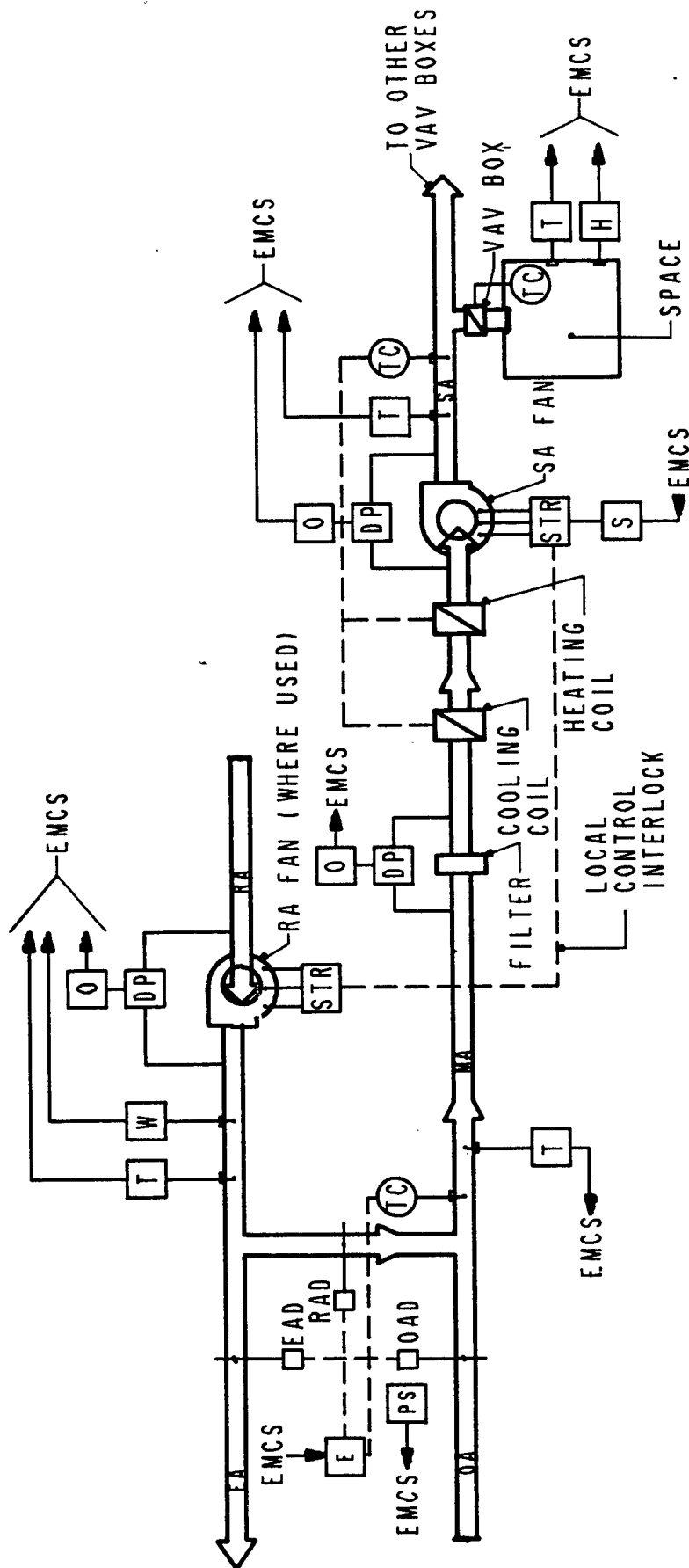


Figure 4-3. Variable air volume AHU schematic.

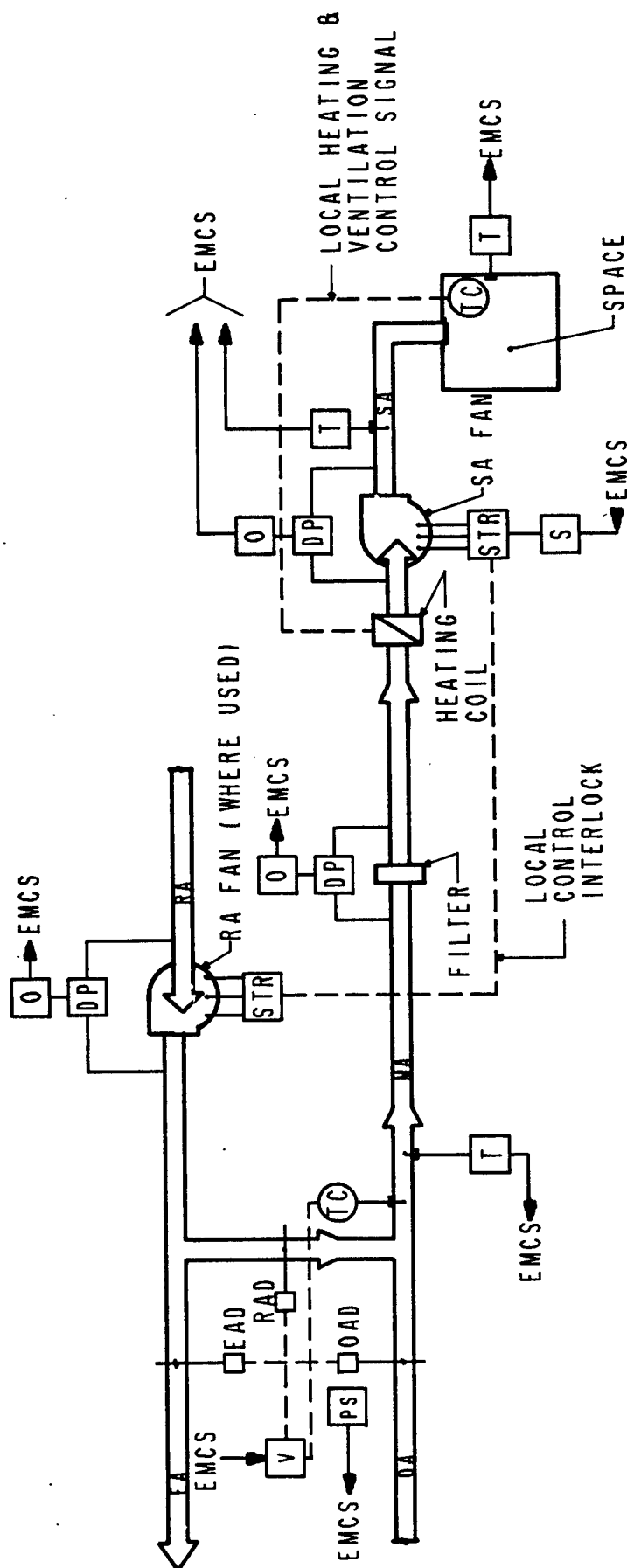


Figure 4-9. Heating and ventilating unit schematic.

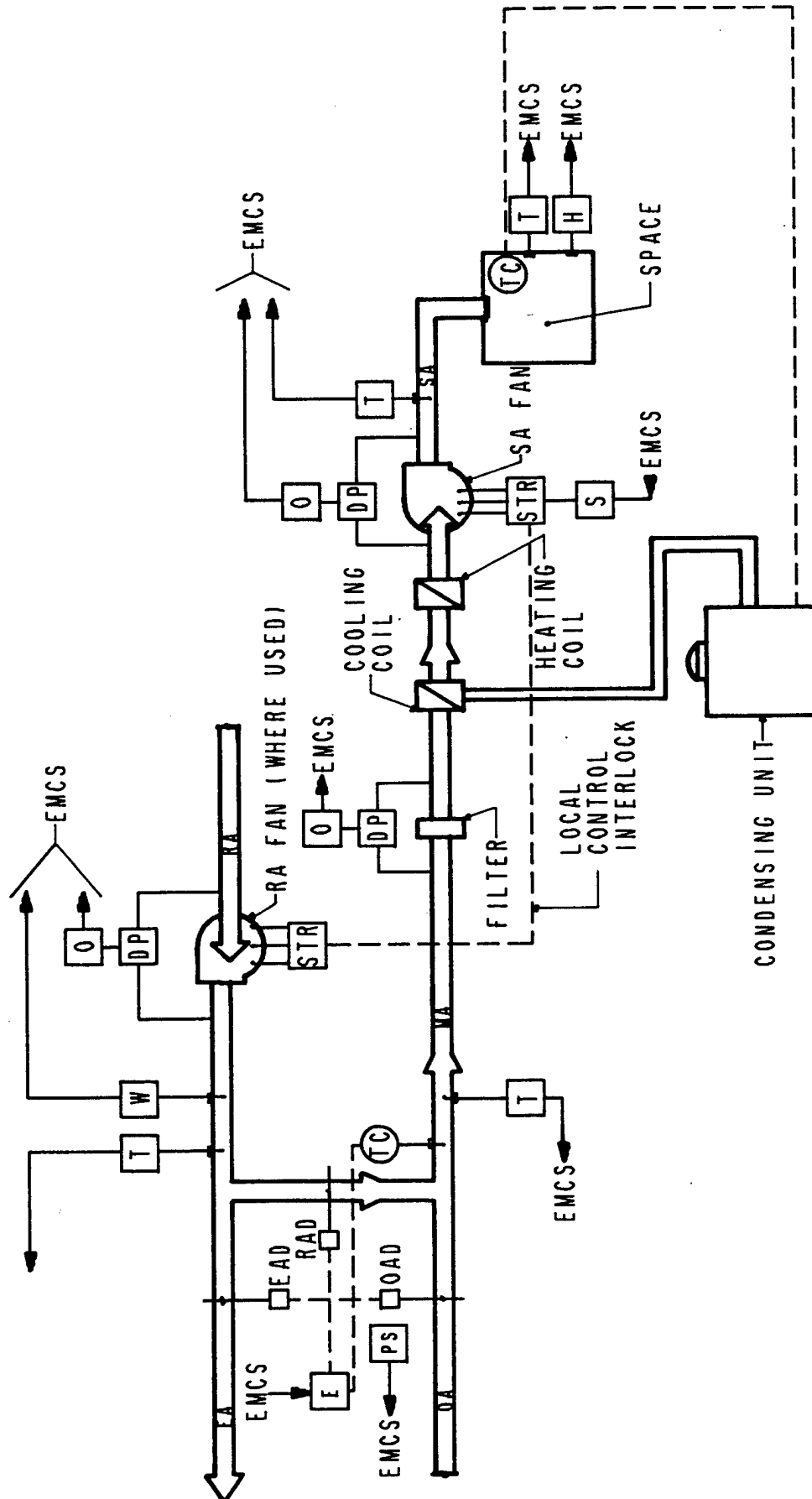


Figure 4-5. Single zone DX-AC unit schematic.

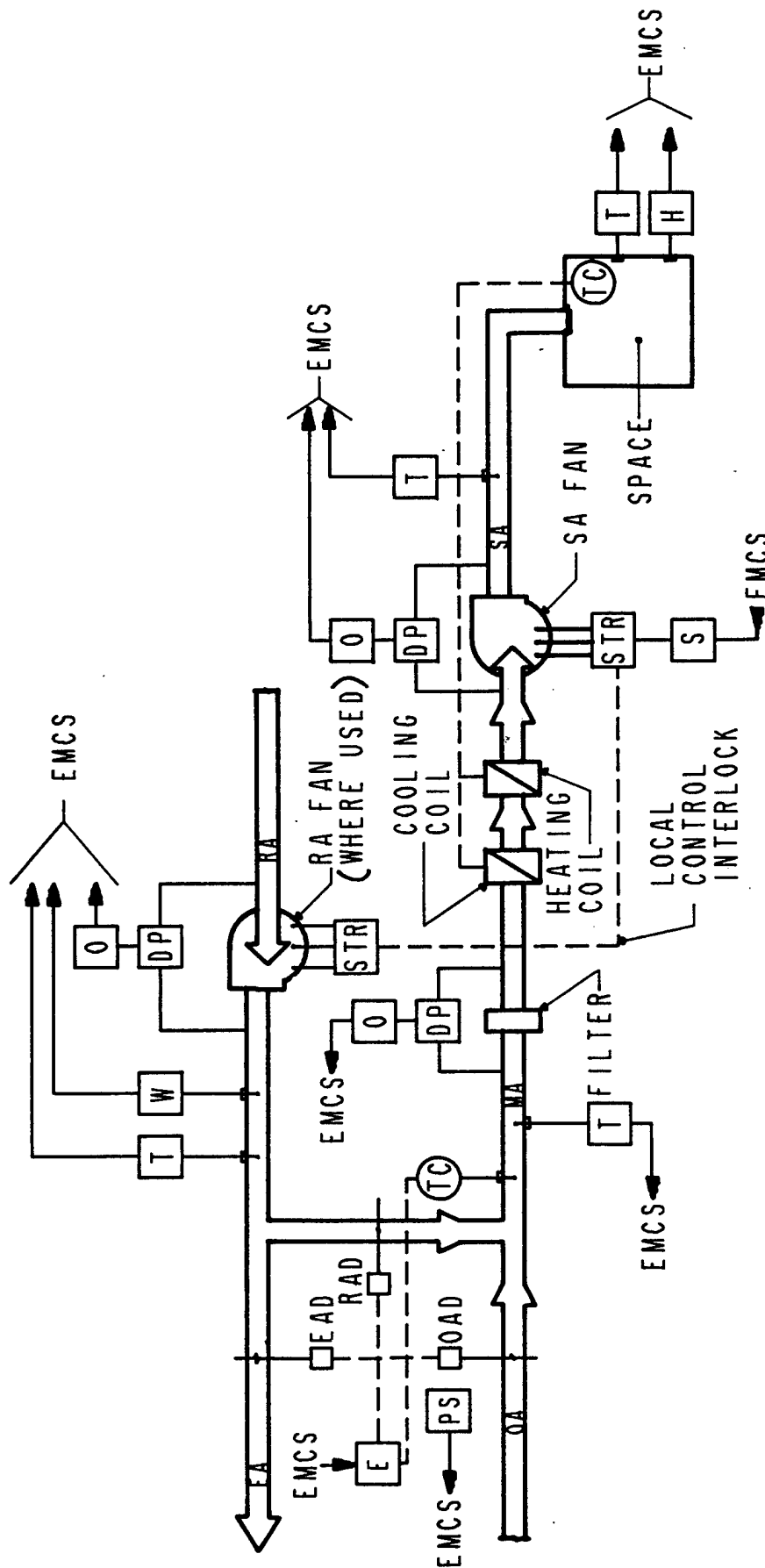


Figure 4-1. Single zone AHU schematic.

15-62

→ EMCS SIGNAL TRANSMITTED TO EMCS
 ← EMCS SIGNAL TRANSMITTED FROM EMCS

[A]	ALARM CONTACT SIGNAL
[E]	ECONOMIZER CONTROL INTERFACE
[F]	FLOW INDICATION
[FL]	FLAME INDICATION
[H]	HUMIDITY INDICATION
[P]	PRESSURE INDICATION
[LV]	LEVEL INDICATION
[M]	METER
[O]	ON-OFF STATUS SIGNAL
[DP]	DIFFERENTIAL PRESSURE SWITCH
[R]	CONTROLLER RESET INTERFACE
[S]	START-STOP INTERFACE
[T]	TEMPERATURE INDICATION
[V]	VENTILATION/RECIRCULATION CONTROL
[PS]	POSITION
[O ₂]	FLUE GAS ANALYSIS, OXYGEN
[C ₁]	FLUE GAS ANALYSIS, CARBON MONOXIDE

[FD]	FURNACE DRAFT DIFFERENTIAL PRESSURE
[DS]	HIGH-LOW DEMAND SIGNAL SELECTOR
[TC]	TEMPERATURE CONTROLLER
[PC]	PRESSURE CONTROLLER
[STR]	MOTOR STARTER
	SENSOR INSTALLED IN THERMOMETER WELL
	SENSOR INSTALLED IN DUCT OR PLENUM
CHW	CHILLED WATER
EA	EXHAUST AIR
SA	SUPPLY AIR
RA	RETURN AIR
OA	OUTSIDE AIR
MA	MIXED AIR
WB	WET BULB
DB	DRY BULB
OAD	OUTSIDE AIR DAMPER
RAD	RETURN AIR DAMPER
EAD	EXHAUST AIR DAMPER
MZD	MULTIZONE DAMPER
RH	RELATIVE HUMIDITY

Table 4-90. Symbols and abbreviations.

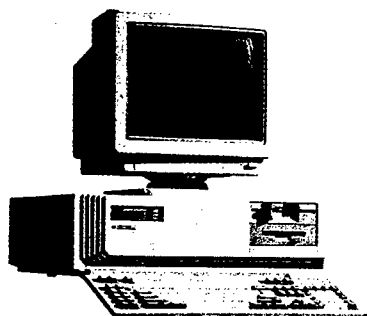
Team Manufacturing Approach

Northgate has studied manufacturing methods and has selected a process that gives the greatest quality and productivity.

Our technicians are skilled in all phases of manufacturing. Working in teams of four, they bring the elements of quality together with craftsmanship that knows no equal. A detailed system of checks and balances ensures strict adherence to our rigid quality control standards. When all is complete, comprehensive burn-in and final testing begin.



Northgate Elegance™ Scalable Processing (SP) Upgradable Systems

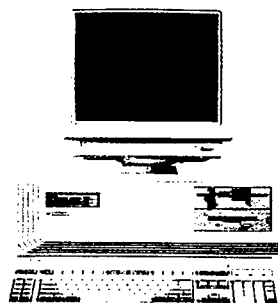


Northgate Elegance SP™ 386/25 or 33

- Intel® 80386DX™ 25 or 33 MHz Processor on Power Module
- Fast, Affordable Upgrades — Simply Replace Power Module
- 4MB RAM (Expands to 32MB)
- 106MB IDE Hard Drive with 17 ms Seek Time
- 64K Cache Memory
- Desktop Case
- 1.2MB 5.25" and 1.44MB 3.5" Floppy Drives
- Exclusive *OmniKey*® Keyboard
- VGA 1024 x 768 Card and Color Monitor
- Microsoft® Windows™ 3.0 and Mouse
- MS-DOS® 3.3, 4.01 or 5
- FCC Class B Certified

\$2899⁰⁰/\$2999⁰⁰

Lease as low as \$100.31/\$103.77 per month*

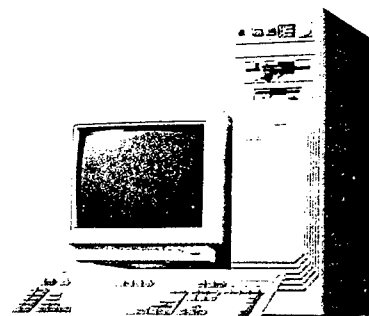


Northgate Elegance SP 486SX™/20

- Intel 80486SX™ 20 MHz Processor on Power Module
- Fast, Affordable Upgrades — Simply Replace Power Module
- 4MB RAM (Expands to 32MB)
- 106MB IDE Hard Drive with 17 ms Seek Time
- 64K Cache Memory
- Desktop Case
- 1.2MB 5.25" and 1.44MB 3.5" Floppy Drives
- Exclusive *OmniKey*® Keyboard
- VGA 1024 x 768 Card and Color Monitor
- Microsoft Windows 3.0 and Mouse
- MS-DOS 3.3, 4.01 or 5
- FCC Class B Certified

\$3149⁰⁰

Lease as low as \$108.96 per month*



Northgate Elegance SP 486DX/33

- Intel 80486DX™ 33 MHz Processor on Power Module
- 4MB RAM (Expands to 64MB)
- 106MB IDE Hard Drive with 17 ms Seek Time
- 64K Cache Memory
- Vertical Power Case
- 1.2MB 5.25" and 1.44MB 3.5" Floppy Drives
- Exclusive *OmniKey*® Keyboard
- VGA 1024 x 768 Card and Color Monitor
- Microsoft Windows 3.0 and Mouse
- MS-DOS 3.3, 4.01 or 5
- FCC Class B Certified

\$3349⁰⁰

Lease as low as \$115.88 per month*

Project No. 290-6379-002

Local _____ L.D. ✓ Placed ✓ Rec'd. _____ Date 2/11/92

_____ P. Hutchins _____ Conversed With Frank Carlen

Of Huntsville Div. COE _____ Regarding EMCS

Mr. Deshazo will send me info. on latest guidelines

He also said the ETC not allowing IDC has been rescinded as of last week.

Mr. Deshazo

FID drives 16 MUX's

MUX can drive 64 pts.

MUX's can be located 100 yds away from FID w/o special driver - even further with modem

Distribution:

Project No. 290-0379-002

Local L.D. Placed Rec'd. 3-2-92
B. Todd Conversed With Jim Kief (or Edward Maruszek)
 Of WVA - Communications Regarding EMCS
(518) 266-5312

WVA uses "twisted pairs" for their control wiring.

Control wiring for Don Brooks' "EMCS" consists of 50 twisted pairs, and they are centrally wired through Building 112 (Mid-Building 110)

They currently do not have enough extra wires to each Building for an EMCS.

Distribution:

Project No. 290-0379-002

Local L.D. Placed Rec'd. 3-3-92
B. Todd Conversed With Mr. Deshazo
Of Army COE, Huntsville Div. Regarding EMCS Configuration
(205) 895-3324

Our cost for the medium EMCS is over \$400,000.

That seems high for just 134 points.

Suggests we use a 16 bit or 32 bit IBM Computable PC with 1 MB of RAM, an internal clock, floppy disk drive, hard disk drive, a dial-up modem and a CRT (monitor).

A printer is also required for data and alarm printouts.

They have used a PC with 64 KB RAM to drive an EMCS with 1000 points.

Distribution:



SUBJECT WVA - Building 44
Add Return Air to HV-1
DESIGNER W. T. Todd
CHECKER _____

AEP NO 290-0379-002
SHEET 1 OF _____
DATE 2-13-92
DATE _____

ECO #16

Reduce Outside Air / Add Return Air to HV-1

Heating and Ventilating unit HV-1 was designed to heat 100% outside air for ventilation of the basement. HV-1 operates 24 hours per day.

The current winter operating mode of HV-1 returns approximately 30% of the supply air through transfer grilles and an opening in the mechanical equipment room door. This mode of operation saves some heating energy but causes a large negative pressure on the basement area which increases the infiltration of outside air.

In 1981, Planning Research Corporation submitted a project to reduce the outside air intake of HV-1 by adding a return air system and controlling the exhaust fans. This analysis is an update of the project submitted by Planning Research Corporation.

The existing and proposed new ventilation modes, and the proposed operating schedule are shown in the tables on the following page.

Current Energy Use:

The basement is maintained at 68°, 24 hours per day, 7 days per week. The heating energy required to heat the outside air was calculated using a

BASEMENT/HV-1 AIR FLOWS (CFM)

Fan No. & Location		Existing Modes		New Ventilation Modes		
		-- MER Damper --		Min	Med	Max
		Open	Closed			
E1	East	0	4850	0	0	4850
E2	East	2430	2430	0	0	2430
E3 or E6	East	1200	1200	1200	1200	1200
E13	East	4850	4850	0	4850	4850
E15	East	2430	2430	0	0	2430
E18	East	200	200	200	200	200
E7 or E5	Center	7520	11280	3760	7520	11280
E16	Storage	827	827	827	827	827
E4	West	9820	9820	0	0	9820
Total Exhaust Air		29277	37887	5987	14597	37887
HV-1 Outside Air		24073	34390	5800	14272	34390
HV-1 Return Air		10317		28590	20118	0
HV-1 Supply Air		34390	34390	34390	34390	34390
Net Air Flow		-5204	-3497	-187	-325	-3497

HV-1 PROPOSED VENTILATION SCHEDULE

Daily Shift Hours	Vent. Mode	Hours of Operation						
		Mon	Tue	Wed	Thu	Fri	Sat	Sun
12M-8AM	Min	7	7	7	7	7	8	8
	Med	1	1	1	1	1	0	0
	Max	0	0	0	0	0	0	0
8AM-4PM	Min	0	0	0	0	0	8	8
	Med	6	6	6	6	6	0	0
	Max	2	2	2	2	2	0	0
4PM-12M	Min	0	0	0	0	0	8	8
	Med	8	8	8	8	8	0	0
	Max	0	0	0	0	0	0	0



SUBJECT WVA - Bldg. 44
Add Return Air
DESIGNER W. T. Todd
CHECKER _____

AEP NO 290-0379-002
SHEET 3 OF _____
DATE 2-13-92
DATE _____

computer spreadsheet program. This program uses bin temperature data for Albany, NY and the following equation:

$$Q = O.A. \text{ cfm} \times 1.1 \times \Delta T \times \text{hrs/yr}$$

The results (see printout on page 6) show that the energy required to heat outside air for HV-1 is:

$$Q_c = 4972.3 \text{ Mbtu/yr}$$

Assuming a boiler efficiency of 0.80 and a steam to hot water converter efficiency of 0.95:

$$Q_c (\text{F.D. \#6}) = 4972.3 \frac{\text{Mbtu}}{\text{yr}} \div 0.8 \div 0.95 = \underline{6542.5 \frac{\text{Mbtu}}{\text{yr}}}$$

The fan for HV-1 will be adjusted to overcome the additional friction of the new return air system. The increased electricity use by this fan motor is expected to be offset by the reduced operating hours of the various exhaust fans.

Future Energy Use:

Saving will be achieved reducing the amount of outside air to be heated and also by reducing the temperature during the third shift and during weekends.

The same computer spreadsheet program was used



SUBJECT WVA - Bldg. 44
Add Return Air
DESIGNER W.T. Todd
CHECKER _____

AEP NO 290-0379-002
SHEET 4 OF _____
DATE 2-13-92
DATE _____

to calculate the future energy use in the various ventilation modes.

The results (see printouts on pages 7-10) are shown below:

* Min. Vent. w/setback to 55°F :

$$\text{3rd shift : } Q_3 = 172.3 \text{ MBtu/yr}$$

$$\text{Weekends : } Q_w = 194.4 \text{ MBtu/yr}$$

* Medium vent. mode, 68°F, shifts 1 & 2 :

$$Q_m = 1228.2 \text{ MBtu/yr}$$

* Maximum vent. mode, 68°F, 2 hours during 1st shift:

$$Q_{mx} = 349.1 \text{ MBtu/yr}$$

The total heating energy required is:

$$Q_F = Q_{mx} + Q_m + Q_w + Q_3$$

$$Q_F = (349.1 + 1228.2 + 194.4 + 172.3) \text{ MBtu/yr}$$

$$Q_F = 1944.0 \text{ MBtu/yr}$$

Applying the boiler and converter efficiencies:

$$Q_F (\text{F.O.\#6}) = 1944.0 \frac{\text{MBtu}}{\text{yr}} \div 0.8 \div 0.95 = \underline{\underline{2557.9 \text{ MBtu/yr}}}$$



SUBJECT ECO # 16

DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

QRIP Calculations

Present Method

$$\#6 \text{ F.O.} = 6543 \frac{\text{MBtu}}{\text{yr}} \times \frac{\$4.40}{\text{MBtu}} = \$28,300$$

Proposed Method

$$\#6 \text{ F.O.} = 2558 \frac{\text{MBtu}}{\text{yr}} \times \frac{\$4.40}{\text{MBtu}} = \$11,300$$

$$\underline{\text{Savings}} = \$17,500$$



SUBJECT WVA-Bldg. 44
Add Return Air
DESIGNER W. T. Todd
CHECKER _____

AEP NO 290-0379-002
SHEET 5 OF _____
DATE 2-13-92
DATE _____

Fuel Oil #6 Savings:

Energy Savings = Current Energy Use - Future Energy Use

$$\text{Savings} = Q_c - Q_f = 6542.5 \frac{\text{MBtu}}{\text{yr}} - 2557.9 \frac{\text{MBtu}}{\text{yr}}$$

$$\text{Energy Savings} = \underline{\underline{3984.6 \text{ MBtu/yr}}}$$

Project Implementation Cost:

The original costs were estimated in 1980 dollars. The ENR Building Cost Index (BCI) is used to escalate the cost estimate to August 1991 dollars.

June 1980 ENR BCI = 1916

August 1991 ENR BCI = 2792

$$\text{Escalation Factor} = 2792/1916 = 1.46$$

1991 Bare costs: Labor(1): $\$13549 \times 1.46 = \$19,782$

Mat'er.(1): $\$14313 \times 1.46 = \$20,897$

(1) Source: Planning Research Corp. Cost Estimate, p. 16-21

Total Project Cost = $\$70,259$

See cost estimate sheets for details

HV-1, Current operating mode

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY

02/12/92

INPUTS: 1) Days Per Week That HVAC Operates 7 Days/Week
 2) Summer Room Dry Bulb Temperature °F (db)
 Room Wet Bulb Temperature °F (wb)
 3) Winter Room Dry Bulb Temperature 68 °F (db)
 If RH Controlled, wb Temp. °F (wb)
 and Ground Water Temperature °F
 4) Outside Air Quantity (cfm) 24073 cfm
 5) HVAC Oper. Hrs/Shift: 12 M -> 8 AM 8 Hrs/Shift
 8 AM -> 4 PM 8 Hrs/Shift
 4 PM -> 12 M 8 Hrs/Shift

Temperatures			Hours of Occurrence			Total Oper. Hours	Outside Air Load (MBtu/Yr)			
db-Range	wb		00-08	08-16	16-24		Cooling	Dehumid	Heating	Humid.
120	124					0	0.00	0.00	0.00	0.00
115	119					0	0.00	0.00	0.00	0.00
110	114					0	0.00	0.00	0.00	0.00
105	109					0	0.00	0.00	0.00	0.00
100	104					0	0.00	0.00	0.00	0.00
95	99	75	0	7	0	7	0.00	0.00	0.00	0.00
90	94	72	0	28	6	34	0.00	0.00	0.00	0.00
85	89	71	0	95	28	123	0.00	0.00	0.00	0.00
80	84	68	4	177	73	254	0.00	0.00	0.00	0.00
75	79	66	27	248	140	415	0.00	0.00	0.00	0.00
70	74	64	115	257	222	594	0.00	0.00	0.00	0.00
65	69	61	234	235	271	740	0.00	0.00	0.00	0.00
60	64	57	263	212	252	727	0.00	0.00	115.51	0.00
55	59	52	274	190	236	700	0.00	0.00	203.90	0.00
50	54	48	263	183	214	660	0.00	0.00	279.63	0.00
45	49	43	242	183	205	630	0.00	0.00	350.33	0.00
40	44	38	229	202	205	636	0.00	0.00	437.88	0.00
35	39	34	261	241	251	753	0.00	0.00	618.13	0.00
30	34	30	295	220	262	777	0.00	0.00	740.71	0.00
25	29	25	216	156	191	563	0.00	0.00	611.24	0.00
20	24	20	163	112	130	405	0.00	0.00	493.33	0.00
15	19	16	110	79	96	285	0.00	0.00	384.89	0.00
10	14	11	84	43	65	192	0.00	0.00	284.72	0.00
5	9	6	60	27	38	125	0.00	0.00	201.91	0.00
0	4	2	37	16	22	75	0.00	0.00	131.08	0.00
-5	-1	-3	27	3	9	39	0.00	0.00	73.32	0.00
-10	-6	-8	10	0	4	14	0.00	0.00	28.18	0.00
-15	-11	-13	5	0	0	5	0.00	0.00	10.72	0.00
-20	-16	-17	3	0	0	3	0.00	0.00	6.83	0.00
-25	-21					0	0.00	0.00	0.00	0.00
-30	-26					0	0.00	0.00	0.00	0.00
-35	-31					0	0.00	0.00	0.00	0.00
-40	-36					0	0.00	0.00	0.00	0.00
-45	-41					0	0.00	0.00	0.00	0.00
Totals			2922	2914	2920	8756	0.00	0.00	4972.31	0.00

Total operating hours for each system 0 0 6589 0

HV-1, Minimum ventilation mode with setback

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY

02/12/92

INPUTS: 1) Days Per Week That HVAC Operates 5 Days/Week
 2) Summer Room Dry Bulb Temperature °F (db)
 Room Wet Bulb Temperature °F (wb)
 3) Winter Room Dry Bulb Temperature 55 °F (db)
 If RH Controlled, wb Temp. °F (wb)
 and Ground Water Temperature °F
 4) Outside Air Quantity (cfm) 5800 cfm
 5) HVAC Oper. Hrs/Shift: 12 M → 8 AM 7 Hrs/Shift
 8 AM → 4 PM 0 Hrs/Shift
 4 PM → 12 M 0 Hrs/Shift

Temperatures			Hours of Occurrence			Total Oper. Hours	Outside Air Load (MBtu/Yr)			
db-Range	wb		00-08	08-16	16-24		Cooling	Dehumid	Heating	Humid.
120	124					0	0.00	0.00	0.00	0.00
115	119					0	0.00	0.00	0.00	0.00
110	114					0	0.00	0.00	0.00	0.00
105	109					0	0.00	0.00	0.00	0.00
100	104					0	0.00	0.00	0.00	0.00
95	99	75	0	7	0	0	0.00	0.00	0.00	0.00
90	94	72	0	28	6	0	0.00	0.00	0.00	0.00
85	89	71	0	95	28	0	0.00	0.00	0.00	0.00
80	84	68	4	177	73	3	0.00	0.00	0.00	0.00
75	79	66	27	248	140	17	0.00	0.00	0.00	0.00
70	74	64	115	257	222	72	0.00	0.00	0.00	0.00
65	69	61	234	235	271	146	0.00	0.00	0.00	0.00
60	64	57	263	212	252	164	0.00	0.00	0.00	0.00
55	59	52	274	190	236	171	0.00	0.00	0.00	0.00
50	54	48	263	183	214	164	0.00	0.00	0.00	0.00
45	49	43	242	183	205	151	0.00	0.00	7.72	0.00
40	44	38	229	202	205	143	0.00	0.00	11.87	0.00
35	39	34	261	241	251	163	0.00	0.00	18.73	0.00
30	34	30	295	220	262	184	0.00	0.00	27.06	0.00
25	29	25	216	156	191	135	0.00	0.00	24.12	0.00
20	24	20	163	112	130	102	0.00	0.00	21.45	0.00
15	19	16	110	79	96	69	0.00	0.00	16.67	0.00
10	14	11	84	43	65	53	0.00	0.00	14.40	0.00
5	9	6	60	27	38	38	0.00	0.00	11.48	0.00
0	4	2	37	16	22	23	0.00	0.00	7.82	0.00
-5	-1	-3	27	3	9	17	0.00	0.00	6.24	0.00
-10	-6	-8	10	0	4	6	0.00	0.00	2.51	0.00
-15	-11	-13	5	0	0	3	0.00	0.00	1.36	0.00
-20	-16	-17	3	0	0	2	0.00	0.00	0.87	0.00
-25	-21					0	0.00	0.00	0.00	0.00
-30	-26					0	0.00	0.00	0.00	0.00
-35	-31					0	0.00	0.00	0.00	0.00
-40	-36					0	0.00	0.00	0.00	0.00
-45	-41					0	0.00	0.00	0.00	0.00
Totals			2922	2914	2920	1826	0.00	0.00	172.30	0.00
Total operating hours for each system							0	0	1089	0

HV-1, Medium ventilation mode

PROJECT: WATERVLIT ARSENAL LIMITED ENERGY STUDY

02/12/92

INPUTS: 1) Days Per Week That HVAC Operates 5 Days/Week
 2) Summer Room Dry Bulb Temperature °F (db)
 Room Wet Bulb Temperature °F (wb)
 3) Winter Room Dry Bulb Temperature 68 °F (db)
 If RH Controlled, wb Temp. °F (wb)
 and Ground Water Temperature °F
 4) Outside Air Quantity (cfm) 14272 cfm
 5) HVAC Oper. Hrs/Shift: 12 M → 8 AM 1 Hrs/Shift
 8 AM → 4 PM 6 Hrs/Shift
 4 PM → 12 M 8 Hrs/Shift

Temperatures			Hours of Occurrence			Total Oper. Hours	Outside Air Load (MBtu/Yr)			
db-Range	wb		00-08	08-16	16-24		Cooling	Dehumid	Heating	Humid.
120	124					0	0.00	0.00	0.00	0.00
115	119					0	0.00	0.00	0.00	0.00
110	114					0	0.00	0.00	0.00	0.00
105	109					0	0.00	0.00	0.00	0.00
100	104					0	0.00	0.00	0.00	0.00
95	99	75	0	7	0	4	0.00	0.00	0.00	0.00
90	94	72	0	28	6	19	0.00	0.00	0.00	0.00
85	89	71	0	95	28	71	0.00	0.00	0.00	0.00
80	84	68	4	177	73	147	0.00	0.00	0.00	0.00
75	79	66	27	248	140	235	0.00	0.00	0.00	0.00
70	74	64	115	257	222	307	0.00	0.00	0.00	0.00
65	69	61	234	235	271	340	0.00	0.00	0.00	0.00
60	64	57	263	212	252	317	0.00	0.00	29.86	0.00
55	59	52	274	190	236	295	0.00	0.00	50.91	0.00
50	54	48	263	183	214	274	0.00	0.00	68.92	0.00
45	49	43	242	183	205	266	0.00	0.00	87.72	0.00
40	44	38	229	202	205	275	0.00	0.00	112.29	0.00
35	39	34	261	241	251	332	0.00	0.00	161.43	0.00
30	34	30	295	220	262	331	0.00	0.00	187.26	0.00
25	29	25	216	156	191	239	0.00	0.00	154.02	0.00
20	24	20	163	112	130	167	0.00	0.00	120.90	0.00
15	19	16	110	79	96	121	0.00	0.00	96.65	0.00
10	14	11	84	43	65	77	0.00	0.00	67.66	0.00
5	9	6	60	27	38	47	0.00	0.00	44.98	0.00
0	4	2	37	16	22	28	0.00	0.00	28.59	0.00
-5	-1	-3	27	3	9	10	0.00	0.00	11.64	0.00
-10	-6	-8	10	0	4	4	0.00	0.00	4.47	0.00
-15	-11	-13	5	0	0	0	0.00	0.00	0.57	0.00
-20	-16	-17	3	0	0	0	0.00	0.00	0.36	0.00
-25	-21					0	0.00	0.00	0.00	0.00
-30	-26					0	0.00	0.00	0.00	0.00
-35	-31					0	0.00	0.00	0.00	0.00
-40	-36					0	0.00	0.00	0.00	0.00
-45	-41					0	0.00	0.00	0.00	0.00
Totals			2922	2914	2920	3908	0.00	0.00	1228.24	0.00
Total operating hours for each system							0	0	2784	0

HV-1, Maximum ventilation mode

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY

02/12/92

- INPUTS: 1) Days Per Week That HVAC Operates 5 Days/Week
 2) Summer Room Dry Bulb Temperature °F (db)
 Room Wet Bulb Temperature °F (wb)
 3) Winter Room Dry Bulb Temperature 68 °F (db)
 If RH Controlled, wb Temp. °F (wb)
 and Ground Water Temperature °F
 4) Outside Air Quantity (cfm) 34390 cfm
 5) HVAC Oper. Hrs/Shft: 12 M → 8 AM 0 Hrs/Shift
 8 AM → 4 PM 2 Hrs/Shift
 4 PM → 12 M 0 Hrs/Shift

Temperatures			Hours of Occurrence			Total Oper. Hours	Outside Air Load (MBtu/Yr)			
db-Range	wb		00-08	08-16	16-24		Cooling	Dehumid	Heating	Humid.
120	124					0	0.00	0.00	0.00	0.00
115	119					0	0.00	0.00	0.00	0.00
110	114					0	0.00	0.00	0.00	0.00
105	109					0	0.00	0.00	0.00	0.00
100	104					0	0.00	0.00	0.00	0.00
95	99	75	0	7	0	1	0.00	0.00	0.00	0.00
90	94	72	0	28	6	5	0.00	0.00	0.00	0.00
85	89	71	0	95	28	17	0.00	0.00	0.00	0.00
80	84	68	4	177	73	32	0.00	0.00	0.00	0.00
75	79	66	27	248	140	44	0.00	0.00	0.00	0.00
70	74	64	115	257	222	46	0.00	0.00	0.00	0.00
65	69	61	234	235	271	42	0.00	0.00	0.00	0.00
60	64	57	263	212	252	38	0.00	0.00	8.59	0.00
55	59	52	274	190	236	34	0.00	0.00	14.12	0.00
50	54	48	263	183	214	33	0.00	0.00	19.78	0.00
45	49	43	242	183	205	33	0.00	0.00	25.96	0.00
40	44	38	229	202	205	36	0.00	0.00	35.48	0.00
35	39	34	261	241	251	43	0.00	0.00	50.47	0.00
30	34	30	295	220	262	39	0.00	0.00	53.50	0.00
25	29	25	216	156	191	28	0.00	0.00	43.21	0.00
20	24	20	163	112	130	20	0.00	0.00	34.80	0.00
15	19	16	110	79	96	14	0.00	0.00	27.22	0.00
10	14	11	84	43	65	8	0.00	0.00	16.27	0.00
5	9	6	60	27	38	5	0.00	0.00	11.13	0.00
0	4	2	37	16	22	3	0.00	0.00	7.13	0.00
-5	-1	-3	27	3	9	1	0.00	0.00	1.44	0.00
-10	-6	-8	10	0	4	0	0.00	0.00	0.00	0.00
-15	-11	-13	5	0	0	0	0.00	0.00	0.00	0.00
-20	-16	-17	3	0	0	0	0.00	0.00	0.00	0.00
-25	-21					0	0.00	0.00	0.00	0.00
-30	-26					0	0.00	0.00	0.00	0.00
-35	-31					0	0.00	0.00	0.00	0.00
-40	-36					0	0.00	0.00	0.00	0.00
-45	-41					0	0.00	0.00	0.00	0.00
Totals			2922	2914	2920	520	0.00	0.00	349.09	0.00
Total operating hours for each system							0	0	333	0

HV-1, minimum ventilation mode with setback

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY

02/12/92

INPUTS: 1) Days Per Week That HVAC Operates 2 Days/Week
 2) Summer Room Dry Bulb Temperature °F (db)
 Room Wet Bulb Temperature °F (wb)
 3) Winter Room Dry Bulb Temperature 55 °F (db)
 If RH Controlled, wb Temp. °F (wb)
 and Ground Water Temperature °F
 4) Outside Air Quantity (cfm) 5800 cfm
 5) HVAC Oper. Hrs/Shft: 12 M → 8 AM 8 Hrs/Shift
 8 AM → 4 PM 8 Hrs/Shift
 4 PM → 12 M 8 Hrs/Shift

Temperatures		Hours of Occurrence			Total Oper. Hours	Outside Air Load (MBtu/Yr)			
db-Range	wb	00-08	08-16	16-24		Cooling	Dehumid	Heating	Humid.
120	124				0	0.00	0.00	0.00	0.00
115	119				0	0.00	0.00	0.00	0.00
110	114				0	0.00	0.00	0.00	0.00
105	109				0	0.00	0.00	0.00	0.00
100	104				0	0.00	0.00	0.00	0.00
95	99	75	0	7	0	2	0.00	0.00	0.00
90	94	72	0	28	6	10	0.00	0.00	0.00
85	89	71	0	95	28	35	0.00	0.00	0.00
80	84	68	4	177	73	73	0.00	0.00	0.00
75	79	66	27	248	140	119	0.00	0.00	0.00
70	74	64	115	257	222	170	0.00	0.00	0.00
65	69	61	234	235	271	211	0.00	0.00	0.00
60	64	57	263	212	252	208	0.00	0.00	0.00
55	59	52	274	190	236	200	0.00	0.00	0.00
50	54	48	263	183	214	189	0.00	0.00	0.00
45	49	43	242	183	205	180	0.00	0.00	9.19
40	44	38	229	202	205	182	0.00	0.00	15.07
35	39	34	261	241	251	215	0.00	0.00	24.71
30	34	30	295	220	262	222	0.00	0.00	32.58
25	29	25	216	156	191	161	0.00	0.00	28.74
20	24	20	163	112	130	116	0.00	0.00	24.36
15	19	16	110	79	96	81	0.00	0.00	19.74
10	14	11	84	43	65	55	0.00	0.00	15.05
5	9	6	60	27	38	36	0.00	0.00	10.94
0	4	2	37	16	22	21	0.00	0.00	7.25
-5	-1	-3	27	3	9	11	0.00	0.00	4.12
-10	-6	-8	10	0	4	4	0.00	0.00	1.61
-15	-11	-13	5	0	0	1	0.00	0.00	0.62
-20	-16	-17	3	0	0	1	0.00	0.00	0.40
-25	-21				0	0.00	0.00	0.00	0.00
-30	-26				0	0.00	0.00	0.00	0.00
-35	-31				0	0.00	0.00	0.00	0.00
-40	-36				0	0.00	0.00	0.00	0.00
-45	-41				0	0.00	0.00	0.00	0.00
Totals		2922	2914	2920	2502	0.00	0.00	194.36	0.00
Total operating hours for each system						0	0	1286	0

02/13/92

ECO Construction Cost Estimate Calculations

ECO Name: Reduce Outside Air and Add Return Air to HV-1

ECO #: ~~100~~ 16

1991 ECO "bare" costs (from cost estimate sheet)		
Material		\$20,897
Labor		\$19,782
	Subtotal bare costs	\$40,679
FICA Insurance (20% of Labor)		\$3,956
Sales Tax (Not Applicable For GOGO)		\$0
	Subtotal	\$44,635
Overhead (15%)		\$6,695
	Subtotal	\$51,330
Profit (10%)		\$5,133
	Subtotal	\$56,463
Bond (1%)		\$565
	Subtotal	\$57,028
Contingency (10%)		\$5,703
		+-----+
Subtotal (Construction Cost Input For LCCID *)		\$62,731
		+-----+
SIOH (6.0% of Construction Cost)		\$3,764
	Subtotal	\$66,495
Design (6.0% of Construction Cost)		\$3,764

Total Project Cost		\$70,259

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

11.1.2.2 Reduce Outside Air Intake.

11.1.2.2.1 Background. The ventilation system in the basement of building 44 is designed for 100 percent outside air (34,390 cfm) with no provisions for modulation or use of return air when maximum ventilation rate is not required. This results in heating an excessive amount of outside air during the heating season. Energy savings will result if a return air system is installed. Outside air and exhaust can be minimized and modulated incrementally to increase when additional ventilation is required. Return air would be modulated in inverse proportion to the outside air volume. In addition, room temperature could be set back during unoccupied hours.

11.1.2.2.2 Modification Recommended at Building 44. Modification of the outside air plenum for HV-1 will be required to make provisions for the addition of a return air plenum, and return air/outside air motorized mixing dampers. Two new return air ducts will be routed to the return air plenum. Belt and pulley replacements will be required to adjust the fan speed for HV-1 to maintain flow volume at increased pressure drop in the return air system. Refer to figure 11-3 for a sketch depicting the changes. Replacement of fan E12 with a two-speed fan and the elimination of the transfer grill through the inside wall is recommended. Mechanical equipment rooms will be ventilated with a maximum of outside air from the existing motorized damper in the outside wall of the air handler room or a minimum of outside air from the new damper in the outside wall of the heating equipment room. A new thermostat in the air handler room will control dampers and fan speed.

Medium Ventilation Mode. Exhaust fan controls will be modified to interlock the most strategic fans with HV-1 for normal daily operations. The recommended fans are E3/E6, E13, E18, E7/E5, and E16. Outside air and return air dampers will automatically be positioned to proportion the air volumes noted as the recommended medium ventilation mode in table 11-3.

Maximum Vent Mode. If additional ventilation is required, when operating in the medium ventilation mode, an adjustable timed switch (2 hours maximum) will be provided to start each of the other fans E1, E2, E15 and E4 individually. In

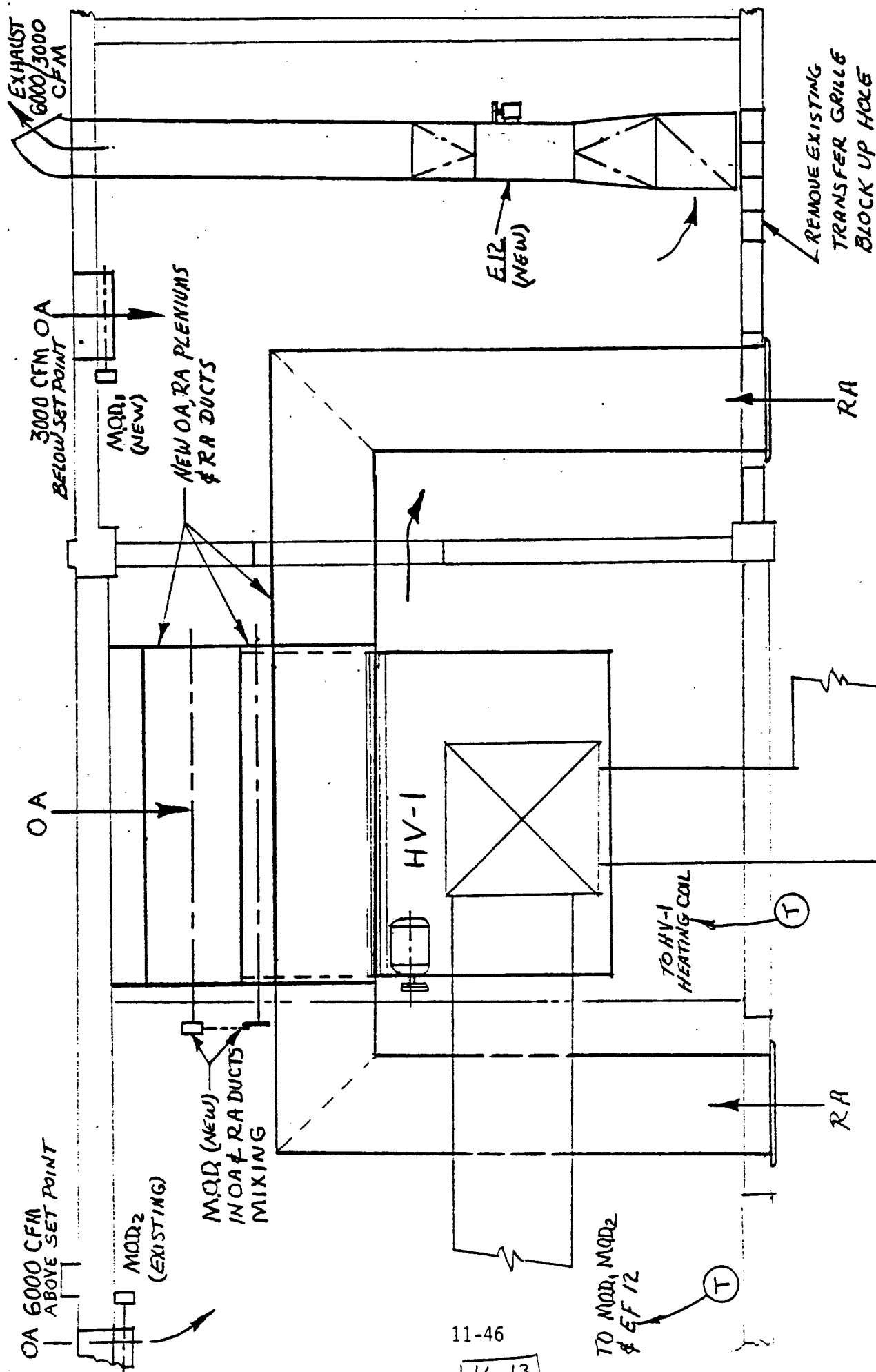


FIGURE 11-3
 MECHANICAL EQUIPMENT ROOM CHANGES

Table 11-3. Exhaust cfm from Basement

Fan No./Location	Design Mode		Recommended Ventilation Modes		
	MER Damper Pos. OPEN	CLOSED	Minimum	Medium	Maximum
	(winter)	(Summer)			
E1 East	0	4850	0	0	4850
E2 East	2430	2430	0	0	2430
E3 or E6 East	1200	1200	1200/0	1200/0	1200/0
E13 East	4850	4850	0	4850	4850
E15 East	2430	2430	0	0	2430
E18 → E8 East	200	200	200	200	200
E7 or E5 Center	~~3760~~ /7520	3760/7520	3760/0*	~~3760~~ /0*	3760/7520*
E12 MER	~~6000~~	0	0**	0**	0**
E16 Secure Storage	827	827	827	827	827
E4 West	9820	9820	0	0	9820
Total Exhaust	39037	37887	5987	~~10837~~	37887
O/A	34390 × 0.7	34390	5800	~~10512~~	34390
Return	~~0~~	0	~~28950~~	~~23878~~	0
Supply	34390	34390	34390	34390	34390
Excess Exhaust	~~4647~~ -5204	-3497	-187	-325	-3497

34390 × 0.3

28590

7520

20118

14272

this area
has a separate
O.A. intake

* Either fan E5 or E7 can be selected to operate at slow speed, the other fan will stop in the minimum or medium mode; in the maximum mode one fan can operate fast while the other operates slow.

** E12 does not exhaust air from basement rooms with recommended ventilation modes. Existing MER damper is removed and hole is used for return air duct or is blocked.

addition, a remote switch located near each fan can initiate a maximum of 2-hour runtime. Return and outside air dampers will modulate to admit more outside air and less return air incrementally as each fan is started.

Minimum Vent Mode (Setback). During nonoccupied hours, minimum exhaust is required, in addition, lower room temperature can be used during the heating season. Fans not required will be shut down during unoccupied hours then re-started prior to occupancy. Return and outside air would be modulated accordingly. This can be accomplished by the Energy Monitor and Control System if incorporated at Watervliet. For the purpose of economic analysis, costs include a timeclock system to reduce ventilation rate and a setback thermostat for room temperature reduction.

11.1.2.2.3 Analysis/Justification. Heat is provided to the coil in HV-1 during October through April (30 weeks). Energy and dollar savings will result from heating a reduced amount of cold outside air during a majority of the occupied hours. Additional savings will accrue during unoccupied hours when the outside air is further reduced and the room is maintained at a lower temperature. Heating degree hours have been used as noted in table 11-4 with the following basic equation to estimate energy use.

$$\text{Btu} = \text{cfm} \times 1.1 \times \text{Degree Hours}$$

Existing System Operation. Basement room temperature is maintained at 65° to 69°F. HV-1 was observed to operate with the outside air duct partially closed and the plenum access door partially open. Basement room air returns through the 48- by 24-inch transfer grill in the heating equipment room wall to HV-1. Outside air volume was estimated at 70 percent and return air at 30 percent of the supply air.

$$\text{Energy required} = 34,390 \times .7 \times 1.1 \times 152,102 = 4,027.707 \text{ MBtu/yr @ HV-1}$$

Table 11-4. Heating Degree Hours
(Based on Albany Weather Data)

	Ref Temp = 65°			Ref Temp = 50°		
	01 - 08	09 - 16	17 - 24	01 - 08	09-16	17 - 24
Oct	4,884	2,212	3,521	1,657	320	837
Nov	6,872	5,113	6,150	3,394	1,899	2,735
Dec	10,157	8,746	9,338	6,442	5,072	5,672
Jan	11,158	9,711	10,346	7,448	6,017	6,643
Feb	9,844	8,104	8,898	6,501	4,772	5,512
Mar	9,049	6,920	7,834	5,342	3,347	4,163
Apr	5,744	3,242	4,223	2,359	790	1,347
Totals	57,708	44,084	50,310	33,143	22,217	26,909
Grand Totals		152,102			82,269	

Recommended System Operation. After modifications to provide for outside/return air modulation during the medium, maximum, and minimum ventilation modes and to provide for temperature reduction during unoccupied hours, energy consumption will be reduced. The following operating schedule is recommended.

Operation During 30-Week Heating Season: The room is maintained at 65° 1 hour prior to and during occupied hours. This would occur during the last hour of the third shift, during the 8-hour dayshift for 5 days per week plus one Saturday per month, and during one second shift per month. It is estimated the medium ventilation mode will be used for 70 percent and the maximum ventilation mode will be used 30 percent of the occupied hours. During unoccupied hours, the room is maintained at 50° and the minimum ventilation rate is used, except the room temperature is increased to 65° 1 hour prior to occupancy.

Operation During the 22-Week Summer Season: Significant energy savings are not anticipated since all fans will probably be required to provide ventilation and temperature control.

Operating Hours (30 Week Heating Season):

Room at 65° 3rd Shift; 1 Hr, 5 Shift/Wk + 1 Hr, 1 Sat/Mo
Day Shift; 8 Hr, 5 Day/Wk + 8 Hr, 1 Sat/Mo
2nd Shift; 8 Hr/Mo

$$\% \text{ 3rd Shift Hrs} = \frac{1 \times 5 \times 30 + 1 \times 1 \times 1/4 \times 30}{8 \times 7 \times 30} \times 100 = 9.375\%$$

$$\% \text{ Day Shift Hrs} = \frac{8 \times 5 \times 30 + 8 \times 1/4 \times 30}{8 \times 7 \times 30} \times 100 = 75\%$$

$$\% \text{ 2nd Shift Hrs} = \frac{8 \times 1/4 \times 30}{8 \times 7 \times 30} \times 100 = 3.57\%$$

Room at 50°

$$\% \text{ 3rd Shift Hrs} = 100 - 9.375 = 90.625\%$$

$$\% \text{ Day Shift Hrs} = 100 - 75 = 25\%$$

$$\% \text{ 2nd Shift Hrs} = 100 - 3.57 = 96.25\%$$

Heat Required for Outside Air (Recommended System):

3rd Shift

$$\text{Room 65°}, \text{ med vent: } 10,512 \times 1.1 \times 57,708 \times .09375 = 62.558$$

$$\text{Room 50°}, \text{ min vent: } 5,800 \times 1.1 \times 33,143 \times .90625 = 191.629$$

Day Shift

$$\text{Room 65°}, \text{ med vent: } 10,512 \times 1.1 \times 44,084 \times .75 \times .70 = 267.620$$

$$\text{Room 65°}, \text{ max vent: } 34,390 \times 1.1 \times 44,084 \times .75 \times .30 = 375.222$$

$$\text{Room 50°}, \text{ min vent: } 5,800 \times 1.1 \times 22,217 \times .25 = 35.436$$

2nd Shift

Room 65°, med vent: $10,512 \times 1.1 \times 50,310 \times .0357 \times .70 = 14.538$

Room 65°, max vent: $34,390 \times 1.1 \times 50,310 \times .0357 \times .30 = 20.383$

Room 50°, min vent: $5,800 \times 1.1 \times 26,909 \times .9625 = \underline{165.241}$

TOTAL

1,132.627 MBtu/yr

Savings With Reduced Outside Air and Temperature Set Back:

Heat Required (Existing) - Heat Required (Recommended) = Savings

Heat Saved @ HV-1 = $4,027.707 - 1,132.627 = 2,895.08$ MBtu/yr

Heat Saved @ Boiler = $\frac{2,895.08}{.7} = 4,135.83$ MBtu/yr

Gallons No. 6 Oil = $\frac{4,125.16 \times 10^6}{149,690} = 27,629$ Gal/yr

Maintenance and Operating Costs

Materials

Replacement Parts and Expendables 500

Labor

Periodic Checks and Replacements 1,200
\$1,700

11.1.2.2.4 ECIP Summary - Building 44 Outside Air Reduction. See ECIP and cost sheets for details; benefits are summarized as follows:

Energy Savings 4,135.83 MBtu/yr

Dollar Savings \$31,926/yr

Project Cost \$82,766

B/C 9.5

E/C 49.97

EC/CC 10.2

Payback 2.6 years

ECIP Economic Analysis Summary

Location: Watervliet Arsenal, Building 44, Basement FY 84
 Project: Reduce Exhaust and Outside Air

Economic Life: 25 Yrs. Date Prepared: 8/19/81 Prepared by W.J. Spillman

COSTS

1. Non-recurring Initial Capital Costs:

a. CWE	\$ 82,766
b. Design $.06 \times 51,553 \times (1.12)^{2.75}$	\$ 4,224
c.	\$ 0
d. Total	\$ 86,990

BENEFITS

2. Recurring Benefit/Cost Differential Other Than Energy:

a. Annual Labor Decrease (+)/Increase (-)	\$ -1,200/Yr.
b. Annual Material Decrease (+)/Increase (-)	\$ -500/Yr.
c. Other Annual Decrease (+)/Increase (-)	\$ 0 /Yr.
d. Total Costs	\$ -1,700/Yr.
e. 10% Discount Factor	\$ 9.524
f. Discounted Recurring Cost (d x e)	\$ -16,191

3. Recurring Energy Benefit/Costs:

a. Type of Fuel: No. 6 Fuel Oil

(1) Annual Energy Decrease (+)/Increase (-)	4,136 MBTU
(2) Cost per MBTU (October 1, 1984)	\$ 8.13/MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$ 33,626/Yr.
(4) Differential Escalation Rate (10%) Factor	25
(5) Discounted Dollar Decrease/Increase (3)x(4)	\$ 840,650

b. Type of Fuel:

(1) Annual Energy Decrease (+)/Increase (-)	MBTU
(2) Cost per MBTU	\$ /MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$ /Yr.
(4) Differential Escalation Rate () Factor	
(5) Discounted Dollar Decrease/Increase ((3)x(4))	\$

c. Type of Fuel:

(1) Annual Energy Decrease (+)/Increase (-)	MBTU
(2) Cost per MBTU	\$ /MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$ /Yr.
(4) Differential Escalation Rate (%) Factor	
(5) Discounted Dollar Decrease/Increase ((3)x(4))	\$

d. Type of Fuel:

(1) Annual Energy Decrease (+)/Increase (-)	MBTU
(2) Cost per MBTU	\$ /MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	\$ /Yr.
(4) Differential Escalation Rate (%) Factor	
(5) Discounted Dollar Decrease/Increase ((3)x(4))	\$

e. Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5)) \$ 840,642

4. Total Benefits (Sum 2f+3e)	\$ 824,459
5. Discounted Benefit/Cost Ratio (Line 4 ÷ Line 1d)	9.5
6. Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1))	4,136
7. E/C Ratio (Line 6 ÷ Line 1a/1000)	49.97
8. Annual \$ Savings (2d+3a(3)+3b(3)+3c(3)+3d(3))	\$ 31,926
9. Pay-back Period ((Line 1a - Salvage) ÷ Line 8)	2.6
10. EC/CC = [Line 3a(3) + 3b(3)] x 25 ÷ Line 1a	10.2

CONSTRUCTION COST ESTIMATE				DATE PREPARED 8/5/81		SHEET 1 OF 3	
PROJECT REDUCE EXHAUST & OUTSIDE AIR				BASIS FOR ESTIMATE ☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify) _____			
LOCATION WATERLIET BUILDING 44 BASEMENT							
ARCHITECT ENGINEER PLANNING RESEARCH CORP.							
DRAWING NO.		COST AS OF (DATE) 1/1/80		ESTIMATOR W. J. Spillman		CHECKED BY	

1980 Means SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Subtotals from Sht. 2 and 3							
Mechanical				10660		9681	
Electrical				2454		4347	
General				435		285	
Subtotals				13549		14313	
Joint Occupancy-Overtime	Labor X	30%		4065		-	
Subtotals				17614		14313	
12%/yr in FI	1	ea	12%	2114		1718	
				19728		16031	
SUB-TOTAL				19728		16031	33759
SALES TAX					0 %	-	
SUB-TOTAL				19728		16031	
PT&I			22 %	4340			
SUB-TOTAL				24068		16031	
OVERHEAD & PROFIT			22 %	5295	22 %	3527	
SUB-TOTAL				29363		19558	
GEOGRAPHIC			-7 %	2055	- %	-	
SUB-TOTAL				27308		19558	= 46866
CONTINGENCY	10 %						4687
CONSTRUCTION COST							51553
SICH	5 %						2578
PROJECT COST (Jan 1981)							54131
ESCALATION	52.9 %						28635
PROJECT COST (Oct 1981)							82766

875781

SHEET 2 of 3

BASIS FOR ESTIMATE

☒ ^{VV} CODE A (NO DESIGN COMPLETED)
☐ CODE B (PRILIMINARY DESIGN)
☐ CODE C (FINAL DESIGN)
☐ OTHER (SPECIFY)

☐ OTHER (SPECIFY) _____

COST AS OF (DATE)

1/1/80

ESTIMATOR

W. J. Spillman

CHECKED BY

11-54

116-22

SUBJECT WVA - Window RetrofitAEP NO 290-0379-002DESIGNER W.T. ToddSHEET 1 OF 1

CHECKER _____

DATE 3-24-92

DATE _____

ECO # 17

INSTALL DOUBLE-PANE WINDOWS

Many of the buildings at WVA have single pane windows. Energy savings can be achieved by replacing the existing windows with double-pane windows or by adding storm windows.

Although there are many different types and sizes of windows at WVA, one type of window will be used to evaluate the effectiveness of window retrofit.

This analysis uses a standard Aluminum Frame, 2'-8" x 6'-8" opening to evaluate 2-Pane windows.

Current Energy Use:

$$\text{Heating Load} = U_w \times A_w \times (68^\circ - \text{O.A.T.}) = Q_H$$

$$\text{Cooling Load} = U_w \times A_w \times (\text{O.A.T.} - 75^\circ\text{F}) = Q_c$$

For single glazed, Aluminum Frame: $U_w = 1.31 \frac{\text{Btu}}{\text{hr} \cdot \text{SF} \cdot ^\circ\text{F}}$

Source = ASHRAE 1989 Fund. Handbook, Pg. 27.16

The load calculations were performed using a spreadsheet computer program with bin temperatures for Albany, NY and the above equations. The results are shown on the following page and below.

$$Q_H = 4.374 \text{ metu/yr}, \text{ Fuel Oil \#6}$$

$$Q_c = 0.112 \text{ metu/yr}, \text{ Electricity}$$

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY
Window Heating and Cooling Load Savings

03/25/92
WINDOW.WQ1

INPUTS: 1) Days Per Week That HVAC Operates 7 Days/Week
2) Summer Room Dry Bulb Temperature 75 °F (db)
3) Winter Room Dry Bulb Temperature 68 °F (db)
4) Window Overall U-Value 1.31 Btu/Hr*SF*°F
6) Surface Area of Window 17.8 SqFt
7) HVAC Oper. Hrs/Shift: 12 M - 8 AM 8 Hrs/Shift
8 AM - 4 PM 8 Hrs/Shift
4 PM - 12 M 8 Hrs/Shift

Temperatures			Hours of Occurrence			Total Oper. Hours	Window Load (Btu/Yr)	
db-Range	wb		00-08	08-16	16-24		Cooling	Heating
120	124					0	0	0
115	119					0	0	0
110	114					0	0	0
105	109					0	0	0
100	104					0	0	0
95	99	75	0	7	0	7	3,587	0
90	94	72	0	28	6	34	13,463	0
85	89	71	0	95	28	123	34,380	0
80	84	68	4	177	73	254	41,415	0
75	79	66	27	248	140	415	19,333	0
70	74	64	115	257	222	594	0	0
65	69	61	234	235	271	740	0	0
60	64	57	263	212	252	727	0	101,604
55	59	52	274	190	236	700	0	179,356
50	54	48	263	183	214	660	0	245,974
45	49	43	242	183	205	630	0	308,166
40	44	38	229	202	205	636	0	385,172
35	39	34	261	241	251	753	0	543,728
30	34	30	295	220	262	777	0	651,551
25	29	25	216	156	191	563	0	537,672
20	24	20	163	112	130	405	0	433,948
15	19	16	110	79	96	285	0	338,563
10	14	11	84	43	65	192	0	250,446
5	9	6	60	27	38	125	0	177,609
0	4	2	37	16	22	75	0	115,300
-5	-1	-3	27	3	9	39	0	64,498
-10	-6	-8	10	0	4	14	0	24,784
-15	-11	-13	5	0	0	5	0	9,434
-20	-16	-17	3	0	0	3	0	6,010
-25	-21					0	0	0
-30	-26					0	0	0
-35	-31					0	0	0
-40	-36					0	0	0
-45	-41					0	0	0
Totals			2922	2914	2920	8756	112,179	4,373,813

Total operating hours for each system 833 6589
Average outside air temp. while cooling/heating 80.8 39.5

SUBJECT WVA - Window RetrofitAEP NO 290-0379-002DESIGNER W.T. ToddSHEET 3 OF CHECKER DATE DATE

Current Heating Energy Use = $Q_H \div \text{Boiler Eff.}$

$$\text{Heating Energy} = 4.374 \frac{\text{MBtu}}{\text{Yr}} \div 0.80 = \underline{5.47 \frac{\text{MBtu}}{\text{Yr}}} \text{ (F.O. \#6)}$$

Current Cooling Energy Use = $Q_C \times \text{Cooling COP}$

$$\text{Cooling Energy} = 0.112 \frac{\text{MBtu}}{\text{Yr}} \times \frac{1.2 \text{ kW}}{12000 \text{ Btu}} \times \frac{3413 \text{ Btu}}{\text{kWh}} = \underline{0.04 \frac{\text{MBtu}}{\text{Yr}}} \text{ (Elec)}$$

Future Energy Use:

Use double glazed, Aluminum Frame w/thermal break:

$$U_w = 0.70 \text{ Btu/Hr. Ft}^2 \cdot \text{OF}$$

Source: ASHRAE, Fund. Handbook, Pg. 27.16.

The same spreadsheet computer program was used to calculate the heating and cooling loads. The results are shown on the following page and listed below:

$$Q_H = 2.337 \text{ MBtu/Yr}$$

$$Q_C = 0.060 \text{ MBtu/Yr}$$

Future Heating Energy Use = $Q_H \div \text{Boiler Eff.}$

$$\text{Heating Energy} = 2.337 \frac{\text{MBtu}}{\text{Yr}} \div 0.8 = \underline{2.92 \frac{\text{MBtu}}{\text{Yr}}} \text{ (F.O. \#6)}$$

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY
Window Heating and Cooling Load Savings

03/25/92
WINDOW.WQ1

INPUTS: 1) Days Per Week That HVAC Operates 7 Days/Week
2) Summer Room Dry Bulb Temperature 75 °F (db)
3) Winter Room Dry Bulb Temperature 68 °F (db)
4) Window Overall U-Value 0.70 Btu/Hr*SF*°F
5) Surface Area of Window 17.8 SqFt
6) HVAC Oper. Hrs/Shift: 12 M - 8 AM 8 Hrs/Shift
8 AM - 4 PM 8 Hrs/Shift
4 PM - 12 M 8 Hrs/Shift

Temperatures			Hours of Occurrence			Total Oper. Hours	Window Load (Btu/Yr)	
db-Range	wb		00-08	08-16	16-24		Cooling	Heating
120	124					0	0	0
115	119					0	0	0
110	114					0	0	0
105	109					0	0	0
100	104					0	0	0
95	99	75	0	7	0	7	1,917	0
90	94	72	0	28	6	34	7,194	0
85	89	71	0	95	28	123	18,371	0
80	84	68	4	177	73	254	22,130	0
75	79	66	27	248	140	415	10,331	0
70	74	64	115	257	222	594	0	0
65	69	61	234	235	271	740	0	0
60	64	57	263	212	252	727	0	54,292
55	59	52	274	190	236	700	0	95,839
50	54	48	263	183	214	660	0	131,436
45	49	43	242	183	205	630	0	164,669
40	44	38	229	202	205	636	0	205,817
35	39	34	261	241	251	753	0	290,542
30	34	30	295	220	262	777	0	348,157
25	29	25	216	156	191	563	0	287,305
20	24	20	163	112	130	405	0	231,881
15	19	16	110	79	96	285	0	180,912
10	14	11	84	43	65	192	0	133,826
5	9	6	60	27	38	125	0	94,905
0	4	2	37	16	22	75	0	61,611
-5	-1	-3	27	3	9	39	0	34,465
-10	-6	-8	10	0	4	14	0	13,243
-15	-11	-13	5	0	0	5	0	5,041
-20	-16	-17	3	0	0	3	0	3,211
-25	-21					0	0	0
-30	-26					0	0	0
-35	-31					0	0	0
-40	-36					0	0	0
-45	-41					0	0	0
Totals			2922	2914	2920	8756	59,943	2,337,152

Total operating hours for each system 833 6589

Average outside air temp. while cooling/heating 80.8 39.5

SUBJECT WVA - Window RetrofitAEP NO 290-0379-002SHEET 5 OF DESIGNER W. T. ToddDATE CHECKER DATE

Future Cooling Energy Use = $Q_c \times \text{Cooling COP}$

$$\text{Cooling Energy} = 0.060 \frac{\text{MBTU}}{\text{Yr}} \times \frac{1.2 \text{ kW}}{12000 \text{ Btu}} \times \frac{3413 \text{ Btu/h}}{\text{kWh}} = \underline{0.02 \frac{\text{MBTU}}{\text{Yr}} (\text{Elec})}$$

Energy Savings:

Heating Energy Savings = Current - Future

$$\text{Energy Savings} = (5.47 - 2.92) \frac{\text{MBtu}}{\text{Yr}} = \underline{2.55 \frac{\text{MBtu}}{\text{Yr}}, \text{F.O. \#6}}$$

Cooling Energy Savings:

$$\text{Energy Savings} = (0.04 - 0.02) \frac{\text{MBtu}}{\text{Yr}} = \underline{0.02 \frac{\text{MBtu}}{\text{Yr}}, \text{Elec.}}$$

Note: These Savings are on a per window basis.

Project Costs:

Construction Cost = \$476 per window

See Cost Estimate Sheets for details

03/25/92

ECO Construction Cost Estimate
Calculations

ECO Name: Install Double-Pane Windows

ECO #:

1991 ECO "bare" costs (from cost estimate sheet)		
Material		\$248
Labor		\$76
	Subtotal bare costs	\$324
FICA Insurance (20% of Labor)		\$15
Sales Tax (Not Applicable For GOGO)		\$0
	Subtotal	\$339
Overhead (15%)		\$51
	Subtotal	\$390
Profit (10%)		\$39
	Subtotal	\$429
Bond (1%)		\$4
	Subtotal	\$433
Contingency (10%)		\$43
Subtotal (Construction Cost Input For LCCID *)		\$476
SIOH (6.0% of Construction Cost)		\$29
	Subtotal	\$505
Design (6.0% of Construction Cost)		\$29
Total Project Cost		\$534

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

SHEET 7 OF

PROJECT

ENERGY ENGINEERING ANALYSIS

LOCATION

WATERVLIEET ARSENAL

ARCHITECT ENGINEER

REYNOLDS, SMITH AND HILLS A.E.P., INC.

Basis for Estimate	Date	Estimate	Remarks

- ☒ CODE A (No design completed)
☐ CODE B (Preliminary design)
☐ CODE C (Final design)
☐ OTHER (Specify)

DRAWING NO.

N/A

ESTIMATOR

W. T. Todd

CHECKED BY

[illegible]



SUBJECT WVA - Window Retrofit
DESIGNER W. T. Todd
CHECKER _____

AEP NO 290-0379.002
SHEET 8 OF _____
DATE _____
DATE _____

ECO # 18

INSTALL STORM WINDOWS

This analysis uses a standard aluminum frame, Double hung, 2'-6" x 5'-0" opening to evaluate storm windows.

Current Energy Use:

The same spreadsheet used for 2-pane windows was used for this analysis. The results are shown on the next page and listed below.

$$Q_H = 3.075 \text{ MBtu/yr}, \text{ Fuel Oil \#6}$$

$$Q_c = 0.079 \text{ MBtu/yr}, \text{ Electricity}$$

$$\text{Heating Energy} = 3.075 \frac{\text{MBtu}}{\text{yr}} \div 0.8 = \underline{3.84 \frac{\text{MBtu}}{\text{yr}}}, \text{ F.O. \#6}$$

$$\text{Cooling Energy} = 0.079 \frac{\text{MBtu}}{\text{yr}} \times \frac{1.2 \text{ kW}}{12000 \text{ Btu}} \times \frac{3413 \text{ Btu/h}}{\text{kWh}} = \underline{0.03 \frac{\text{MBtu}}{\text{yr}}}, \text{ Elec.}$$

Future Energy Use:

Assume storm window combined with existing window is not quite as effective as a double pane window ($U_w = 0.70$ for 2-pane)

$$U_w = 0.80 \text{ Btu/hr} \cdot \text{ft}^2 \cdot ^\circ\text{F}$$

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY
Window Heating and Cooling Load Savings

03/25/92
WINDOW.WQ1

INPUTS: 1) Days Per Week That HVAC Operates 7 Days/Week
2) Summer Room Dry Bulb Temperature 75 °F (db)
3) Winter Room Dry Bulb Temperature 68 °F (db)
4) Window Overall U-Value 1.31 Btu/Hr*SF*°F
6) Surface Area of Window 12.5 SqFt
7) HVAC Oper. Hrs/Shift: 12 M - 8 AM 8 Hrs/Shift
8 AM - 4 PM 8 Hrs/Shift
4 PM - 12 M 8 Hrs/Shift

Temperatures			Hours of Occurrence			Total Oper. Hours	Window Load (Btu/Yr)	
db-Range	wb		00-08	08-16	16-24		Cooling	Heating
120	124					0	0	0
115	119					0	0	0
110	114					0	0	0
105	109					0	0	0
100	104					0	0	0
95	99	75	0	7	0	7	2,522	0
90	94	72	0	28	6	34	9,465	0
85	89	71	0	95	28	123	24,170	0
80	84	68	4	177	73	254	29,115	0
75	79	66	27	248	140	415	13,591	0
70	74	64	115	257	222	594	0	0
65	69	61	234	235	271	740	0	0
60	64	57	263	212	252	727	0	71,428
55	59	52	274	190	236	700	0	126,088
50	54	48	263	183	214	660	0	172,920
45	49	43	242	183	205	630	0	216,641
40	44	38	229	202	205	636	0	270,777
35	39	34	261	241	251	753	0	382,242
30	34	30	295	220	262	777	0	458,042
25	29	25	216	156	191	563	0	377,984
20	24	20	163	112	130	405	0	305,066
15	19	16	110	79	96	285	0	238,011
10	14	11	84	43	65	192	0	176,064
5	9	6	60	27	38	125	0	124,859
0	4	2	37	16	22	75	0	81,056
-5	-1	-3	27	3	9	39	0	45,342
-10	-6	-8	10	0	4	14	0	17,423
-15	-11	-13	5	0	0	5	0	6,632
-20	-16	-17	3	0	0	3	0	4,225
-25	-21					0	0	0
-30	-26					0	0	0
-35	-31					0	0	0
-40	-36					0	0	0
-45	-41					0	0	0

Totals	2922	2914	2920	8756	78,862	3,074,799
Total operating hours for each system					833	6589
Average outside air temp. while cooling/heating					80.8	39.5



SUBJECT WVA - Window Retrofit
DESIGNER W.T. Todd
CHECKER _____

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The same spread sheet computer program was used to calculate the future heating and cooling loads. The results are shown on the next page and listed below.

$$Q_H = 1.878 \text{ MBtu/yr}, \text{ F.O. \#6}$$

$$Q_C = 0.048 \text{ MBtu/yr}, \text{ Elec.}$$

$$\text{Heating Energy} = 1.878 \frac{\text{MBtu}}{\text{yr}} \div 0.8 = \underline{2.35 \frac{\text{MBtu}}{\text{yr}}}, \text{ F.O. \#6}$$

$$\text{Cooling Energy} = 0.048 \frac{\text{MBtu}}{\text{yr}} \times \frac{1.2 \text{ kW}}{12000 \text{ Btu}} \times \frac{3413 \text{ Btu}}{\text{Kwh}} = \underline{0.02 \frac{\text{MBtu}}{\text{yr}}}, \text{ Elec}$$

Energy Savings = Current - Future

$$\text{Heating Energy} = (3.84 - 2.35) \frac{\text{MBtu}}{\text{yr}} = \underline{1.49 \frac{\text{MBtu}}{\text{yr}}}, \text{ F.O. \#6}$$

$$\text{Cooling Energy} = (0.03 - 0.02) \frac{\text{MBtu}}{\text{yr}} = \underline{0.01 \frac{\text{MBtu}}{\text{yr}}}, \text{ Elec}$$

Note - these savings are on a per window basis

Project Costs:

Construction Cost = \$101 per window

See Cost Estimate Sheets for details.

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY
Window Heating and Cooling Load Savings

03/25/92
WINDOW.WQ1

INPUTS: 1) Days Per Week That HVAC Operates 7 Days/Week
2) Summer Room Dry Bulb Temperature 75 °F (db)
3) Winter Room Dry Bulb Temperature 68 °F (db)
4) Window Overall U-Value 0.80 Btu/Hr*SF*°F
5) Surface Area of Window 12.5 SqFt
6) HVAC Oper. Hrs/Shift: 12 M - 8 AM 8 Hrs/Shift
8 AM - 4 PM 8 Hrs/Shift
4 PM - 12 M 8 Hrs/Shift

Temperatures			Hours of Occurrence			Total Oper. Hours	Window Load (Btu/Yr)	
db-Range	wb		00-08	08-16	16-24		Cooling	Heating
120	124					0	0	0
115	119					0	0	0
110	114					0	0	0
105	109					0	0	0
100	104					0	0	0
95	99	75	0	7	0	7	1,540	0
90	94	72	0	28	6	34	5,780	0
85	89	71	0	95	28	123	14,760	0
80	84	68	4	177	73	254	17,780	0
75	79	66	27	248	140	415	8,300	0
70	74	64	115	257	222	594	0	0
65	69	61	234	235	271	740	0	0
60	64	57	263	212	252	727	0	43,620
55	59	52	274	190	236	700	0	77,000
50	54	48	263	183	214	660	0	105,600
45	49	43	242	183	205	630	0	132,300
40	44	38	229	202	205	636	0	165,360
35	39	34	261	241	251	753	0	233,430
30	34	30	295	220	262	777	0	279,720
25	29	25	216	156	191	563	0	230,830
20	24	20	163	112	130	405	0	186,300
15	19	16	110	79	96	285	0	145,350
10	14	11	84	43	65	192	0	107,520
5	9	6	60	27	38	125	0	76,250
0	4	2	37	16	22	75	0	49,500
-5	-1	-3	27	3	9	39	0	27,690
-10	-6	-8	10	0	4	14	0	10,640
-15	-11	-13	5	0	0	5	0	4,050
-20	-16	-17	3	0	0	3	0	2,580
-25	-21					0	0	0
-30	-26					0	0	0
-35	-31					0	0	0
-40	-36					0	0	0
-45	-41					0	0	0
Totals			2922	2914	2920	8756	48,160	1,877,740

Total operating hours for each system 833 6589

Average outside air temp. while cooling/heating 80.8 39.5

03/25/92

ECO Construction Cost Estimate Calculations

ECO Name: Install Storm Windows

ECO #:

1991 ECO "bare" costs (from cost estimate sheet)		
Material		\$56
Labor		\$13
	Subtotal bare costs	\$69
FICA Insurance (20% of Labor)		\$3
Sales Tax (Not Applicable For GOGO)		\$0
	Subtotal	\$72
Overhead (15%)		\$11
	Subtotal	\$83
Profit (10%)		\$8
	Subtotal	\$91
Bond (1%)		\$1
	Subtotal	\$92
Contingency (10%)		\$9
	Subtotal (Construction Cost Input For LCCID *)	\$101
	SIOH (6.0% of Construction Cost)	\$6
	Subtotal	\$107
	Design (6.0% of Construction Cost)	\$6
Total Project Cost		\$113

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.



SUBJECT ECO# 19
Occupancy Sensors
DESIGNER Hutchins
CHECKER -

AEP NO 290-0379-002
SHEET OF
DATE 3/19/92
DATE

Screening Calc's - Restroom

- Calculate savings for typical restroom

Assume lights are on from 0600 to 1800, 12 hrs
five days per week - and are only needed 40% of the time

- Estimate payback

Room size	=	500 sf
Lighting load (watts)	=	500 w (1w/sf, p. 19-10)
Annual lighting hrs.	=	3000 hrs
Annual kwh	=	1500 kwh
Annual MBtu	=	5.1 MBtu
Annual savings (%)	=	60%
Annual savings (MBtu)	=	3.1 MBtu
Installed cost	=	\$205
Annual cost savings	=	\$63
Payback (years)	=	3.3 yrs.

Therefore, to achieve a payback less than 4 yrs., restrooms selected should average > 400 sf.

Cost estimate
FICA (20%)
SUBTOTAL

mat. ⁽¹⁾	labor ⁽²⁾
85	\$ 37.50
	7.50
\$ 85	\$ 45.00

SUBTOTAL
OTHER MARKUPS (@ 58%)

\$ 130
75
\$ 205

- (1) 5% off list
(2) 1 1/2 hrs @ \$25/hr



SUBJECT ECO#19 - Occupancy
Sensors
DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

Screening Calc.: - Break room

- Assume lights are on 50% of the time from 0600 to 1800 or 6 hrs/day. - they are needed for two breaks & lunch - a total time of 2 hrs/day - savings are 67%
- Estimate payback

Room size	=	1000 sf
Lighting level	=	1000 watts (1w/sf)
Annual lighting hrs.	=	1500 hrs
Annual kWh	=	1500 kWh
Annual MBtu	=	5.1 MBtu
Annual savings (%)	=	67%
Annual savings (MBtu)	=	3.4 MBtu
Installed cost	=	\$240
Annual cost savings	=	\$70
Payback (yrs)	=	3.4 yrs

Cost Estimate
FICA (20%)
SUBTOTAL

mat (1)	Labor (2)
\$114	\$37.50
	7.50
<u>114</u>	<u>\$45.00</u>

\$159-

OTHER MARK-UPS (58%)

92
\$241



SUBJECT Eco#
Occ. Sensors
DESIGNER Hutchins
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

Screening Calc's - Office

Calculate current energy use, savings, payback

Room size	=	15' x 10' = 150 sf.
Lighting load	=	192 watts (2 F40 fixtures)
Annual lighting hours	=	2500 hrs (10 hr/day)
Annual kWh	=	480 kWh
Annual MBtu	=	1.64 MBtu
Annual savings (%)	=	25%
Annual savings (MBtu)	=	0.4 MBtu
Annual cost savings (@ \$20/MBtu)	=	\$ 8.3
Installed cost	=	\$ 96
Payback	=	12 yrs.

Cost Estimate

FICA (20%)

SUBTOTAL

OTHER MARK UPS (@ 58%)

Mat ⁽¹⁾	Lab ⁽²⁾
\$ 53	\$ 6.25
	1.25
\$ 53	\$ 7.50
\$ 60.50	
35.09	
\$ 95.59	

- (1) 5% off list
(2) 1/4 hr @ \$25/hr.



SUBJECT ECO #19 Occupancy
Sensor
DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

Based on screening calculations, restrooms and breakrooms are recommended. Since our survey indicated that most break room areas lighting were turn off when not occupied. Restrooms lights have a greater tendency to be left on when unoccupied.



SUBJECT EEO #19 Occupancy
Sensor
DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

QRIP/OSD PIF CALC.S

PRESENT METHOD ENERGY USE

From p. 19-1 annual MBtu = 3.1 MBtu / 500 sf

p. 19-6 bath sf = 34,136

For 34,136 sf $\Rightarrow 34,136 \times 5.1 / 500 = 348 \text{ MBtu/yr.}$

Cost = $348 \text{ MBtu} \times \$20.35 / \text{MBtu} = \$7080 / \text{yr.}$

PROPOSED METHOD ENERGY USE

From p. 19-1 $(5.1 - 3.1) \text{ MBtu} / 500 \text{ sf}$

$34,136 \times 2.0 \text{ MBtu} / 500 \text{ sf} = 137 \text{ MBtu/yr.}$

Cost = $92 \times \$20.35 / \text{MBtu} = \$2790 / \text{yr.}$

SAVINGS

ENERGY = $348 - 137 = 211 \text{ MBtu/yr.}$

COST = $7080 - 2790 = \$4290 / \text{yr.}$

WATERVLIET ARSENAL
ECO #19 OCCUPANCY SENSORS

RESTROOM INVENTORY

BLDG #	#	DIMENSIONS	AREA (SF)	NOTES
10	3	10X16, 16X19, 14X19(2)	996	1ST FLOOR
	3	10X16, 16X19, 14X19(2)	996	2ND FLOOR
	4	10X15(2), 8X16, 12X15	608	3RD FLOOR
	1	12X18	216	BASEMENT
15	1	13X32	416	
20	2	40X70	5600	
21	4	15X16(2), 10X10(2)	680	
22	-	-	-	
23	-	-	-	
24	3	15X17, 17X21(2)	969	
25	3	35X45	4725	LADIES' LOCKERS
	3	30X30	1800	MEN'S LOCKERS
35	2	40X50	4000	MAIN FLOOR MEN'S/LADY'S LOCKERS
	1	34X38	1292	BASEMENT MEN'S LOCKER
40	2	20X30	1200	1ST FLOOR SOUTH-MOST WING
	2	20X30	1200	1ST FLOOR NORTH END
	2	15X20, 10X30	600	1ST FLOOR NORTH-MOST WING
44	1	18X20	360	BASEMENT
	2	18X20(2)	720	1ST FLOOR WEST END
110	2	13X20, 8X20	420	MAIN FLOOR
	1	15X20	300	NORTH END
	2	10X20, 9X24	416	SOUTH END
115	2	15X15	450	
120	2	20X20	800	1ST FLOOR - SOUTH
	3	13X20(2), 10X20	720	2ND FLOOR
124	-	-	-	
125	4	3/4(38X80), 16X26, 16X18(2)	3272	MAIN FLOOR - NORTH
130	-	-	-	
135	2	20X20	800	
145	2	10X18, 20X20	580	
TOTALS	59		34,136	

LOCATIONS ARE FOUND ON FLOOR PLANS IN VOL. III A



SUBJECT ECO# 19 Occupancy
Sensors
DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

- Calculate annual replacement costs
Life expectancy = 12 yrs.
Therefore all sensors will be replaced
once or at the end of 12 years and
the replacement will operate until the
end of the 25 yr. study life

Cost of replacement
(see p. 19-1)

$$\$130 \times 59 = \underline{\underline{\$7670}}$$

No other mark up since
you would be using
installation labor

03/31/92

ECO Construction Cost Estimate Calculations

ECO Name: OCCUPANCY SENSORS

ECO #: 19

1991 ECO "bare" costs (from cost estimate sheet)

Material	\$5,369
Labor	\$2,213

Subtotal bare costs	\$7,582
FICA Insurance (20% of Labor)	\$443
Sales Tax (not applicable for GOGO)	\$0

Subtotal	\$8,025
Overhead (15%)	\$1,204

Subtotal	\$9,229
Profit (10%)	\$923

Subtotal	\$10,152
Bond (1%)	\$102

Subtotal	\$10,254
Contingency (10%)	\$1,025

Subtotal (Construction Cost Input For LCCID *)	\$11,279

SIOH (6% of Construction Cost)	\$677

Subtotal	\$11,956
Design (6% of Construction Cost)	\$677

Total Project Cost	\$12,633

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.



SUBJECT ECO #19 Occupancy
Sensor
DESIGNER Hutchins
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

ESTIMATED LIGHTING INTENSITY IN RESTROOMS (w/sf)

RESTROOM LIGHTING DATA

EXAMPLES	SIZE (SF)	TOTAL WATTS	WATTS PER SF	FOOT- CANDLES
1	1080	576	0.5	15
2	196	192	1.0	30
3	225	480	2.1	50
4	308	480	1.6	70
5	504	288	0.6	30
6	468	576	1.2	90
7	516	672	1.3	75
TOTAL	3297	3264	<u>1.0</u>	
Avg	471			

Project No. 290-0379-002

Local L.D. ✓ Placed ✓ Rec'd. Date 3/19/92

P. Hutchins Conversed With Rich

Of UNENCO Regarding Occupancy Sensors

(214) 442-1900

	Type	MAT	COST	LAB
BATHROOM	OVERHEAD U/S			3/4 hr dropped
	C600-R			? solid

Classroom	PIR OVERHEAD			
	OR WALL MOUNT SOM 1200 ZHD			1/4 hr.

Hallway	C500-2000 15X100			
	U/S			

Office	WALL-MOUNT switch			
	7.5 AMP			

~~Breakroom~~	min. 34X34	SOM-500-A PIR		
		SOM-1000-B		
Breakroom	min. 34X34	7.5 AMP		
		SOM-1000-A2 PIR		

carpet affects u/s

10 yr life expectancy

UNENCO & UEC ARE SAME COMPANY

DO NOT HAVE PHOTOCELL RIGHT NOW.

SUBTRACT 7.5%-10%

Distribution:



Manufacturers & Designers
of
Sensible Controls

Switchomat™

The world's best investment in automatic light switching with a 9-year proven track record!

\$50 invested now will earn a \$500 return by 1999

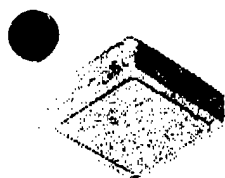


Automatic
Light Switch

Now you can replace your forgetful switches and have aesthetically pleasing, automatic switches by means of infrared occupancy sensors. Ultra safe, no heat generating components, installed in minutes. Total equipment cost is only \$48.00 in quantities of 250 and up. **Switchomat™** controls an area up to 800 square feet and 1800 watts. Pay back is less than one year, based on 350 watt load at 8¢ per KWH. UEC is the leader and innovator in infrared and ultrasonic occupancy sensors for small, medium or large areas, including HVAC controls. All products are covered by a five year factory warranty and a 90 day money back guarantee.

PASSIVE INFRARED AUTOMATIC 2 WIRE WALL LIGHT SWITCHES

 Model SOM-500-A	Switchomat™ Manual lights off switch with built-in safety neon night light. Occupancy sensor, up to 800 sq. ft. coverage. 120/277 Volt, 1000/1800 Watt switching capacity fluorescent or incandescent. Immediate activation when entering room.	1-23	24-95	96 & UP
		\$60.00	\$56.00	\$52.00
 Model SOM-1000-A	Switchomat™ Occupancy sensor, up to 1000 sq. ft. coverage. 120/277 Volt, 1000/1800 Watt switching capacity fluorescent or incandescent, 180° coverage. Immediate activation when entering room.	64.00	60.00	56.00
 Model SOM-1000-A-2	Switchomat™ 2 switches, 2 circuits. Occupancy sensor, up to 1000 sq. ft. coverage. 120/277 Volt, 1000/1800 Watt switching capacity on each circuit (2 wires) 180° coverage. Immediate activation when entering room. Heavy duty model with larger switching capacity available upon request.	70.00	66.00	62.00
 Model SOM-1000-B	Switchomat™ Occupancy sensor, up to 1000 sq.ft. coverage. Single circuit heavy load capacity. Minimum 900 Watt to Maximum 2400 Watt at 120V ballast rating. Minimum 1800 Watt to Maximum 4500 Watt at 277V ballast rating, 180° coverage. Immediate activation when entering room.	71.00	67.00	63.00
 Model SOM-1200-2-HD	Switchomat™ MODEL SOM-1200-2-HD, SPECIFICALLY DESIGNED FOR CLASSROOMS.			
	2 switches, 2 circuits, occupancy sensor, up to 4000 sq. ft. coverage, 120/277V, 2000/4000 Watt switching capacity on each circuit (2 wires) 180° coverage. Immediate activation when entering. Can be mounted in either a double or triple gang wall box or plaster ring.	96.00	92.00	88.00



Model C-400
Model C-600-H
Model HMS-1
Size: 4" x 4" x 1"

MODEL C-400, Occupancy sensor 400 sq. ft. coverage. For use with remote power switch packs, or can be mounted together with power switch pack.

\$62.00

\$58.00

\$54.00

MODEL C-600-H, Selected and modified for hallway installations. For use with remote power switch packs, or can be mounted together with power switch pack.

69.00

65.00

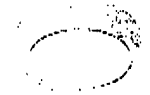
61.00

MODEL HMS-1, Room Occupancy sensor with built-in comfort cycle timer. 400 sq. ft. coverage for Hotel/Motel guest room HVAC control. For use with remote power switch packs, or can be mounted together with power switch pack.

78.00

73.00

69.00



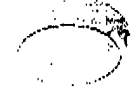
Model C-600-R
Size: 4.25" x 1"

MODEL C-600-R, Occupancy sensor 600 sq. ft. coverage equipped with versatile transmitter power slide switch feature for use in small rooms. For use with remote power switch packs, or can be mounted together with power switch pack.

69.00

65.00

61.00



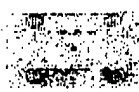
Model C-1000
Size: 5" x 1"

MODEL C-1000, Occupancy sensor 1000 sq. ft. coverage or for multiple unit installation in large open offices. For use with remote power switch packs, or can be mounted together with power switch pack.

80.00

76.00

72.00



Model C-500-2000
Size: 5" x 3 3/4" x 1 1/2"

MODEL C-500-2000, Occupancy sensor, 2000 sq. ft. coverage or for multiple unit installations in large open offices. Also suitable for long hallways 100' x 15'. For use with remote power switch packs, or can be mounted together with power switch pack.

98.00

93.00

88.00

NEW!

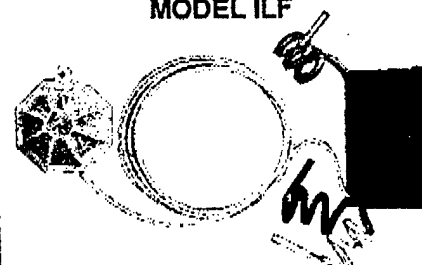
INTELLIGENT LIGHT FIXTURE

NEW!

Now you can make any light fixture, or even a bank of lights turn on and off automatically. By using the superbly engineered infrared sensor/power switch pack combination, it can be installed inside a fixture ballast channel in less than 15 minutes without disturbing the existing ceiling or wiring.

Patent Pending

MODEL ILF



Call or write for free feasibility analysis!

REMOTE POWER/SWITCH PACKS



Size: 2 3/4" x 1 1/2" x 1 1/2"

MODEL 211, Power/Switch Pack, 120V, with isolated relay contacts. 20 AMP Ballast rating. 40 year life expectancy rated at full load. *Heavy duty power packs for motor loads available upon request.*

22.00

20.00

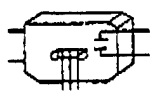
18.00

MODEL 212, Power/Switch Pack, 208V/240V, with isolated relay contacts. 20 AMP Ballast rating. 40 year life expectancy rated at full load. *Heavy duty power packs for motor loads available upon request.*

22.00

20.00

18.00



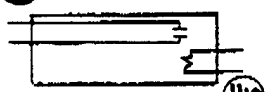
Model 211, 212 & 213

MODEL 213, Power/Switch Pack, 277V, with isolated relay contacts. 20 AMP Ballast rating. 40 year life expectancy rated at full load. *Heavy duty power packs for motor loads available upon request.*

22.00

20.00

18.00



Model SRP-1

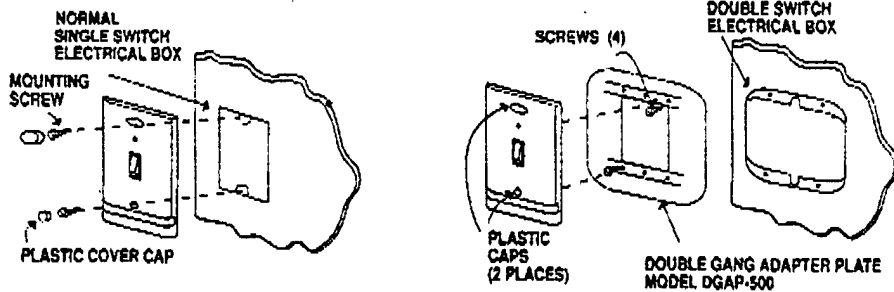
MODEL SRP-1, Slave Relay Pack, 20 AMP Ballast rating. 40 year life expectancy rated at full load.

12.00

11.00

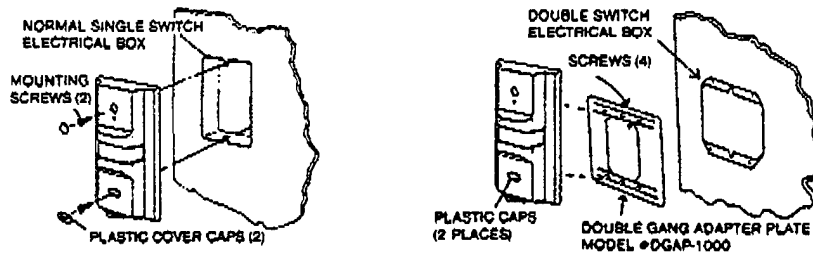
10.00

Model SOM-500 Accessory



1-23	24 & Up
\$2.75	\$2.50

Model SOM-1000 Accessory



1-23	24 & Up
\$2.75	\$2.50

CEILING MOUNTED PASSIVE INFRARED OCCUPANCY SENSORS



MODEL PIR-1000-P
Size 3" x 4 1/4" x 1 1/4"

Conserver™

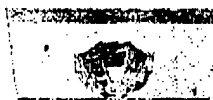
PIR-1000-P, self contained occupancy sensor, up to 1000 sq. ft. coverage, 20 amp switching capacity. Specify voltage when ordering.

MODEL PIR-1000-P-H
Size 3" x 4 1/4" x 1 1/4"

For long hallways and warehouses, specify type H-P, 16' x 80' coverage. Specify voltage when ordering.

MODEL PIR-2000-P
Size 3" x 4 1/4" x 1 1/4"

For large areas of detection 45' x 45', specify PIR-2000-P. Specify voltage when ordering.



MODEL PIR-1000
Size 3" x 4 1/4" x 1 1/4"

Conserver™

PIR-1000, Occupancy sensor up to 1000 sq. ft. coverage. For use with remote power switch pack.

MODEL PIR-1000-H
Size 3" x 4 1/4" x 1 1/4"

For long hallways and warehouse specify type "H", 16' x 80' coverage.

MODEL PIR-2000
Size 3" x 4 1/4" x 1 1/4"

For large areas of detection 45' x 45', specify PIR-2000.

1-23	24-85	96 & UP
\$68.00	\$64.00	\$62.00
75.00	71.00	67.00
95.00	90.00	85.00
60.00	56.00	52.00
65.00	61.00	57.00
85.00	80.00	75.00

OTHER BACKUP CALCULATIONS

**O&M ENERGY SAVINGS
BACK-UP CALCULATIONS**



SUBJECT O&M Savings
34 watt Fluorescents
DESIGNER P. Hutchins
CHECKER _____

AEP NO 290-0379-004
SHEET _____ OF _____
DATE 3/18/92
DATE _____

Upon failure, replace 40-watt fluorescent lamps with 34-watt lamps.

Energy savings:

Non production area:

$$(40-34) \text{ watts} \times \frac{1 \text{ kw}}{1000 \text{ w}} \times 2340 \frac{\text{hr}}{\text{yr}} = \underline{14 \text{ kwh/yr}}$$

Production area

$$(40-34) \times 8400 \frac{\text{hrs}}{\text{yr}} \div 1000 = \underline{50 \text{ kwh/yr}}$$

Energy Cost Savings

$$\text{Non production: } 14 \times \$0.068/\text{kwh} = \underline{\$0.95/\text{yr}}$$

$$\text{Production: } 50 \times \$0.068/\text{kwh} = \underline{\$3.40/\text{yr}}$$

Material Cost Differential

$$\$3.05 - 2.4 = \$0.81/\text{lamp}$$

MEANS Electrical
Cost Data 1991
p. 201

Payback

$$\text{Non-Production: } 0.81 \div 0.95 = \underline{0.9 \text{ years}}$$

$$\text{Production: } 0.81 \div 3.40 = \underline{0.25 \text{ years}}$$

OM-1



SUBJECT O&M Savings
Energy Efficient Ballasts
DESIGNER Hutchins
CHECKER _____

AEP NO 290-0379-002
SHEET _____ OF _____
DATE 3/31/92
DATE _____

Upon failure replace standard fluorescent ballast with energy efficient type

Ballast Data

Four Foot Fluorescents

TYPE	FIXTURE (1) (WATTS)	COST	
		GSA	VENDOR
STANDARD	96	\$ 7.75	
EEE (2)	80	10.30 (3)	\$20.00
ELECTRONIC	71	13.00 (3)	25.20

Eight Foot Fluorescents

TYPE	FIXTURE (1) WATTS	COST	
		GSA	VENDOR
STANDARD	175	\$ 11.76	
EEE (2)	158	-	-
ELECTRONIC	130	\$ 19.10	35.00

(1) 2-40 watt lamps

(2) EEE = energy efficient electromagnetic ballast

(3) Estimated based on cost data on eight foot lamps



SUBJECT O&M Savings
Fluorescent Ballasts
DESIGNER _____
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE 3/31/92
DATE _____

Energy savings:

Production areas: $(\text{watts}_{\text{STD}} - \text{watts}_{\text{ALT}}) \times 24 \text{ h/da}$
 $\times 5 \text{ da/wk} \times 50 \text{ wk/yr.}$

Non Production: $(\text{w}_s - \text{w}_A) \times 10 \text{ h/da} \times 5 \text{ da/wk}$
 $\times 50 \text{ wk/yr.}$

TYPE	AREA	ANNUAL		PAYBACK (YRS)
		SAVINGS (MSTH)	\$	
EER-4'	PROD	0.33	6.70	0.4
EER-4'	NON-PROD	0.14	2.80	1.0
ELRC-4'	PROD	0.51	10.40	0.5
ELRC-4'	NON-PROD	0.21	4.30	1.2
ELRC-8'	PROD	0.92	18.75	0.4
ELRC-8'	NON-PROD	0.14	2.80	1.0

FLUORESCENT BALLAST SPECIFICATIONS

WVA - #290-0379-002

12-Feb-92

LAMPS	WATTS	BALLASTS	BALLAST INPUT (W)	PRICE (\$)
F40T12/RS STD	40	ADV MARK IV	80	\$20.00
		EBT ELECTRONIC	71	
		GE OPTIMISER	71	
		GE PERFORMANCE SS	70	
		STANDARD	96	
F40T12/RS ENERGY	34	ADV MARK IV	66	\$20.00
		EBT ELECTRONIC	59	\$25.20
		GE OPTIMISER	59	
F40T12/RS ENERGY	32	GE MAXI-MISER II	72	
F40T8/IS STD	40	EBT ELECTRONIC	70	
F32T8/IS ENERGY	32	EBT ELECTRONIC	58	\$26.90
		T8 MAGNETIC	66	
F96T12/IS STD	75	GE MAXI-MISER II	158	
		EBT ELECTRONIC	130	
		STANDARD	175	
F96T12/IS ENERGY	60	GE MAXI-MISER II	136	
		EBT ELECTRONIC	105	\$35.00
F96T12/HO STD	105	GE WATT-MISER	237	
		GE MAXI-MISER II	254	
		STANDARD	255	
		EBT ELECTRONIC	190	
F96T12/HO ENERGY	95	GE MAXI-MISER II	212	
		EBT ELECTRONIC	160	\$44.00
F96PG17 STD	215	STANDARD	460	
ENERGY	185	STANDARD	400	
F90T17 STD	90	STANDARD	215	
ENERGY	82	STANDARD	200	
F90T12	84	STANDARD	200	

OM-4



SUBJECT O&M Savings - Repair
Compressed Air Leaks
DESIGNER Hutchins
CHECKER _____

AEP NO 290-0379-002
SHEET _____ OF _____
DATE 3/18/92
DATE _____

O&M Savings - Compressed Air Leaks

From ASHRAE, a $1/32"$ hole wastes \$252/yr @ 4¢/kwh

$$\text{For WVA} : \$252 \cdot \frac{6.8¢}{4¢} = \underline{\underline{\$428}} \text{ / yr / leak}$$

$$\frac{\$428 \div 6.8¢/\text{kwh} \times 3413 \text{ Btu}}{1.46} = \underline{\underline{22 \text{ MBtu / yr / leak}}}$$



SUBJECT Increase Condensate
Return to B. 136
DESIGNER P. Hutchins
CHECKER _____

AEP NO 290-0379-002
SHEET _____ OF _____
DATE 11/15/91
DATE _____

- Calculate the energy savings due to increasing condensate return
- Calculate present energy use

For this analysis boiler logs were collected and reviewed for the period June 1990 to May 1991. These were used in place of fiscal year data since the logs contain concurrent data on fuel use, steam generation and make-up water.

An analysis of this data is shown on the following page.

Present energy use = 301,700 MBtu #6 Fuel Oil

Energy savings = 7100 MBtu

Future energy use = 294,600 MBtu

WATERVLIT ARSENAL
STEAM GENERATION, FUEL USE & CONDENSATE RETURN

FILENAME: STEAM.WQ1

18-Mar-92

ENERGY SAVINGS FOR INCREASING CONDENSATE RETURN EXCEPT FOR PLATING TANKS IN BLDG. 35

MON	YR	STEAM GENERATED BLDG 136 (MBTU)		AVG M-U (%)	#6 FUEL CONSUMED W/ PROCESS		#6 FUEL CONSUMED W/O PROCESS		#6 FUEL CONSUMED W/O PROCESS & 10% MAKE-UP (MBTU)	SAVINGS (MBTU)
		W/ PROCESS	W/O PROCESS		(GAL)	(MBTU)	(MBTU)			
6	/ 90	0	0	100	0	0	0		0	0
7		0	0	100	0	0	0		0	0
8		0	0	100	0	0	0		0	0
9		0	0	100	0	0	0		0	0
10		13,050	9,300	66	101,103	15,165	10,808		10,222	586
11		31,774	28,024	52	264,549	39,682	34,999		33,675	1,324
12		40,149	36,399	43	339,326	50,899	46,145		44,794	1,351
1	/ 91	46,563	42,813	34	392,146	58,822	54,085		52,929	1,156
2		41,772	38,022	29	346,357	51,954	47,290		46,477	813
3		38,739	34,989	31	309,436	46,415	41,922		41,096	827
4		25,616	21,866	46	205,867	30,880	26,359		25,474	886
5		6,573	2,823	57	52,610	7,892	3,389		3,240	149
TOTALS		244,236	214,236		2,011,394	301,709	264,997		257,905	7,091

Make up energy use = (old make-up % - 10%) * steam gen'd (#) * 90 Btu/# / 0.80

For use of this form, see AR 420.49; the proponent agency is USACE.

For use of this form, see AR 420.49; the proponent agency is USACE.

147

1201	113.0

FEET USED DURING MONTH (STANDARD TONS)

527.5	6335	EVAPORATION 18 STEAM PER LB. STD. FUEL

SEE REVERSE SIDE
FOR INSTRUCTIONS

PREPARED BY

DATE 11/

APPROVED BY

DATE _____

POST ENGINEER

DATE _____

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

PLANT

Boiler Plant

BLDG. NO.

136

MONTH

Dec - 1990

#	STEAM PRODUCED				FUEL USED LB. M.C.F. GAL	FEED- WATER TO BOILER 1,000 LB. K 16/244	EVAP. PER UNIT 100 LB.	OUTSIDE TEMP. AV.	FEEDWATER HEATER		%BOILER		FLUE GAS TEMPERATURE				FLUE TEMP	FLUE TEMP	MAKE UP	EFF.	INIT.	
	#1	#2	#3	#4					1,000 LB.	1,000 LB.	1,000 LB.	1,000 LB.	1,000 LB.	1,000 LB.	1,000 LB.	1,000 LB.						1,000 LB.
1	532.5	576.2					944.3	14.5	43.3	6	230	66.1				436	450			496	77.3	LEO
2	430.0	533.8					826.9	14.5	46.1	6	230	65.3				410	383			55.7	77.3	LEO
3	637.7	664.4					1134.2	14.7	37.6	6	230	50.9				450	413			49.8	78.3	LEO
4	630.5	591.7					1031.6	14.6	44.8	6	230	69.1				440	437			47.1	78.0	LEO
5	744.9	738.1					1219.5	14.7	33.3	6	230	68.9				450	420			59.5	78.4	LEO
6	691.6	731.3					1192.1	14.7	38.8	6	230	70.0				441	413			40.4	78.6	LEO
7	647.9	724.2					1107.2	14.7	41.2	6	230	66.2				437	410			41.7	78.5	LEO
8	577.4	558.7					914.6	14.7	42.5	6	230	55.6				430	395			42.2	78.3	LEO
9	573.6	620.8					1012.3	14.8	41.0	6	230	53.5				430	403			36.7	78.3	LEO
10	621.8	738.2					1012.3	14.8	41.0	6	230	53.5				430	403			36.7	78.3	LEO
11	783.6	679.9					1058.7	14.7	42.6	6	230	59.6				437	412			39.4	78.2	LEO
12	627.2	674.1					1265.7	14.8	30.5	6	230	66.9				453	417			36.4	78.9	LEO
13	628.6	618.8					1122.7	14.8	38.1	6	230	72.3				450	410			35.5	78.5	LEO
14	711.9	607.6					1052.0	14.6	45.9	6	230	58.1				447	410			38.0	78.8	LEO
15	715.9	681.9					1204.5	14.7	33.3	6	230	74.4				440	420			42.0	78.3	LEO
16	624.5	703.2					1144.1	14.8	37.2	6	230	61.6				440	420			36.0	78.9	LEO
17	622.7	720.7					1211.2	14.8	37.4	6	230	67.9				440	420			36.0	78.9	LEO
18	662.5	647.0					1086.9	14.9	43.5	6	230	61.0				440	420			36.0	78.9	LEO
19	662.5	647.0					1291.6	14.6	31.9	6	230	71.1				440	420			36.0	78.9	LEO
20	718.8	707.1					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
21	625.3	622.4					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
22	711.0						1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
23	704.2						1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
24	743.0	75.7					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
25	647.0	598.5					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
26	676.1	713.0					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
27	657.7	686.7					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
28	616.1	661.5					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
29	537.7	564.5					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
30	521.8	544.2					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
31	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
32	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
33	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
34	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
35	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
36	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
37	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
38	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
39	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
40	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
41	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
42	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
43	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
44	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
45	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
46	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
47	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
48	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
49	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
50	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
51	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
52	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
53	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
54	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
55	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
56	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
57	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
58	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
59	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
60	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
61	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
62	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
63	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
64	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
65	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
66	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
67	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
68	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
69	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
70	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
71	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
72	521.1	179.9					1099.7	14.6	45.4	6	230	65.4				440	420			36.0	78.9	LEO
73	521.1	179.9					1099.7	14.6	45.4	6	230	65.4										

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

#	STEAM PRODUCED					FEED- WATER TO BOILER	FUEL USED LB. M.C.F. GAL.	EVAP. LB. PER UNIT	OUTSIDE		FEEDWATER HEATER		BOILER			BOILER			TEMP.		UP	EFF.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420.49; the proponent agency is USACE.

INSTALLATION

WATERVLIET ARSENAL

PLANT

Boiler Plant

BLOG. NO.

136

MONTH

FEB 1991

INIT:

EFF.

MAKE LIP

FLUE GAS TEMPERATURE

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FACILITIES ENGINEERING OPERATING LOG (Boiler Plant) For use of this form, see AR 420-49; the proponent agency is USACE.

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)										WATERVLIET ARSENAL										Boiler Plant										MARCH 91																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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#1	#2	#3	#4	#5	STEAM PRODUCED					FEED-WATER TO BOILER	FUEL USED LB. M.C.F. GAL.	EVAP. LB. OR UNIT	OUTSIDE TEMP. AV.		PRESS. TEMP.		WATER HEATER		%BOILER			FLUE GAS TEMPERATURE			FLUE TEMP	FLUE MAKE	EFF.	INIT.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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REMARKS	APPROVED BY	DATE	POST ENGINEER	DATE
O ₂ Analyzers out of order				

ECIP 1--HIGH-EFFICIENCY LIGHTING



SUBJECT ECIP # 1
LAMPS / BALLASTS
DESIGNER C. Warren
CHECKER _____

AEP NO 290-0374-002
SHEET 1 OF 1
DATE 4/1/92
DATE _____

SAVINGS CALCULATIONS

FROM ECO PROJECTS

<u>ECO #</u>	<u>ANNUAL ELECT</u> <u>SAVINGS (Watt-hr/yr)</u>	<u>DIFFERENTIAL</u> <u>LAMP REPL</u> <u>COSTS (\$/yr)</u>	<u>REBATE AMT.</u> <u>(\$)</u>
8C	117	96	2203
8D	589	809	3138
8H	<u>4478</u>	<u>2530</u>	<u>64979</u>
TOTAL	5,184	3,435	70,320

04/01/92

ECO Construction Cost Estimate
Calculations

ECO Name: Energy Efficient Fluorescent Lights & Ballasts

ECO #: ECIP 1

1991 ECO "bare" costs (from cost estimate sheet)

Material	\$151,780
Labor	\$114,206

Subtotal bare costs	\$265,986
FICA Insurance (20% of Labor)	\$22,841
Sales Tax (not applicable for GOGO)	\$0

Subtotal	\$288,827
Overhead (15%)	\$43,324

Subtotal	\$332,151
Profit (10%)	\$33,215

Subtotal	\$365,366
Bond (1%)	\$3,654

Subtotal	\$369,020
Contingency (10%)	\$36,902

Subtotal (Construction Cost Input For LCCID *)	\$405,922

SIOH (6% of Construction Cost)	\$24,355

Subtotal	\$430,277
Design (6% of Construction Cost)	\$24,355

Total Project Cost	\$454,632

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

ECIP 1 - HIGH EFFICIENCY LIGHTING

ECIP COST ESTIMATE CALCULATIONS

	#	LABOR	MATERIAL	
32W TB LAMPS	308	\$693	\$647	
FICA (20% LAB)		\$139		
SUBTOTAL		\$832	\$647	
OVERHEAD (15%)		\$125	\$97	
SUBTOTAL		\$956	\$744	
PROFIT (10%)		\$96	\$74	
SUBTOTAL		\$1,052	\$818	
BOND (1%)		\$11	\$8	
SUBTOTAL		\$1,062	\$827	
PER UNIT		\$3.45	\$2.68	\$6.13

	#	LABOR	MATERIAL	
32W TB BALLASTS	102	\$2,142	\$2,992	
FICA (20% LAB)		\$428		
SUBTOTAL		\$2,570	\$2,992	
OVERHEAD (15%)		\$386	\$449	
SUBTOTAL		\$2,956	\$3,441	
PROFIT (10%)		\$296	\$344	
SUBTOTAL		\$3,252	\$3,785	
BOND (1%)		\$33	\$38	
SUBTOTAL		\$3,284	\$3,823	
PER UNIT		\$32.20	\$37.48	\$69.67

	#	LABOR	MATERIAL	
34W LAMPS	7845	\$17,651	\$14,121	
FICA (20% LAB)		\$3,530		
SUBTOTAL		\$21,181	\$14,121	
OVERHEAD (15%)		\$3,177	\$2,118	
SUBTOTAL		\$24,358	\$16,239	
PROFIT (10%)		\$2,436	\$1,624	
SUBTOTAL		\$26,794	\$17,863	
BOND (1%)		\$268	\$179	
SUBTOTAL		\$27,062	\$18,042	
PER UNIT		\$3.45	\$2.30	\$5.75

	#	LABOR	MATERIAL	
60W LAMPS	6248	\$15,620	\$24,680	
FICA (20% LAB)		\$3,124		
SUBTOTAL		\$18,744	\$24,680	
OVERHEAD (15%)		\$2,812	\$3,702	
SUBTOTAL		\$21,556	\$28,382	
PROFIT (10%)		\$2,156	\$2,838	
SUBTOTAL		\$23,711	\$31,220	
BOND (1%)		\$237	\$312	
SUBTOTAL		\$23,948	\$31,532	
PER UNIT		\$3.83	\$5.05	\$8.88

	#	LABOR	MATERIAL	
60W LAMP BALLASTS	3124	\$78,100	\$109,340	
FICA (20% LAB)		\$15,620		
SUBTOTAL		\$93,720	\$109,340	
OVERHEAD (15%)		\$14,058	\$16,401	
SUBTOTAL		\$107,778	\$125,741	
PROFIT (10%)		\$10,778	\$12,574	
SUBTOTAL		\$118,556	\$138,315	
BOND (1%)		\$1,186	\$1,383	
SUBTOTAL		\$119,741	\$139,698	
PER UNIT		\$38.33	\$44.72	\$83.05

(E-4)

FORM 1391 - COST ESTIMATE

32W LAMPS	308	\$6.13	2	1,889	1,889
ELECT. BALL	102	\$69.67	7	7,107	7,107
34W LAMPS	7845	\$5.75	45	55,481	45,104
60W LAMPS	6248	\$8.88	56	45,104	55,481
EL BALL	3124	\$83.05	259	259,440	259,440

SUB			369	369,020	
CONT (10%)			37	36,902	
TOT CONTRACT			406	405,922	
SIGN (6%)			24	24,355	
TOTAL REQUEST			430	430,277	

308	2.25	693	2.10	647
102	21.00	2,142	29.33	2,992
7845	2.25	17,651	1.80	14,121
6248	2.50	15,620	3.95	24,680
3124	25.00	78,100	35.00	109,340

114,206	151,779

ENERGY PLAN

ENERGY PLAN CALCULATIONS

	ELC	FSD	NAG	FSR	TOT	ACTUAL
FY91	182,203	2,002	84,527	302,279	571,011	571,011
EC06	0	0	3,205	2,255	5,460	
EC012	2,497	0	(3,122)	0	(625)	
EC04	2,707	0	0	21,650	24,357	
EC07	814	0	0	0	814	
EC02	0	0	-278000	278000	0	
EC010	1,901	0	0	0	1,901	
	7,919	0	(277,917)	301,905	31,907	
FY93	174,284	2,002	362,444	0	538,730	538,730
EC08	5,184	0	0	0	5,184	
EC015	0	0	9,851	0	9,851	
	5,184	0	9,851	0	15,035	
FY96	169,100	2,002	352,593	0	523,695	523,695

FY91	\$3,669,678	\$354,893	\$54,282	\$1,998,073	\$6,076,926	\$6,024,000
EC05	\$151,000	\$0	\$0	\$0	\$151,000	\$151,000
FY92	\$3,518,678	\$354,893	\$54,282	\$1,328,382	\$5,256,235	\$5,203,309
EC06	\$0	\$0	\$13,333	\$9,922	\$23,255	\$23,300
EC012	\$50,814	\$0	(\$12,988)	\$0	\$37,826	\$37,900
EC04	\$55,087	\$0	\$0	\$95,260	\$150,347	\$141,900
EC07	\$16,565	\$0	\$0	\$0	\$16,565	\$15,600
EC02	\$0	\$0	(\$1,156,480)	\$1,223,200	\$66,720	\$66,720
EC010	\$38,685	\$0	\$0	\$0	\$38,685	\$33,000

	\$161,152	\$0	(\$1,156,135)	\$1,328,382	\$333,399	\$318,420

FY93	\$3,357,526	\$354,893	\$1,210,417	\$0	\$4,922,836	\$4,884,889
EC08	\$105,494	\$0	\$0	\$0	\$105,494	\$104,900
EC015	\$0	\$0	\$40,980	\$0	\$40,980	\$44,400

	\$105,494	\$0	\$40,980	\$0	\$146,475	\$149,300

FY96	\$3,252,032	\$354,893	\$1,169,437	\$0	\$4,776,362	\$4,735,589

REDUCTIONS (NBTU)	47,316
(\$)	\$1,288,411

	ELC	FSD	NAG	FSR	TOT	971691
FY91	182,203	2,002	84,527	302,279	571,011	
FY92	182,203	2,002	84,527	302,279	571,011	
FY93	174,284	2,002	362,444	0	538,730	
FY94	174,284	2,002	362,444	0	538,730	
FY95	174,284	2,002	362,444	0	538,730	
FY96	169,100	2,002	352,593	0	523,695	47,316

FY91	\$3,637,718	\$351,802	\$53,809	\$1,980,671	\$6,024,000	
FY92	\$3,486,718	\$351,802	\$53,809	\$1,328,382	\$5,220,711	
FY93	\$3,331,645	\$352,157	\$1,201,086	\$0	\$4,884,889	
FY94	\$3,331,645	\$352,157	\$1,201,086	\$0	\$4,884,889	
FY95	\$3,331,645	\$352,157	\$1,201,086	\$0	\$4,884,889	
FY96	\$3,224,272	\$351,864	\$1,159,454	\$0	\$4,735,589	\$1,288,411

WATERVLIET ARSENAL
ENVIRONMENTAL IMPACT OF ENERGY SAVING PROJECTS

ENVIR.WQ1

EMISSIONS IN LBS PER MBTU

EMISSION	#6 FUEL OIL					NGAS	BACT
	COAL	0.5%	1%	2%			
SO2	1.8	0.54	1.08	2.36	0	0	
NOx	0.061	0.36	0.29	0.36	0.25	0.04	
Particulates	0.15	0.06	0.09	0.17	0.003	0.0002	
CO2	209	169	169	169	110	110	

EMISSIONS IN LBS PER KWH

EMISSION	#6 FUEL OIL					NGAS	BACT
	COAL	0.5%	1%	2%			
SO2	0.019	0.006	0.012	0.025	0	0	
NOx	0.001	0.004	0.003	0.004	0.003	0.0004	
Particulates	0.002	0.001	0.001	0.002	3E-05	2E-06	
CO2	2.23	1.80	1.80	1.80	1.17	1.17	

Source : Strategic Planning for Energy and the Environment,
Winter 1990-1991, p. 57
Environmental Costs of Electricity, DOE & New York State
Energy Research and Development Authority

EMISSIONS IN LBS PER MBTU

EMISSION	NGAS	COAL	OIL
CO2	115	200	170
SO2	0.0005	2.67	0.95
NOx	0.39	1.12	0.48
CO	20	30	30
Hydrocarbons	3	10	5
Particulates	10	230	2540

Source : American Gas Association, Edison Electric Institute

WATERVLIET ARSENAL
ENVIRONMENTAL AFFECTS OF ENERGY SAVING PROJECTS

NIAGRA-MOHAWK EMISSIONS ESTIMATE

Fuel Type	Percent	Emissions (lbs/kwh)			
		SO2	NOX	Part.	CO2
Coal	42	0.019	0.001	0.002	2.23
Natural Gas	10	0	0.003	3E-05	1.17
Residual Oil	34	0.012	0.003	0.001	1.8
Nuclear	14	-	-	-	-
Hydro	-	-	-	-	-
Net Total		0.012	0.002	0.001	1.666



SUBJECT ENVIRONMENTAL Impact
of Projects
DESIGNER P. Hutchins
CHECKER _____

AEP NO _____
SHEET _____ OF _____
DATE _____
DATE _____

Nisega Mohawk Generation Fuel Mix

1990

	<u>GWH</u>	<u>%</u>
Coal	8678	42
Nat Gas	1950	10
Res. Oil	7109	34
Nuclear	2975	14
Hydro	<u>55</u>	<u>-</u>
	20,767	100

OS-64

State of New York
Department of Public Service
Office Services Unit
Three Empire State Plaza
Albany, NY 12223

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EP-6

FUEL REQUIREMENTS

TABLE VI-1
FUEL REQUIREMENTS - HISTORICAL - Coal & Natural Gas

	COAL					NATURAL GAS				
	1986	1987	1988	1989	1990	1986	1987	1988	1989	1990
Installed Gen. Cap. (MW)										
New York Power Pool	3973	4763	4770	4807	4800	833	682	894	896	957
Central Hudson	-	366	366	370	370	151	-	62	72	116
Con Edison	-	-	-	-	-	30	30	30	30	30
LILCO	-	-	-	-	-	-	-	-	-	-
NYSEG	2366	2386	2405	2414	2414	-	-	-	-	-
Niagara Mohawk	1270	1275	1275	1285	1294	637	637	712	705	686
Orange & Rockland	-	399	387	387	385	-	-	75	74	90
RG&E	337	337	337	337	337	15	15	15	15	15
NYPA	-	-	-	-	-	-	-	-	-	-
Fuel Consumption(2)(6)										
Thousands of Tons										
Millions of Cubic Feet										
New York Power Pool	8316	9939	11166	12269	12076	131450	173393	147030	180444	223798
Central Hudson	-	414	884	889	818	258	6037	2179	4810	6240
Con Edison	-	-	-	-	-	78799	84627	81426	91576	119046
LILCO	-	-	-	-	-	25339	28774	28087	25669	35243
NYSEG	5327	5955	6107	6467	6403	-	-	-	-	-
Niagara Mohawk	2462	2805	3054	3499	3420	2096	19514	11869	27089	22560
Orange & Rockland	-	143	453	588	665	15697	14813	12018	12332	16717
RG&E	527	520	665	826	770	26	47	4	727	293
NYPA	-	-	-	-	-	9035	19581	11447	18241	23699
Generation (GWH)(1)(5)										
New York Power Pool	20652	25204	28323	31026	30679	12459	16392	14103	17220	21570
Central Hudson	-	1087	2281	2292	2202	20	522	174	405	577
Con Edison	-	-	-	-	-	7499	8190	8022	8889	11732
LILCO	-	-	-	-	-	2308	2650	2534	2352	3303
NYSEG	13196	15025	15588	16345	16211	-	-	-	-	-
Niagara Mohawk	6140	7185	7894	9013	8678	177	1785	1070	2456	1950
Orange & Rockland	-	347	1090	1263	1612	1576	1385	1172	1315	1614
RG&E	1316	1560	1670	2113	1976	1	3	-	41	19
NYPA	-	-	-	-	-	878	1857	1131	1762	2375
Fuel Cost										
Cents per Million BTU										
Central Hudson	-	190	192	192	204	438	312	232	278	279
Con Edison	-	-	-	-	-	253	303	246	263	282
LILCO	-	-	-	-	-	228	256	231	249	230
NYSEG	166	157	153	156	165	-	-	-	-	-
Niagara Mohawk	178	157	153	153	157	387	217	215	251	249
Orange & Rockland	-	195	201	211	216	222	212	236	270	273
RG&E	173	167	163	154	156	390	342	408	269	302
NYPA	-	-	-	-	-	214	258	230	247	277

**TABLE VI-1
FUEL REQUIREMENTS - HISTORICAL - Residual Oil & Distillate Oil**

Installed Gen. Cap. (MW) New York Power Pool	RESIDUAL OIL					DISTILLATE OIL				
	1986	1987	1988	1989	1990	1986	1987	1988	1989	1990
Central Hudson	895	546	480	480	517	43	43	38	38	43
Con Edison	6138	6173	6323	6323	6227	2046	2046	2046	2037	2037
LILCO	2693	2730	2731	2718	2730	1059	1059	1103	1359	1347
NYSEG	-	2272	-	-	-	7	7	7	7	7
Niagara Mohawk	2262	2361	2286	2286	2286	237	237	237	230	-
Orange & Rockland	902	507	507	507	489	74	74	-	-	-
RG&E	173	204	204	204	204	14	14	14	14	14
NYPA	833	833	825	825	825	-	-	-	-	-
Fuel Consumption Thousands of BBLs(2)(6) New York Power Pool	52246	50943	63495	64714	53355	1311	1206	1946	3499	905
Central Hudson	5989	3596	3645	3892	3396	4	7	8	29	8
Con Edison	17631	18047	23474	27633	19225	359	508	827	1551	224
LILCO	14842	17697	18828	18616	15730	738	683	1099	1856	670
NYSEG	-	-	-	-	-	1	1	1	1	0
Niagara Mohawk	9613	7159	11975	10405	11554	7	3	5	7	-
Orange & Rockland	2200	1742	1948	2087	912	-	-	-	-	-
RG&E	312	569	920	789	898	2	4	6	45	1
NYPA	1759	1933	2705	1293	1640	-	-	-	-	-
Generation (OMH) New York Power Pool	31533	30946	38978	39704	32630	447	486	781	1420	357
Central Hudson	3769	2283	2341	2533	2200	1	3	7	12	1
Con Edison	10208	10592	14225	16803	11579	127	177	299	581	78
LILCO	9083	11293	11584	11287	9660	315	304	471	810	277
NYSEG	-	-	-	-	-	-	-	-	-	-
Niagara Mohawk	5809	4254	7442	6488	7109	3	1	2	3	-
Orange & Rockland	1428	1078	1214	1276	583	-	-	-	-	-
RG&E	175	318	545	465	529	1	1	2	14	1
NYPA	1061	1138	1627	792	970	-	-	-	-	-
Fuel Cost Cents per Million BTU Central Hudson	270	290	238	267	300	655	531	487	513	619
Con Edison	311	323	279	311	390	527	440	402	447	558
LILCO	249	290	252	279	326	408	403	382	526	457
NYSEG	-	-	-	-	-	673	530	568	680	-
Niagara Mohawk	286	323	252	287	317	447	495	484	488	-
Orange & Rockland	301	297	276	318	355	-	-	-	-	-
RG&E	323	344	286	313	327	463	430	431	600	650
NYPA	250	322	263	290	354	-	-	-	-	-

TABLE VI-1
FUEL REQUIREMENTS - HISTORICAL - Nuclear & Conventional Hydro

	NUCLEAR					CONVENTIONAL HYDRO				
	1986	1987	1988	1989	1990	1986	1987	1988	1989	1990
Installed Gen. Cap. (MW)										
New York Power Pool	3025	3042	4774	4162	4046	4011	4011	4017	4013	4057
Central Hudson	-	-	97	97	97	45	45	45	45	42
Con Edison	849	849	849	849	919	-	-	-	-	-
LIACO	-	-	194	194	194	-	-	-	-	-
NYSEG	-	-	194	193	194	70	69	67	65	68
Niagara Mohawk	610	610	1054	441	1056	609	596	596	594	626
Orange & Rockland	-	-	-	-	-	34	14	44	44	44
RG&E	470	470	621	621	621	47	17	47	47	47
NYP&A	1896	1913	1765	1765	1765	3206	3210	3218	3218	3230
Fuel Consumption										
Billions of BTUs(2)(6)										
New York Power Pool	239373	245363	256240	247588	255747					
Central Hudson	-	-	3550	4319	4120					
Con Edison	43993	58423	66543	49461	56576					
LIACO	-	-	7105	8662	8845					
NYSEG	-	-	7099	8638	8240					
Niagara Mohawk	33294	48542	11641	19676	32657					
Orange & Rockland	-	-	-	-	-					
RG&E	38661	40538	41661	39660	43024					
NYP&A	123425	97860	118641	117172	102285					
Generation (GWh)										
New York Power Pool	22086	22584	23652	22921	23670	30317	29280	24657	24793	26588
Central Hudson	-	-	320	386	371	135	127	122	116	154
Con Edison	1794	5127	6043	4446	5189	-	-	-	-	-
LIACO	-	-	639	771	741	-	-	-	-	-
NYSEG	-	-	639	771	743	338	280	245	292	355
Niagara Mohawk	1147	4615	1059	1762	2975	1477	2724	2494	3004	3355
Orange & Rockland	-	-	-	-	-	158	193	163	145	201
RG&E	1603	1793	1884	3659	4017	235	224	169	175	245
NYP&A	11542	9049	11068	11124	9634	25974	24732	21864	21061	22278
Fuel Cost										
Cents per Million BTU										
Central Hudson	-	-	145	95	109					
Con Edison	55	56	50	50	63					
LIACO	-	-	118	116	81					
NYSEG	-	-	106	99	99					
Niagara Mohawk	64	65	111	115	94					
Orange & Rockland	-	-	-	-	-					
RG&E	18	51	49	50	56					
NYP&A	66	68	56	63	56					

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