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Report of Results of Benchmarking Survey of Central Heating Operations at NASA Centers and Various Corporations

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REPORT OF RESULTS OF BENCHMARKING SURVEY OF CENTRAL HEATING OPERATIONS AT NASA CENTERS AND VARIOUS CORPORATIONS

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EXECUTIVE SUMMARY

In recent years, Total Quality Management has swept across the country. Many companies and the Government have started looking at every aspect on how business is done and how money is spent. The idea or goal is to provide a service that is better, faster and cheaper.

The first step in this process is to document or measure the process or operation as it stands now. For Lewis Research Center, this report is the first step in the analysis of heating plant operations. This report establishes the original benchmark that can be referred to in the future. The report also provides a comparison to other organization's heating plants to help in the brainstorming of new ideas.

The next step is to propose and implement changes that would meet the goals as mentioned above. After the changes have been implemented the measuring process starts over again. This provides for a continuous improvement process.

RESULTS OF BENCHMARKING SURVEY OF CENTRAL HEATING OPERATIONS AT NASA CENTERS AND VARIOUS CORPORATIONS

I. INTRODUCTION

In June, 1994, a survey was sent to a number of organizations concerning their heating plant operations. This document reports the results of that survey.

The following is a synopsis of the cover letter that was sent with the survey:

> Approximately one year ago you participated in a NASA-wide Facilities Maintenance Benchmarking initiative. The information you provided us in conjunction with that from other companies and NASA Centers has been extremely useful in helping us analyze how we conduct our business.
>
> Lewis Research Center is now ready to take this benchmarking initiative to another level. We would like to solicit your participation one more time. This time it is a much more focused benchmarking activity dealing only with Steam Plant operations and maintenance. Enclosed is a survey intended to solicit information regarding your maintenance processes, metrics, safety procedures, documentation, and other initiatives concerning the operations and maintenance of your Steam Plant. This information will be invaluable in assessing our current performance in this area.
>
> Once again, this survey is being sent to all the original participating companies and NASA installations who have indicated to have this capability. Our plan is essentially the same as before, that is, to analyze the data and provide you with the results.

II. PREFACE

In no way was the survey in-depth enough to detail every aspect of each organization's boiler system, but it provided enough information to compare and analyze as well as generate questions. In order to ensure confidentiality of the non-government participants, reference to company names have been deleted from the data.

II. OBJECTIVE

The objective of this survey was to establish a baseline of information and statistics. This information may be used to improve the performance of each heating plant by increasing reliability and reducing costs.

IV. ORGANIZATIONS SURVEYED AND COMMENT

The following is a list of organizations surveyed, of which nine responded with data that was analyzed in this report.

NASA ORGANIZATIONS

NASA Headquarters, Washington D.C.
Comment: For information only

Ames Research Center, Moffett Field, Ca
Comment: No response

Goddard Space Flight Center, Greenbelt, MD
Comment: No response

Lyndon B. Johnson Space Flight Center, Houston, TX
Comment: Survey completed

John F. Kennedy Space Center, Florida
Comment: Two surveys completed, but with limited information due to different type of heating systems.

Lewis Research Center, Cleveland, OH
Comment: Survey completed

Langley Research Center, Hampton, VA
Comment: Survey completed

George C. Marshall Space Flight Center, Huntsville, AL
Comment: Survey completed

John C. Stennis Space Center, Mississippi
Comment: Does not have a central heating plant

Wallops Flight Facility, Wallops Island, VA
Comment: Survey completed

NASA Industrial Plant, Downey, CA
Comment: No response

Dryden Flight Research Facility , Edwards, CA
Comment: Survey completed

INDUSTRY ORGANIZATIONS

E. I. DuPont De Nemours and Company, Inc., Wilmington, DE
Comment: Survey Completed

3M Corporation in Minneapolis, St. Paul, MN
Comment: Survey Completed

General Motors Truck and Bus Group, Inc., Baltimore, MD
Comment: Survey Completed

SURVEYS NOT RETURNED

Westinghouse Electronic Systems Group
Cleveland Energy Resources
Kent State University
Cleveland Clinic Foundation
Texas Instruments Defense
Hewlett Packard Corporation
AT&T Network System Group
Federal Express Corporation
Kings Dominion

V. CONCLUDING STATEMENT

Lewis Research Center would like to thank all the participants in the survey. Each participant can draw their own overall conclusions of the information in this report. All of the facilities are different in one way or another, so interpretation of the information and data was done as accurately as possible. Observations, questions or comments about this report would be appreciated.

The following section, VI. Survey Data and Identification, list the data that was collected from the surveys. The next section, VII. Key Benchmarks, displays some of the data in graphical form. The highlights of each organization and their respective survey responses are shown in Section VIII, Organization Highlights, and Appendix, Completed Surveys.

VI. SURVEY DATA AND IDENTIFICATION

This section of the report shows the extracted data from the nine surveys mentioned in the previous section. See data sheets on the following pages. Below is brief description of each item in spreadsheet.

Organization - Organization surveyed

Acronym - Shortened name

1. **SQ.FT.** - The total area of floor space that is heated by steam production from heating plant.

2. **DESIGN TEMPS, HIGH/LOW** - Design temperatures of where organization is located.

3. **YEARLY LOAD** - Total steam production from heating boilers in M LBS (1000 LBS) for a given year.

4. **MAX LOAD** - The highest production of steam at any one time (rate) for a given year in LBS/hour.

5. **PLANT CAPACITY** - The theoretically highest steam production (rate) for the heating plant in LBS/hour.

7. **ELECTRIC RATES** - What the Electric Utility charges for the use of electricity that usually includes an energy charge in $/KWH and a demand charge in $/KW. Demand charge is related to the total demand of the facility.

8. **NATURAL GAS RATES** - The cost of natural gas in $/SMCF (Standard 1000 Cubic Foot)

9. **FUEL OIL RATES** - The cost of Fuel Oil in $/gallon (In some cased may be #2 or #4 fuel oil).

10. **WATER RATES** - The cost of water in $/1000gallons

11. **FUEL COST** - The total fuel used in the boilers in the heating plant in Dollars for a given year.

12. **FUEL COST/SQ.FT.** - Column 11 divided by column 1. The fuel cost to heat a sq.ft. of floor space in $/sq.ft. for a given year.

12a. **FUEL COST/1000#** - Column 11 divide by column 3. The average fuel cost for each 1000 LBS of steam produced for a given year.

13. **CHEMICAL COST** - The cost of the chemicals that was used for water treatment in the heating plant for a given year.

14. MAINTENANCE COST - The cost of maintenance for the heating plant including parts and labor for a given year.

15. PERSONNEL COST - The cost of employing or contracting operating personnel for the heating plant for a given year.

16. TOTAL COSTS - Adding columns 11, 14 and 16. The total costs include fuel, chemical and personnel costs for a given year.

17. TOTAL COST/SQ.FT. - Column 16 divided by column 1. The total cost to heat a sq.ft. of floor space in $/sq.ft. for a given year.

18. UNIT COST - Column 16 divide by column 3. The average fuel cost for each 1000 LBS of steam produced for a given year.

19. % CONDENSATE RETURN - The average percent of steam condensate that is returned to the heating plant for reprocessing.

20. MAX LOAD/SQ.FT. - Column 4 divided by column 1. The highest production of steam at one time (rate) for a given year for each sq.ft. of floor space being heated in LBS per hour/Sq.Ft.

21. PLANT CAP./SQ.FT. - Column 5 divided by column 1. The theoretically highest steam production (rate) of the heating plant for each sq.ft. of floor space being heated in LBS per hour/Sq.Ft.

HEATING PLANT BENCHMARKING SURVEY DATA

Organization	Acronym	1	2		3	4	5
		square foot	design temperatures high	design temperatures low	yearly load m lbs	max load lbs/hr	plant capacity lbs/hr
1 Johnson SFC	JSC	2 900 000	96	27	186 000	60 000	165 000
2 Lewis RC	LeRC	1 192 00	95	1	302 592	90 000	199 000
3 Langley RC	LaRC	3 431 000	93	10	482 633	34 000	390 000
4 Marshall SFC	MSFC	425 690	95	11	62 173	16 099	57 805
5 Wallps FF	WFF	380 000	93	10	106 949	21 220	65 000
6 Dryden FRF	OFRF	282 511	91	38	22 243	18 364	20 405
7 Company A	A	2 400 000	92	10	678 000	250 000	320 000
8 Company B	B	7 500 000	92	–16	1 360 000	356 000	560 000
9 Company C	C	3 000 000	92	14	425 000	146 000	280 000

Organization	Acronym	7		8	9	10
		electric rates		natural gas rates, $/MCF	F.O. rates $/gal	water rates $/1000 gal
		energy $/kWh	demand $/kW			
1 Johnson SFC	JSC	0.045	9.80	2.940	0.600	0.500
2 Lewis RC	LeRC	.056	---	3.680	.630	1.130
3 Langley RC	LaRC	.023	9.42	3.530	.467	1.430
4 Marshall SFC	MSFC	.051	---	---	.525	7.400
5 Wallps FF	WFF	.032	9.89	0.000	.580	1.600
6 Dryden FRF	OFRF	.063	---	6.368	---	1.610
7 Company A	A	.049	0.07	---	.370	10.800
8 Company B	B	.035	7.51	2.490	.323	1.500
9 Company C	C	.031	8.32	3.950	.625	----

Organization	Acronym	11	12	12a	13	14	15
		fuel cost $	fuel cost/ square foot	fuel cost/ 1000#	chemical cost	maint. cost	personnel cost
1 Johnson SFC	JSC	900 228	0.31	4.84	6 800	15 4000	219 000
2 Lewis RC	LeRC	1 334 304	1.12	4.41	38 375	98 080	426 628
3 Langley RC	LaRC	486 179	0.65	4.60	67 000	390 800	208 000
4 Marshall SFC	MSFC	326 398	0.77	5.25	----		65 000
5 Wallps FF	WFF	461 980	1.22	4.32	4 000	327 557	268 032
6 Dryden FRF	OFRF	228 993	0.81	10.30	8 500	75 000	0
7 Company A	A	2 368 000	0.99	3.49	24 200	155 000	850 000
8 Company B	B	3 771 230	0.50	2.77	175 000	500 000	1 400 000
9 Company C	C	2 388 050	0.80	5.62	140 000	0	1 041 856

Organization	Acronym	16	17	18	19	20	21
		total costs	total costs/ square foot	unit cost $/1000#	% cond. return	maximum load/ square foot	plant cap./ square foot
1 Johnson SFC	JSC	1 126 028	0.39	6.05	85	0.021	0.057
2 Lewis RC	LeRC	1 799 307	1.51	5.95	70	0.076	0.167
3 Langley RC	LaRC	3 261 179	0.95	6.76	85	0.010	0.114
4 Marshall SFC	MSFC	391 398	0.92	6.30	40	0.038	0.136
5 Wallps FF	WFF	735 012	1.93	6.87	92	0.056	0.171
6 Dryden FRF	OFRF	237 493	0.84	10.68	100	0.065	0.072
7 Company A	A	3 242 200	1.35	4.78	50	0.104	0.133
8 Company B	B	5 346 230	0.71	3.93	90	0.047	0.075
9 Company C	C	3 569 906	1.19	8.40	85	0.049	0.093

VII. KEY BENCHMARKS

This section presents key benchmarks that are common with all the organizations.

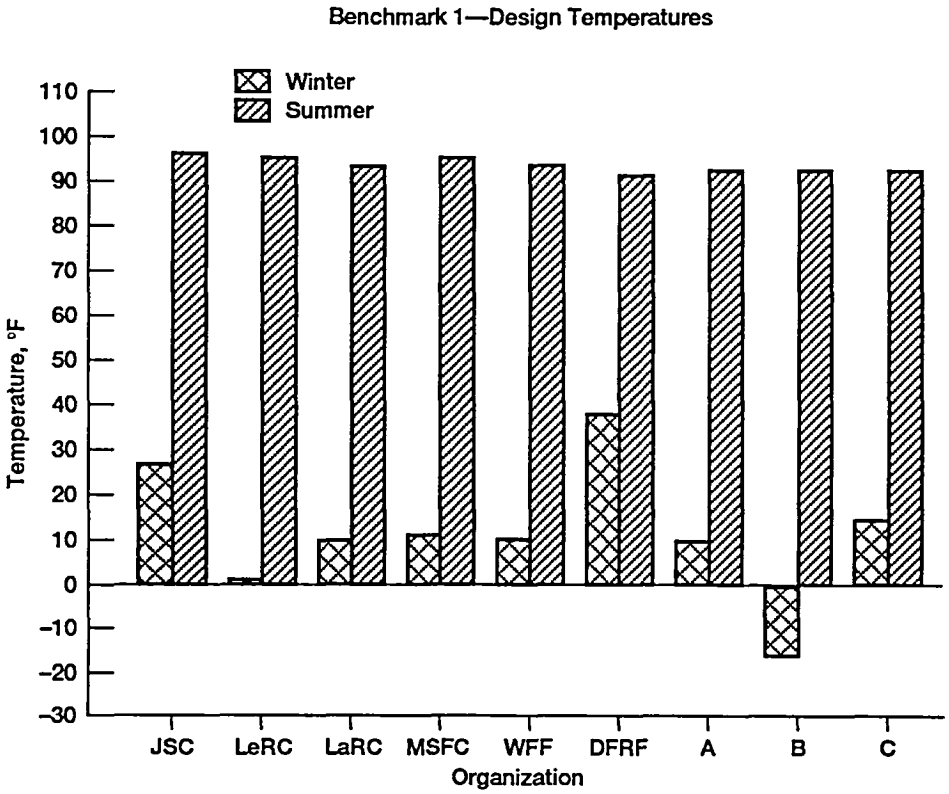
The following pages of this section display graphs and data tables that more easily compare the survey data. Below is a list of the Benchmarks.

Benchmark #1	DESIGN TEMPERATURES
Benchmark #2	MAXIMUM LOAD - PLANT CAPACITY
Benchmark #3	UTILITY COSTS - WATER
Benchmark #4	UTILITY COSTS - NATURAL GAS
Benchmark #5	UTILITY COSTS - FUEL OIL
Benchmark #6	UTILITY COSTS - ELECTRIC RATES
Benchmark #7	COSTS
Benchmark #8	FUEL COST / 1000 LBS STEAM
Benchmark #9	STEAM UNIT COST
Benchmark #10	YEARLY TOTAL COST / SQ. FT. (AREA HEATED)
Benchmark #11	YEARLY FUEL COST / SQ. FT. (AREA HEATED)
Benchmark #12	% CONDENSATE RETURN

Other notes to consider when reviewing data:

1. Most facilities use some steam for other uses besides space heating.

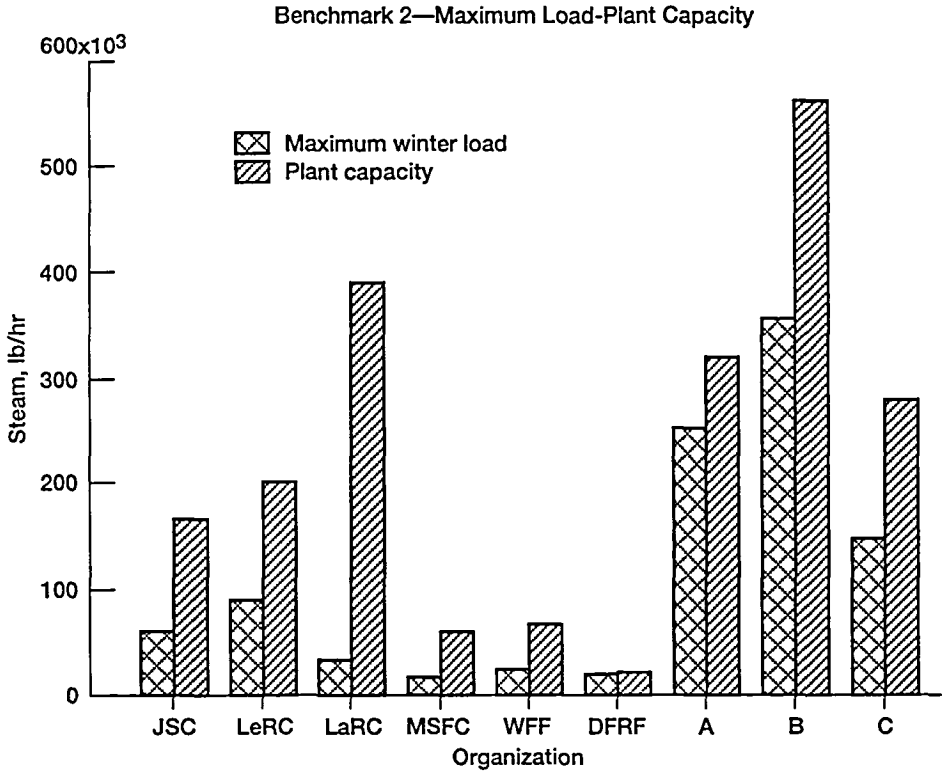
2. Langley Research Center is supplied with a base load of steam from the City of Hampton. This cost and steam production is included in some overall cost and steam data.



BENCHMARK 1.—This graph indicates the severity of winter temperatures for each organization. Note the Northern climates vs. the Southern climates.

BENCHMARK 1 DATA

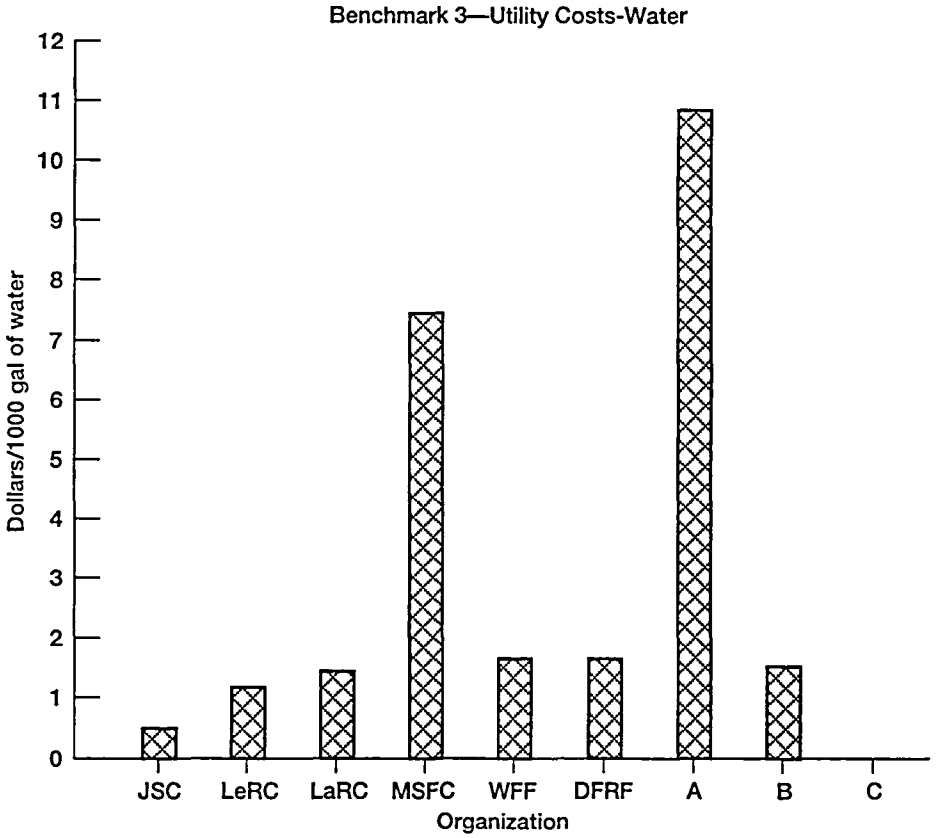
Organization	Location	Design temperatures, F	
		Summer	Winter
Johnson SFC	Houston, TX	96	27
Lewis RC	Cleveland, OH	95	1
Langley RC	Hampton, VA	93	10
Marshall SFC	Huntsville, AL	95	11
Wallps FF	Wallops, Is, VA	93	10
Dryden FRF	Edwards, CA	91	38
Company A	----------	92	10
Company B	----------	92	-16
Company C	----------	92	14



BENCHMARK 2.—*This graph compares the maximum steam production rate that has occurred vs. steam production that the heating plant can theoretically produce.* [The graph indicates the larger facilities and/or coldest climates.] The graph also shows backup steam capabilities.

BENCHMARK 2 DATA

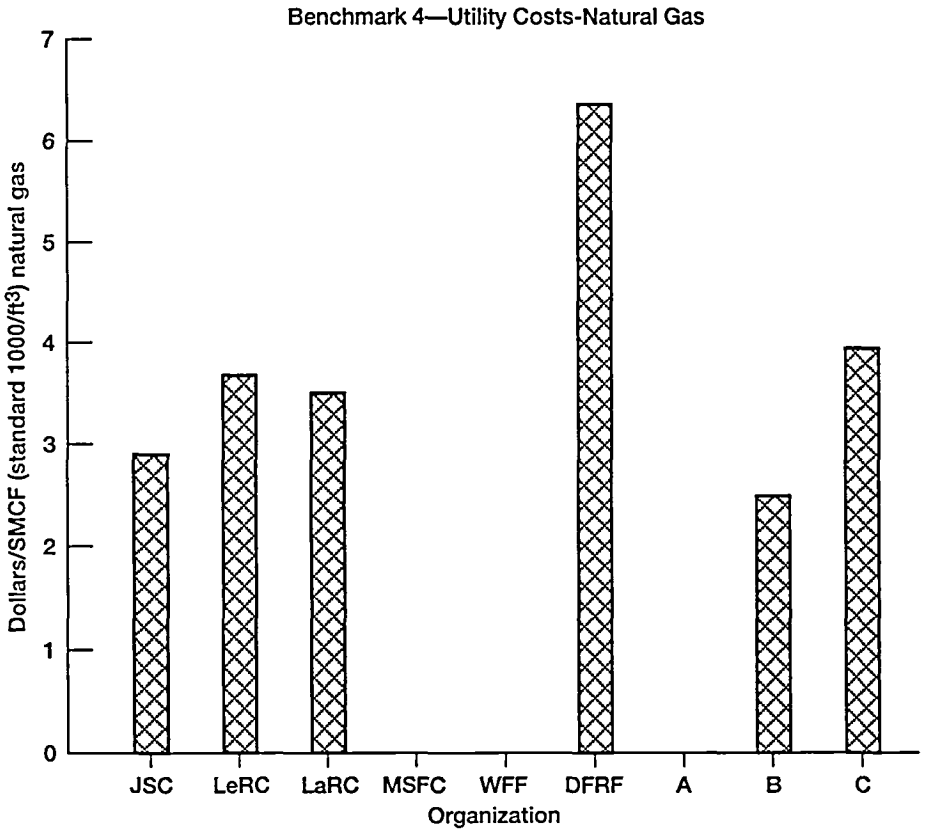
Organization	Design temperatures, F	
	Maximum load	Plant capacity
Johnson SFC	60 000	165 000
Lewis RC	90 000	199 000
Langley RC	34 000	390 000
Marshall SFC	16 099	57 805
Wallps FF	21 220	65 000
Dryden FRF	18 364	20 405
Company A	250 000	320 000
Company B	356 000	560 000
Company C	146 000	280 000



BENCHMARK 3.—This graph shows how much each organization pays for water. The cost for water for two of the organizations is way above average.

BENCHMARK 3 DATA

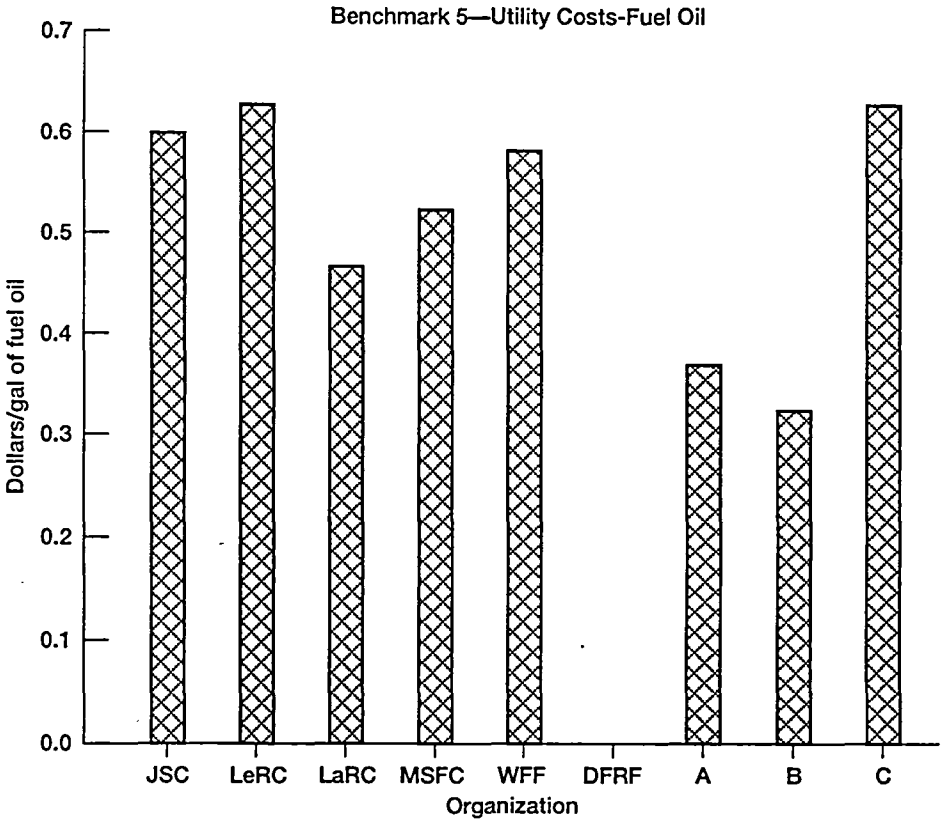
Organization	Utility cost—Water $/1000 gallons
Johnson SFC	0.50
Lewis RC	1.13
Langley RC	1.43
Marshall SFC	7.40
Wallps FF	1.60
Dryden FRF	1.61
Company A	10.80
Company B	1.50
Company C	N/A



BENCHMARK 4.—This graph shows how much each organization pays for natural gas. One organization pays almost double the average while one organization that uses a large amount has a lower than average rate.

BENCHMARK 4 DATA

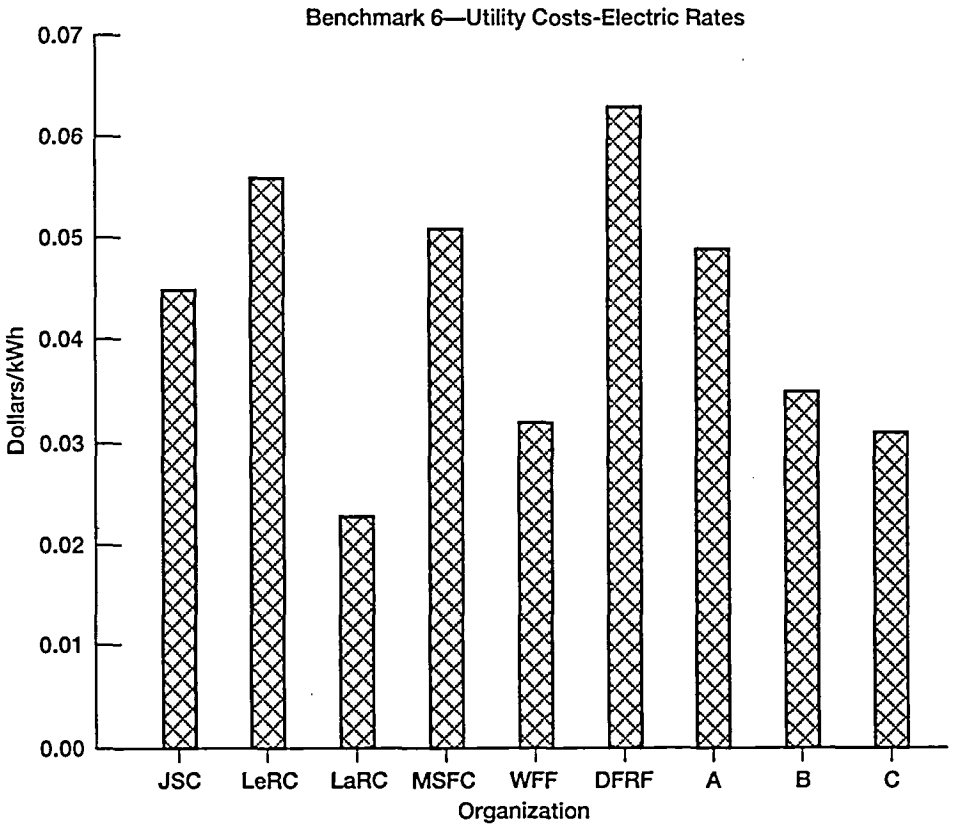
Organization	Utility cost—Natural gas $/SMCF (STD. 1000 cu. ft)
Johnson SFC	2.94
Lewis RC	3.68
Langley RC	3.53
Marshall SFC	N/A
Wallps FF	N/A
Dryden FRF	6.37
Company A	N/A
Company B	2.49
Company C	3.95



BENCHMARK 5.—This graph shows how much each organization pays for fuel oil. The same organization that has a low rate for natural gas has very low rate for fuel oil.

BENCHMARK 5 DATA

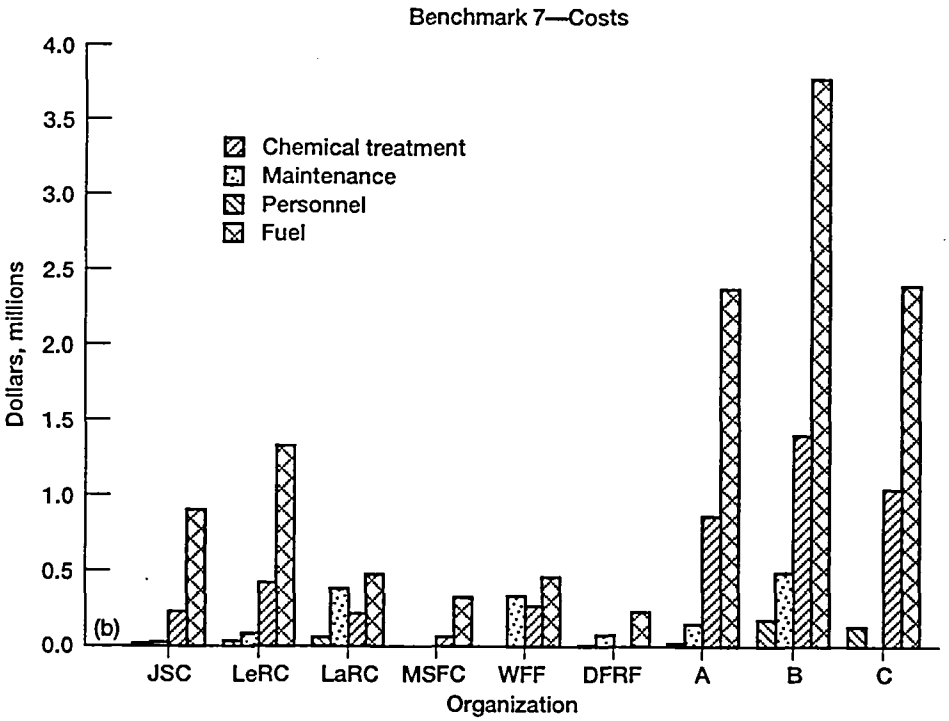
Organization	Utility cost—Fuel oil $/gallon
Johnson SFC	0.60
Lewis RC	0.63
Langley RC	0.47
Marshall SFC	0.53
Wallps FF	0.58
Dryden FRF	N/A
Company A	0.37
Company B	0.32
Company C	0.63



BENCHMARK 6.—This graph shows how much each organization pays for electricity. One NASA center has a very good rate.

BENCHMARK 6 DATA

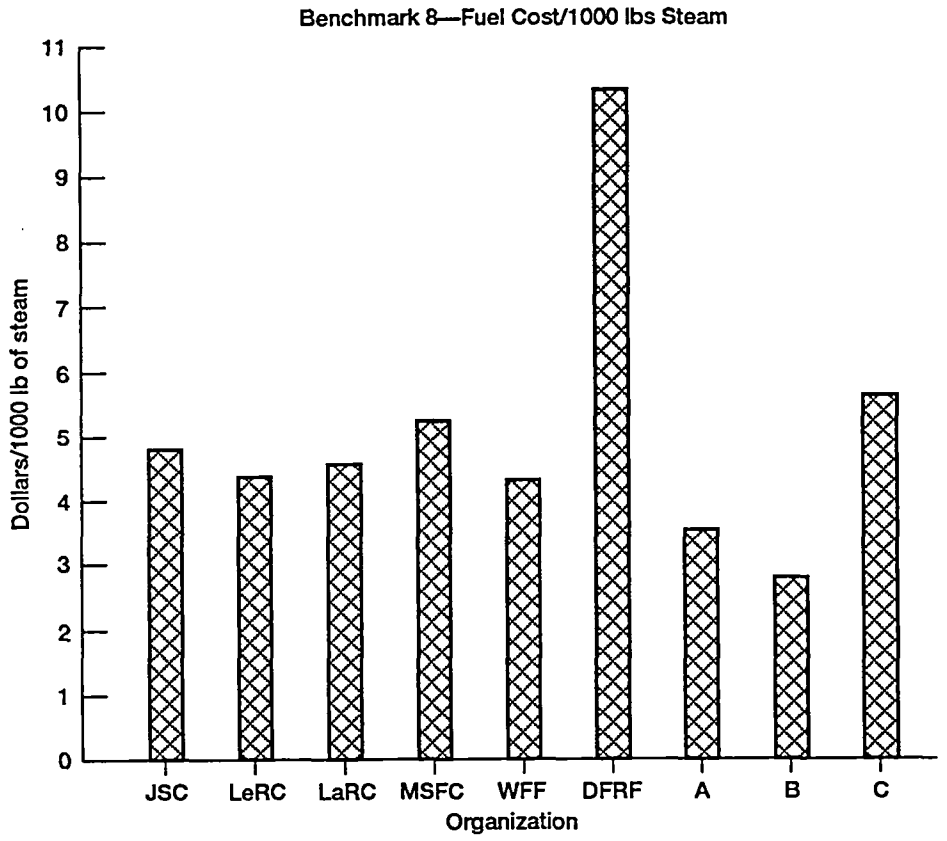
Organization	Utility cost—Electric rates $/KWH
Johnson SFC	0.045
Lewis RC	0.056
Langley RC	0.023
Marshall SFC	0.051
Wallps FF	0.032
Dryden FRF	0.063
Company A	0.049
Company B	0.035
Company C	0.031



BENCHMARK 7.—This graph breaks down some of the different costs associated with the heating plant. Note the fuel cost dwarfs the other costs, especially in the larger facilities.

BENCHMARK 7 DATA

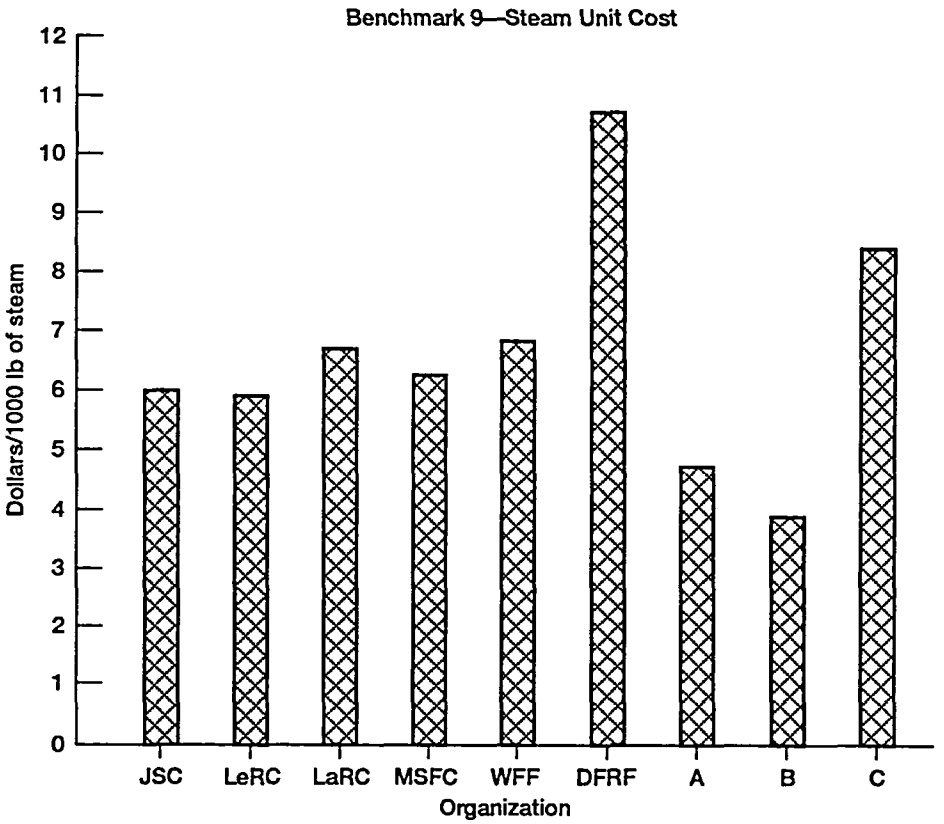
Organization	Costs				
	Chemical	Maintenance	Personnel	Fuel	Total
Johnson SFC	6 800	15 400	219 000	900 228	1 141 428
Lewis RC	38 375	98 000	426 628	1 334 304	1 897 307
Langley RC	67 000	390 800	208 000	486 179	1 151 979
Marshall SFC	N/A	N/A	65 000	326 398	391 398
Wallps FF	4 000	327 557	269 032	461 980	1 062 569
Dryden FRF	8 500	75 000	N/A	228 993	312 493
Company A	24 200	155 000	850 000	2 368 000	3 397 200
Company B	175 000	500 000	1 400 000	3 771 230	5 846 230
Company C	140 000	N/A	1 041 856	2 388 050	3 569 906



BENCHMARK 8.—This graph shows the fuel cost to produce a 1000 lbs of steam based on a given years steam production. This graph will vary due to the cost of the fuel and boiler efficiency.

BENCHMARK 8 DATA

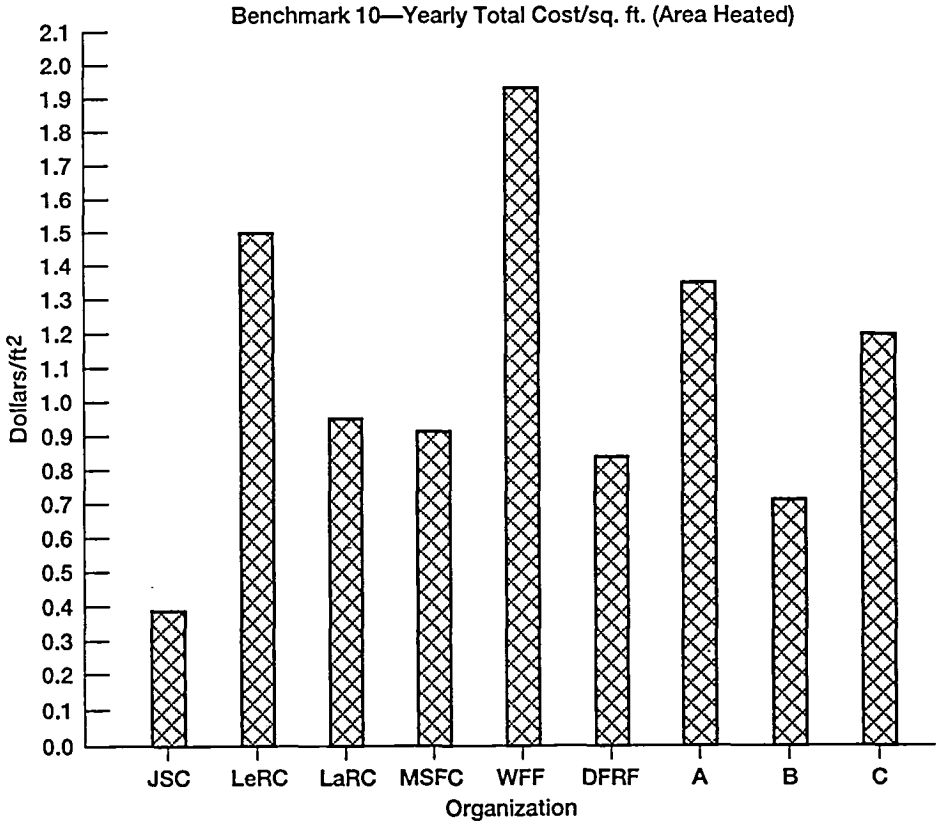
Organization	Yearly fuel costs $	Yearly steam load 1000 lbs	Yearly average fuel cost/1000 lbs
Johnson SFC	900 228	186 000	4.84
Lewis RC	1 334 304	302 592	4.41
Langley RC	486 179	482 633	4.60
Marshall SFC	326 398	62 173	5.25
Wallps FF	461 980	106 949	4.32
Dryden FRF	228 993	22 243	10.30
Company A	2 368 000	678 000	3.49
Company B	3 771 230	1 360 000	2.77
Company C	2 388 050	425 000	5.62



BENCHMARK 9.—This graph indicates a more complete total cost for steam than benchmark #8 because it includes personnel and chemical costs. Note that maintenance costs were not included due to inconsistencies in data.

BENCHMARK 9 DATA

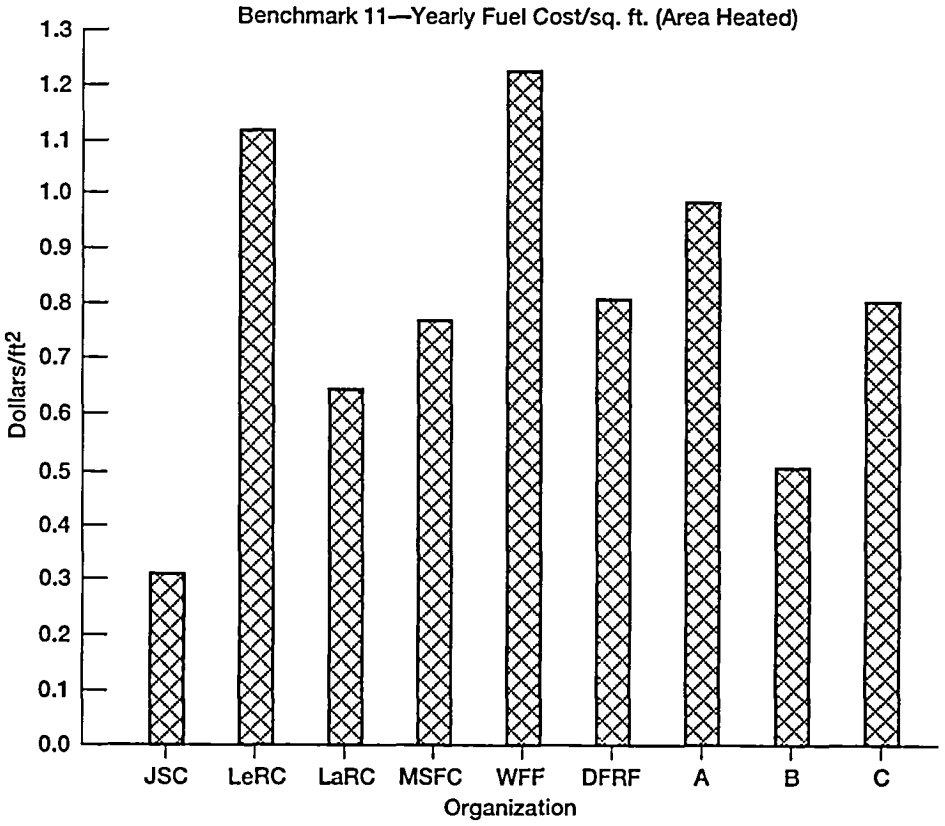
Organization	Total costs $	Yearly steam load 1000 lbs	Yearly average steam unit cost total cost/1000 lbs
Johnson SFC	1 126 028	186 000	6.05
Lewis RC	1 799 307	302 592	5.95
Langley RC	3 261 179	482 633	6.76
Marshall SFC	391 398	62 173	6.30
Wallps FF	735 012	106 949	6.87
Dryden FRF	237 493	22 243	10.68
Company A	3 242 200	678 000	4.78
Company B	5 346 230	1 360 000	3.93
Company C	3 569 906	425 000	8.40



BENCHMARK 10.—This graph indicates the average total cost to heat a square foot of floor space. This graph can have many variables due to the conditions of the areas to be heated. Generally, colder climates should require higher costs.

BENCHMARK 10 DATA

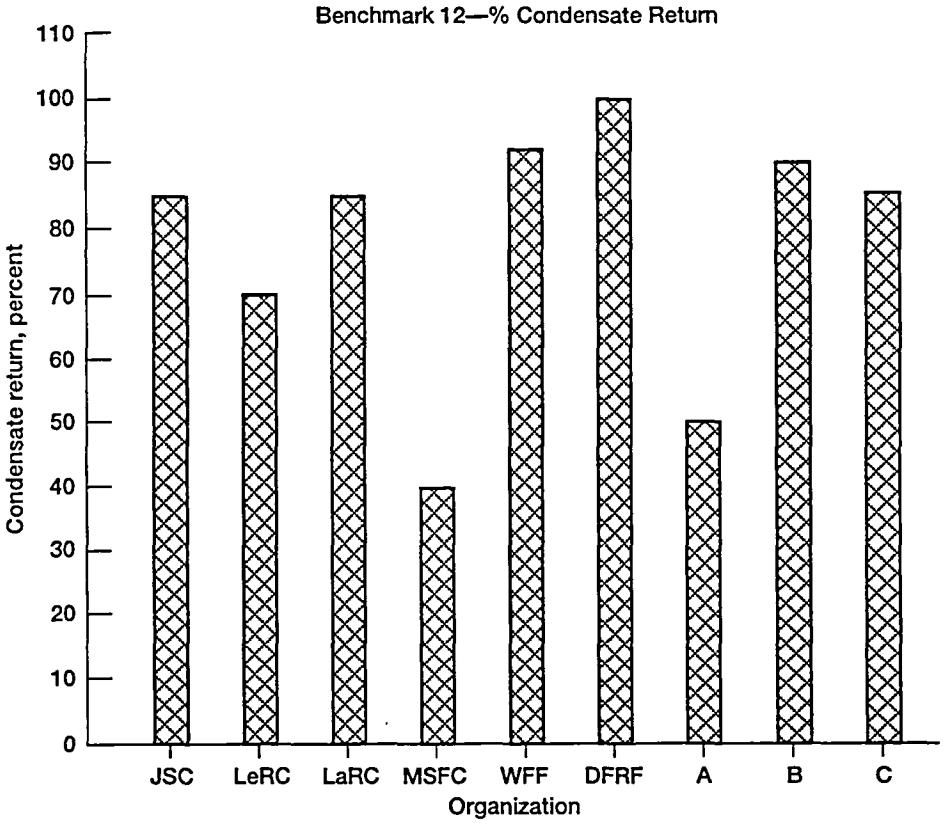
Organization	Total costs $	Area heated square feet	Total cost to heat an average square foot
Johnson SFC	1 126 028	2 900 000	0.39
Lewis RC	1 799 307	1 192 000	1.51
Langley RC	3 261 179	3 431 000	0.95
Marshall SFC	391 398	425 000	0.92
Wallps FF	735 012	380 000	1.93
Dryden FRF	237 493	282 511	0.84
Company A	3 242 200	2 400 00	1.35
Company B	5 346 230	7 500 000	0.71
Company C	3 569 906	3 000 000	1.19



BENCHMARK 11.—This graph is similar to Benchmark #10, but only considers the cost of fuel.

BENCHMARK 11 DATA

Organization	Fuel costs $	Area heated square feet	Total cost to heat an average square foot
Johnson SFC	900 000	2 900 000	0.31
Lewis RC	1 334 304	1 192 000	1.12
Langley RC	486 179	3 431 000	0.65
Marshall SFC	326 398	425 000	0.77
Wallps FF	461 980	380 000	1.22
Dryden FRF	228 993	282 511	0.81
Company A	2 368 000	2 400 00	0.99
Company B	3 771 230	7 500 000	0.50
Company C	2 388 050	3 000 000	0.80



BENCHMARK 12.—This graph indicates the percentage of steam condensate that is returned to the boilers after the steam is distributed to system.

BENCHMARK 12 DATA

Organization	Condensate return percent
Johnson SFC	85
Lewis RC	70
Langley RC	85
Marshall SFC	40
Wallps FF	92
Dryden FRF	100
Company A	50
Company B	90
Company C	85

VIII. ORGANIZATION HIGHLIGHTS

JOHNSON SPACE FLIGHT CENTER HIGHLIGHTS

- 50 BUILDINGS 2.9 MIL. SQ. FT.
- NEWER 420# BOILERS AVE. AGE 15 YEARS
- 85% CONDENSATE RETURN
- LOW COST PER SQ FT (WARM CLIMATE)
- 3 PERSONNEL/SHIFT
- ENERGY CONSERVATION ANALYSIS PERFORMED

LEWIS RESEARCH CENTER HIGHLIGHTS

- REFURBISHED OLDER BOILERS, NEWER LARGER BOILER AVE. AGE 45 YEARS
- 51 BUILDINGS 1.2 MIL SQ. FT.
- 70 PERCENT CONDENSATE RETURN
- COSTS ARE AVERAGE
- PM PROGRAM UNDERWAY
- 3 PERSONNEL/SHIFT

LANGLEY RESEARCH CENTER HIGHLIGHTS

- 70 BUILDINGS, 3.4 MIL SQ FT
- LARGE BOILERS, LARGE CAPACITY
- 350 PSI BOILDERS AVE. AGE 20 YEARS
- 85 PERCENT CONDENSATE RETURN
- STEAM EJECTORS USE UP TO 96 000 LBS/HR — 20–30 PERCENT OF TOTAL YEARLY LOAD
- 3 PERSONNEL 1ST SHIFT
- TWO STUDIES RECENTLY COMPLETED
- BASE STEAM SUPPLY FROM CITY OF HAMPTON AVE. SUPPLY 43 000 LBS/HOUR YEARLY COST — 2.5 MILLION

MARSHALL SPACE FLIGHT CENTER HIGHLIGHTS

- 33 BUILDINGS 425K SQ. FT.
- 3 SMALL BOILER PLANTS WITH 3 BOILERS EACH
- 100# BOILERS AVE. AGE 28 YEARS
- #2 FUEL OIL USED
- GENERALLY OUT OF SERVICE IN SUMMER
- 35 PERCENT CONDENSATE RETURN SHOULD INCREASE SOON
- COMBUSTION TESTS PERFORMED REGULARLY
- 1 OPERATOR PER SHIFT
- COSTS ARE AVERAGE

WALLOPS FLIGHT FACILITY HIGHLIGHTS

- 100# BOILERS AVE. AGE 9 YEARS
- 27 BUILDINGS 380K SQ FT
- #2 AND #6 FUEL OIL USED
- 92% CONDENSATE RETURN
- PLANT SHUTDOWN IN SUMMER
- 3 PERSONNEL/SHIFT
- AVERAGE COSTS
- 2 EXTENISVE STUDIES 1994

DRYDEN FLIGHT RESEARCH FACILITY

- 2 BUILDINGS 282K SQ FT
- 15# BOILERS AVE. AGE 27 YEARS
- 100% CONDENSATE RETURN
- NATURAL GAS COSTS ARE ALMOST DOUBLE AVERAGE
- WATCH ENGINEER FOR TOTAL FACILITY

COMPANY A HIGHLIGHTS

- 32 BUILDINGS 2.4 MIL. SQ FT
- 150# BOILERS AVE. AGE 40 YEARS
- 50 PERCENT CONDENSATE RETURN
- UPDATING CONTROLS FROM PNEUMATIC TO ELECTRONIC
- 3 OPERATORS PER 12 HOUR SHIFT
- #6 FUEL OIL

COMPANY B HIGHLIGHTS

- 27 BUILDINGS 7.5 MIL. SQ FT
- VERY LARGE FACILITY
- BOILERS AVE. AGE 28 YEARS
- 90 PERCENT CONDENSATE RETURN
- NATURAL GAS/FUEL OIL
- 4 TO 7 PERSONNEL/1ST SHIFT 4/2ND, 3RD SHIFT
- 6 STEAM DRIVEN CHILLERS
- VERY LOW COSTS

COMPANY C HIGHLIGHTS

- 3.0 MIL SQ FT
- 5 150 PSI BOILERS
- 2 SMALL SOLID WASTE BOILERS
- AVE. AGE 35 YEARS
- 60 PERCENT CONDENSATE RETURN
- 10 PERSONNEL/1ST SHIFT 4/2ND, 3RD SHIFT
- AVERAGE COSTS

APPENDIX COMPLETED SURVEYS

The surveys in this section are arranged in the following order:

- JOHNSON SPACE FLIGHT CENTER
- LEWIS RESEARCH CENTER
- LANGLEY RESEARCH CENTER
- MARSHALL SPACE FLIGHT CENTER
- WALLOPS FLIGHT FACILITY
- DRYDEN FLIGHT RESEARCH FACILITY
- COMPANY A
- COMPANY B
- COMPANY C

SURVEY OF CENTRAL HEATING PLANT OPERATIONS

Conducted by:

NASA

Lewis Research Center

Cleveland, Ohio

Survey Completed by:

Company Name	NASA–Johnson Space Center
Division	JJ/Plant Engineering Division of Center Operations
Address	2101 NASA Road 1
	Houston, Texas 77058–3696
Contact	Harry W. Hart
Telephone	(713) 483–3129

Survey
of Central Heating Plant Operations

I. General Information

1. Provide brief description of Heating Plant (Type of boilers, number of boilers, general setup of heating plant, etc.).

Three operational water tube boilers with superheater capability. All boilers supply steam to a common header. Plant has three pressure reducing, de-superheating stations to lower header pressure to 100 psig with 20°F superheater from 400 psig.

2. Provide numerical information about Boilers at Heating Plant:

Boiler #	3	4	2	1	5
HP	45,000 lbs/hr	60,000 lbs/hr	60,000 lbs/hr	Out	Out
Operating Pressure	420 psig	420 psig	420 psig	of Service	of Service
BTU Input	$64x10^6$/hr	$74x10^6$/hr	$74x10^6$/hr		
MFG.	Murray	Zurn	Zurn		
Install Date	1963	1987	1990		
Fuel(s)	gas/No. 2 oil	gas/No. 2 oil			
Steam Output	45,000 lbs/hr	60,000 lbs/hr	60,000 lbs/hr		

3. Provide brief description of distribution system (how many buildings or areas supplied, uses, piping arrangements, etc.)

Entire central mall, approximately 50 buildings, is supplied steam through a utility tunnel. Pressure reducing station at central plant lowers steam pressure from 400 psig to 100 psig. Each building has its own steam pressure reducing station to reduce steam pressure to 15 psig.

4. Provide description of the chemical treatment system (boiler blowdown, chemicals used, injection system, softeners, etc.)

A water softener - Zeolite system.
A de-alkalizer system.
Sodium phosphate and sodium sulfite.
Amines - neutralizing & filming.
Caustic soda.
Salt.
Boiler blowdown at 2,500 mhos conductivity.

5. Provide description of condensate return system to the boilers (% return, economizer used, feedwater pumps, deairator tank)

Enerfin enconomizer rated at 3,843,800 BTU/hr
Economizer - Feedwater heater boiler 24-2, 4.
Approximately 85% condensate return from site.
Condensate return units in mall buildings with piping in tunnel for condensate return.
Multistage boiler feedwater pumps.

6. Provide description of boiler and/or burner controls (flame safeguard, diagnostic capabilities, heating plant controls, energy monitoring, energy management system, etc.)

Microprocessor controls on boiler 24-2, 4 pneumatic controls on boiler 24-3.
Microprocessor controls have oxygen trim control to save energy.
Fireye microprocessor EP160 burner management with message and self diagnostics.

II. Loads and Costs Analysis

1. Heat Loads for Heating Plant

A. What is the average yearly load ? 21,233 lbs/hr-1993

B. What is the average summer load ? 12,000-15,000 lbs/hr

C. What is the average winter load ? 28,000 lbs/hr

D. What is the maximum winter load ? 60,000 lbs/hr

2. What is the yearly utility use ?

Fuels:

use 80-85% of gas @ plant boilers.

Natural gas 306,200 M.Cu.FT.(1000 Cubic foot)@80 psig

Fuel Oil * Gallons 232 gallons/hr @ 25,000 lbs/hr

Electric N/A KWH

Heating Plant auxiliary or support utilities:

Natural gas N/A M.Cu.FT.(1000 Cubic foot)@__ psig

Fuel Oil N/A Gallons

Electric 30 KWH 75-200 hpboiler feedwater pump est. 40 hp year average.

3. What are the utility unit prices ?

Natural Gas 2.94 $/M.Cu.FT. @80 psig

Electric 1. Energy Charge .045 $/KWH

2. Demand Charge 9.80 $/KW

Water .0005 $/gallon

Fuel Oil .60 $/gallon

* Operate only a few hours prior to each mission, some training, and plant gas outages. Yearly consumption of diesel is very minimal.

4. What is the yearly costs for the following:

Chemical Costs (Total) 6,800 $/yr $

Individual chemical costs Salt - 1150 $/yr

Sodium phosphate - 150 $/yr

Sodium sulfite - 250 $/yr

Filming/Neutralizing amines - 4050 $/yr
Caustic soda - 1200 $/yr

Maintenance Costs 15,400.00 $/yr 4400.00/yr each boiler

Breakdown labor 13,200.00 $/yr + 12,00.00 Hartford inspector

material 1,000.00 Relief valve certification, etc.

Operation Personnel 219,000 $/yr

Breakdown chief - halftime plus

boiler/chiller operator - half time
8760 hrs. x 25.00/hour, includes benefits.

Major Repairs Varies $

Breakdown 3 years ago retubed boiler

24-3, cost about $120,000.

Other costs 12,000 $

Description Boiler feedwater pump @

30 hp @ 24 hours @ 365 days.

5. Overall Costs

Total Costs	253,200	$, year 1993- estimated
		$, year 1992
		$, year 1991
Steam Generated	186,000,000	lbs. or BTU, year 1993
		year 1992
		year 1991
Unit Cost	* 1.36	$/1,000 lbs., year 1993
		year 1992
		year 1991

* Does not include the cost of natural gas to operate the boiler.

III. Operations

1. Indicate in the following table the documentation that is used at the Heating Plant:

DOCUMENT	AVAILABLE		COMMENTS
	YES	NO	
DRAWINGS - SCHEMATICS BOILERS	X		
MECHANICAL SYSTEMS	X		
BOILER ELEMENTARY	X		
ELECTRICAL BUILDING	X		
ISOMETRICS	X		
GENERAL BUILDING	X		
OTHER	X		Control Logic for boiler controls.
BOILER START-UP PROCEDURE	X		Boiler vendor info.
PROCEDURE FOR STEAM DRUM ENTRY	X		
EMERGENCY CALL PROCEDURE	X		
HEATING PLANT EVACUATION PROCEDURE	X		
BOILER SAFETY OPERATION CHECKOUT PROCEDURE	X		Microprocessor fireye checks safeties.
PROCEDURE FOR HANDLING CHEMICALS	X		
LIST OF CHEMICALS WITH MSDS	X		
CONFINED SPACE ENTRY PROCEDURE	X		Check the oxygen levels.
BOILER MAINTENANCE PROCEDURES	X		
EQUIPMENT MAINTENANCE PROCEDURES	X		

2. Provide information concerning the Heating Plant personnel.

a. Are personnel on duty at the Heating Plant
24 hours a day? Yes
365 days a year? Yes
other _____

b. Breakdown the personnel that are on duty at specific times.

1st Shift # of operators 2 # of supervisors 1

2nd Shift # of operators 2 # of supervisors 1

3rd Shift # of operators 2 # of supervisors 1

Are there any other personnel on duty besides operators, such as maintenance personnel? Crafts work 1st & 2nd shifts, Monday thru Friday. During STS missions, crafts work around the clock.

c. What is the qualifications of the operators?

# of 1st Class Operators _____

# of 2nd Class Operators _____

# of 3rd Class Operators _____

Other qualifications Union certified

d. Do the operators receive training? Yes

What kind of training? On the job training in boiler/chiller operation, etc.

3. Provide any information concerning engineering studies of the heating plant such as plant and/or boiler efficiencies, plant reliability/availability or other measurable function (please attach study). Energy Conservation analysis by Jones, Nall, and Davis, Inc. of Atlanta, Georgia, discussed site and plant energy concerns.

SURVEY OF CENTRAL HEATING PLANT OPERATIONS

Conducted by:

NASA

Lewis Research Center

Cleveland, Ohio

Survey Completed by:

Company Name	NASA–Lewis Research Center
Division	Facilities Operations Division
Address	21000 Brookpark Road
	Cleveland, Ohio 44135
Contact	T. Knapp
Telephone	(216) 433–3129

Survey
of Central Heating Plant Operations

I. General Information

1. Provide brief description of Heating Plant (Type of boilers, number of boilers, general setup of heating plant, etc.).
BLDG # 12 (MAIN STEAM PLANT) HAS 5 WATER TUBE BOILERS THAT USE NATURAL GAS OR #2 Fuel oil. THEY OPERATE AT 100 PSI WITH A TOTAL CAPACITY OF 200,000 LBS/HR. THE BOILERS ARE SUPPLIED BY Either one OF TWO TURBINE DRIVEN FEED WATER PUMPS. THERE IS AN "AUTO" START ELECTRIC FEED WATER PUMP AS backup AND AN "Auto start EMERGENCY AIR COMPRESSOR FOR THE PNEUMATIC CONTROLS. IT HAS 2 PAIRS OF WATER SOFTNERS FOR THE MAKE UP WATER SYSTEM AND A DEAERATING FEED WATER HEATER (FEED WATER TANK)

2. Provide numerical information about Boilers at Heating Plant:

Boiler #	1	2	3	4	5
HP	600	600	420	600	1200
Operating Pressure	100 PSI	100 PSI	100 PSI	100 PSI	100 PSI
BTU Input Per Hour	45,400,000	45,400,000	28,123,000	50,212,000	90,000,000
MFG.	Babcock & Wilcox	B&W	KEELER	KEELER	ERIE CITY
Install Date	11-2-49	11-2-49	1941	1943	12-2-70
Fuel(s)	NG. & F.O.	NG & F.O.	NG. & F.O.	NG & F.O.	NG & F.O.
Steam Output	35,000 LB/HR	35,000 LB/HR	18,000 LB/HR	41,000 LB/HR	70,000 LB/HR

3. Provide brief description of distribution system (how many buildings or areas supplied, uses, piping arrangements, etc.)
100PSI STEAM IS GENERATED AT BLDG # 12, (MAIN) STEAM PLANT). IT IS DISTRIBUTED TO APPROX. 56 BLDGS. THROUGH AN UNDERGROUND STEAM PIPING SYSTEM. PIPE SIZES RANGING FROM 12" ON the main SYSTEM (TAYLOR RD.), AND 8" TO 1 1/2" ON THE INlets TO the INDIVIDUAL BUILDINGS. THE CONDENSATE IS RETURNED to the MAIN STEAM PLANT THROUGH A CONDENSATE PUMPING & RETURN SYSTEM IN EACH BUILDING. IT IS PIPED TO THE BOILER FEED WATER TANK FOR SUPPLY TO BOILERS THROUGH the STEAM DRIVEN FEED WATER PUMPS. 100PSI STEAM SUPPLY PRESSURE IS REDUCED at EACH BUILDING TO 15PSI AND IS USED FOR HEATING & HUMIDIFICATION SYSTEMS, AND IN SOME CASES RESEARCH FACILITIES.

4. Provide description of the chemical treatment system (boiler blowdown, chemicals used, injection system, softeners, etc.)

THE CHEMICAL TREATMENT IN BLDG.*12 CONSISTS OF TWO SEPARATE SYSTEMS. THE FIRST SYSTEM ADDS SULFITE TO THE DEAIRATOR TANK TO CONTROL OXYGEN IN THE FEEDWATER. THE SECOND SYSTEM CONSISTS OF A TANK AND 5 VARIABLE CAPACITY PUMPS THAT INDIVIDUALLY FEED EACH BOILER. CHEMICALS ARE ADDED TO THIS 30 GALLON TANK & MIXED. BETZ 947, AN AMINE, IS ADDED FOR CONDENSATE LINE TREATMENT. A PHOSPHATE, (BETZ CPS-3) AND A DISPERSANT (BETZ OS-10) ARE ALSO ADDED. T.D.S. IS CONTROLLED BY BOTTOM BLOWDOWNS AND AUTOMATIC SURFACE BLOW DOWNS. MAKEUP WATER IS SOFTENED USING 2 PAIRS OF BRUNER WATER SOFTNERS. CHEMICAL DOSAGES FOR WATER TREATMENT ARE DETERMINED BY DAILY WATER TESTING AND ANALYSIS BY STEAM PLANT PERSONAL.

5. Provide description of condensate return system to the boilers (% return, economizer used, feedwater pumps, deairator tank)

THE CONDENSATE RETURN SYSTEM CONSISTS OF INDIVIDUAL CONDENSATE RECEIVER/PUMP UNITS LOCATED IN EACH BLDG., THAT PUMP CONDENSATE DIRECTLY BACK TO THE DEAIRATOR TANK IN BLDG*12 MAKEUP WATER IS SOFTENED AND ADDED TO DEAIRATOR TANK TO MAINTAIN PROPER LEVELS. THE TEMP OF THE DEAIRATOR TANK FEED WATER IS MAINTAINED AT 225°F USING A LOW PRESS STEAM SUPPLY, AND EXHAUST STEAM FROM THE FEEDWATER PUMP DRIVE TURBINE. THE PERCENT OF MAKE UP WATER VARIES FROM MONTH TO MONTH. THE LAST 6 MONTHS AVERAGE WOULD BE APPROX. 29%. SLIGHTLY HIGH DUE TO CONDENSATE "DUMPING" AT BLDG #125. THE FEED WATER PUMPS TAKE SUCTION FROM THE DEAERATOR TANK AND PUMP TO THE BOILERS. BOILER #5, OUR LARGEST CAPACITY BOILER HAS AN ECONOMIZER THAT USES FLUE GAS TO ADD ADDITIONAL HEAT TO THE FEED WATER SUPPLY.

6. Provide description of boiler and/or burner controls (flame safeguard, diagnostic capabilities, heating plant controls, energy monitoring, energy management system, etc.)

THE BURNER CONTROLS CONSIST OF A PNEUMATIC AND ELECTRONIC TO PNEUMATIC CONTROL SYSTEM. BASICALLY THE SYSTEM CONVERTS STEAM PRESS. INTO A PNEUMATIC SIGNAL WHICH IS SENT TO THE PLANT MASTER, WHICH THEN SENDS ITS SIGNAL TO THE BOILER MASTER ON EACH OF THE BOILERS. THAT SIGNAL, EITHER PNEUMATIC OR ELECTRIC IS SENT TO THE VARIOUS PNEUMATIC DRIVE UNITS THAT CONTROL THE FIRING RATE.

THE FLAME SAFEGUARD SYSTEM CONSISTS OF A HONEYWELL BC7000 BURNER PROGRAMER, AN ULTRAVIOLET DETECTOR AND A LIMIT SWITCH CIRCUIT. THE BC7000 GOES THROUGH A SERIES OF STEPS TO LIGHT OFF THE PILOT AND THEN THE MAIN FLAME. ONCE THE BURNER IS LIGHT & OPERATING, THE BC7000 CONTINUOUSLY MONITORS THE SYSTEM AND WILL SAFELY SHUT DOWN THE BOILER IF A PROBLEM ARISES. IT WILL ALSO GIVE A CODED MESSAGE IDENTIFYING WHAT SHUT THE BOILER DOWN. THERE ARE MANY OTHER SAFETY SYSTEMS INCORPORATED IN THE OPERATION OF THE BOILERS.

II. Loads and Costs Analysis

1. Heat Loads for Heating Plant

A. What is the average yearly load ? 273,890,000 LBS. STM. (AVERAGE 1991, 1992, 1993)
19,315 LB/HR

une, July, Aug., 1993 ← B. What is the average summer load ? 42,648,000 LB/STM (average 72°F)
54,246 LB/HR

Dec, JAN, FEB., 1993 1994 1994 ← C. What is the average winter load ? 117,173,000 LB/STM. (average 26°F)

D. What is the maximum winter load ? 90,000 LB/HR (-10°F)
(EXTREME CONDITION)

2. What is the yearly utility use ?

Fuels:

(1993) Natural gas 361,754 M.Cu.FT.(1000 Cubic foot)@__ psig

(1993) Fuel Oil 20,713 Gallons

(1993) Electric 1,012,950 KWH (ESTIMATED USAGE)

Heating Plant auxiliary or support utilities:

Natural gas DNA M.Cu.FT.(1000 Cubic foot)@__ psig

Fuel Oil DNA Gallons

Electric DNA KWH

3. What are the utility unit prices ?

(1993) Natural Gas $3.68 $/M.Cu.FT. @__psig

Electric 1. Energy Charge .0561 $/KWH

2. Demand Charge _____ $/KW

Water $9.49 $/~~gallon~~ 1000 cu ft.

Fuel Oil $0.63 $/gallon

4. What is the yearly costs for the following:

Chemical Costs (Total) 38,375.28 $

Individual chemical costs SALT = $7.80 per 80 LB BAG
BETZ #750 = 23.76 / gallon
BETZ #947 = 33.30 / gallon
Betz OS-10 = 31.62 / gallon
Betz #733 0.93 / LB
Betz # CPS3 = 4.32 / LB.

Maintenance Costs 98,080.08 $

Breakdown labor 22,887.50

material 75,192.58

Operation Personnel 426,628.29 $

Breakdown 14 operators @ 14.65 per Hour (average)

Major Repairs $200,000 $

Breakdown Complete Teardown. Remove asbestos insulation & brick tiles on entire boiler. Replace insulation & Tiles and install new 10 gg panels

Other costs $9500.00 $

Description Rebuild Feed Water Pump steam turbine dri
Replace bearings, turbine, shaft.

5. Overall Costs

Total Costs	1,978,343.91	$, year	1993
	1,744,841.80	$, year	1992
	1,698,689.34	$, year	1991
Steam Generated	302,592,000	lbs. or BTU, year	1993
	268,221,000	year	1992
	250,857,000	year	1991
Unit Cost	$6.54	$/1,000 lbs., year	1993
	$6.51	year	1992
	$6.77	year	1991

III. Operations

1. Indicate in the following table the documentation that is used at the Heating Plant:

DOCUMENT	AVAILABLE YES	AVAILABLE NO	COMMENTS
DRAWINGS - SCHEMATICS BOILERS	✓		all prints updated 1993
MECHANICAL SYSTEMS	✓		all prints updated 1993
ELECTRICAL BOILER ELEMENTARY	✓		
BUILDING	✓		
ISOMETRICS	✓		
GENERAL BUILDING	✓		
OTHER	✓		
BOILER START-UP PROCEDURE	✓		
PROCEDURE FOR STEAM DRUM ENTRY	✓		
EMERGENCY CALL PROCEDURE	✓		
HEATING PLANT EVACUATION PROCEDURE	✓		
BOILER SAFETY OPERATION CHECKOUT PROCEDURE	✓		
PROCEDURE FOR HANDLING CHEMICALS	✓		
LIST OF CHEMICALS WITH MSDS	✓		
CONFINED SPACE ENTRY PROCEDURE	✓		
BOILER MAINTENANCE PROCEDURES	✓		
EQUIPMENT MAINTENANCE PROCEDURES	✓		

2. Provide information concerning the Heating Plant personnel.

a. Are personnel on duty at the Heating Plant
24 hours a day? YES
365 days a year? YES
other _____

b. Breakdown the personnel that are on duty at specific times.

1st Shift # of operators 2 # of supervisors 1 (Stm. Plant Foreman

2nd Shift # of operators 2 # of supervisors 1 (Lead operator)

3rd Shift # of operators 2 # of supervisors 1 (Lead operator)

Are there any other personnel on duty besides operators, such as maintenance personnel? 1 Chemical Treatment / mechanic on 1st Shift - (Mon - Friday)

c. What is the qualifications of the operators?

# of 1st Class Operators 1

# of 2nd Class Operators 1

# of 3rd Class Operators 1 & (City of (100,000 population) or State operators license

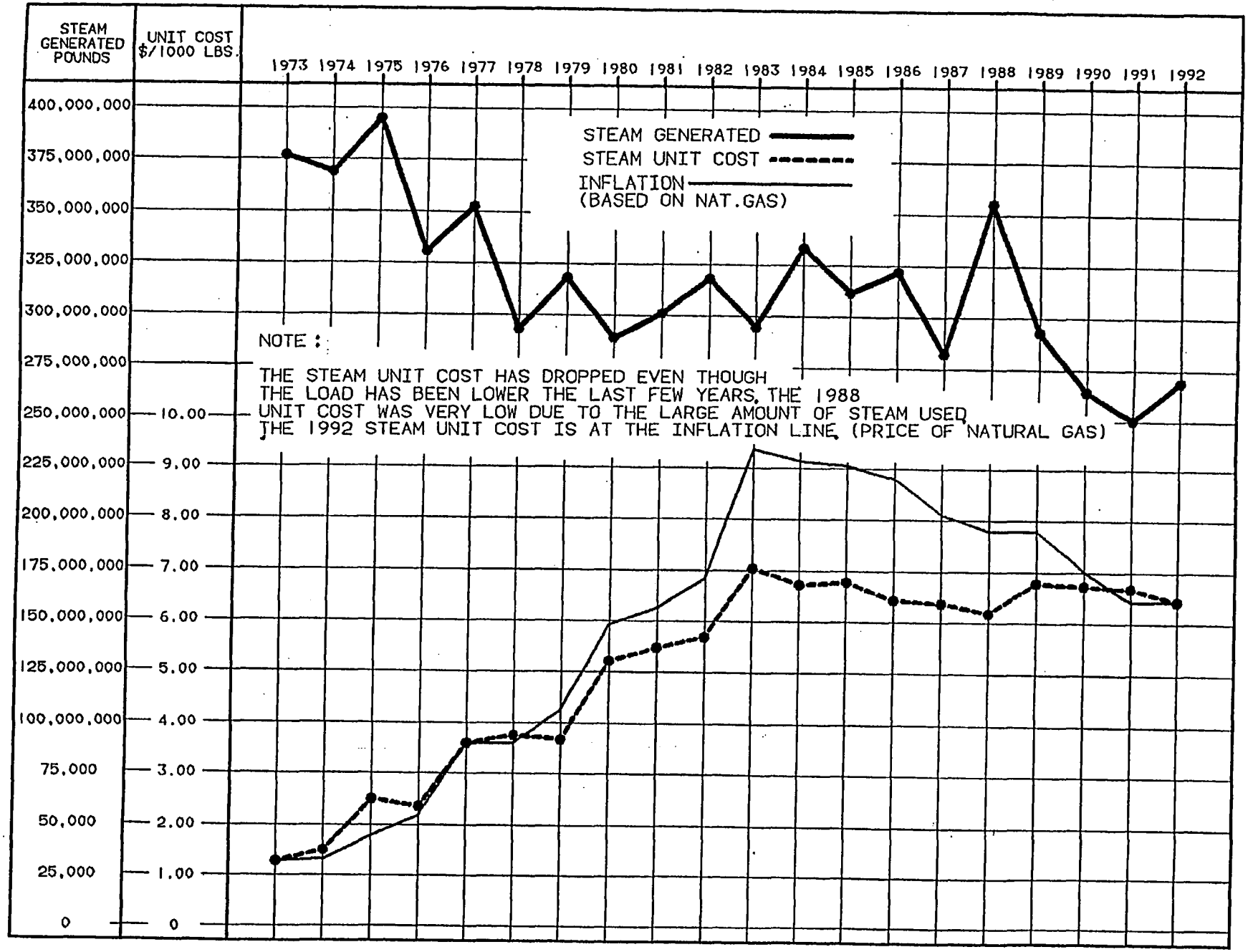
Other qualifications Plant Foreman = Minimum 5 yrs exp. in H.P.S. generating plant (100 PSI) as operating engr. at least 1 yr as Plant Foreman Boiler operator = State operators license, and minimum of 4 years experience at H.P.S. plant

d. Do the operators receive training? yes. or 1 yr exp. at Lewis Steam Plant (100 PSI) as helper

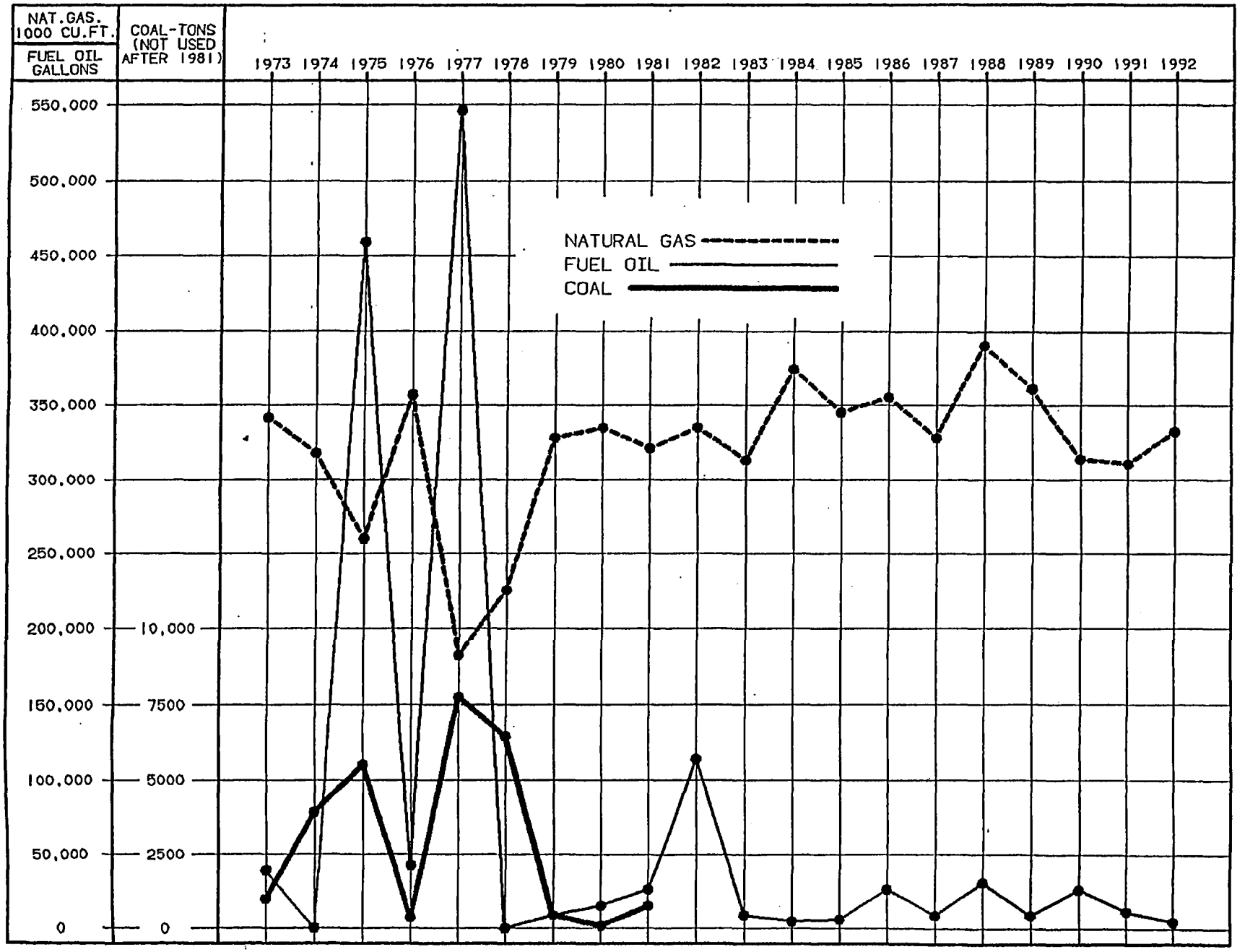
What kind of training? Asbestos Awareness, Confined Space, Hazard Comm., Safety Awareness, Lockout/tagout, Chemical Handling training)

3. Provide any information concerning engineering studies of the heating plant such as plant and/or boiler efficiencies, plant reliability/availability or other measurable function (please attach study). ① Boiler Relief Valve Recertification Study. ② Metric Evaluation of Boiler Availability (monthly) ③ Caesar Study (Stress study of all steam pipes)

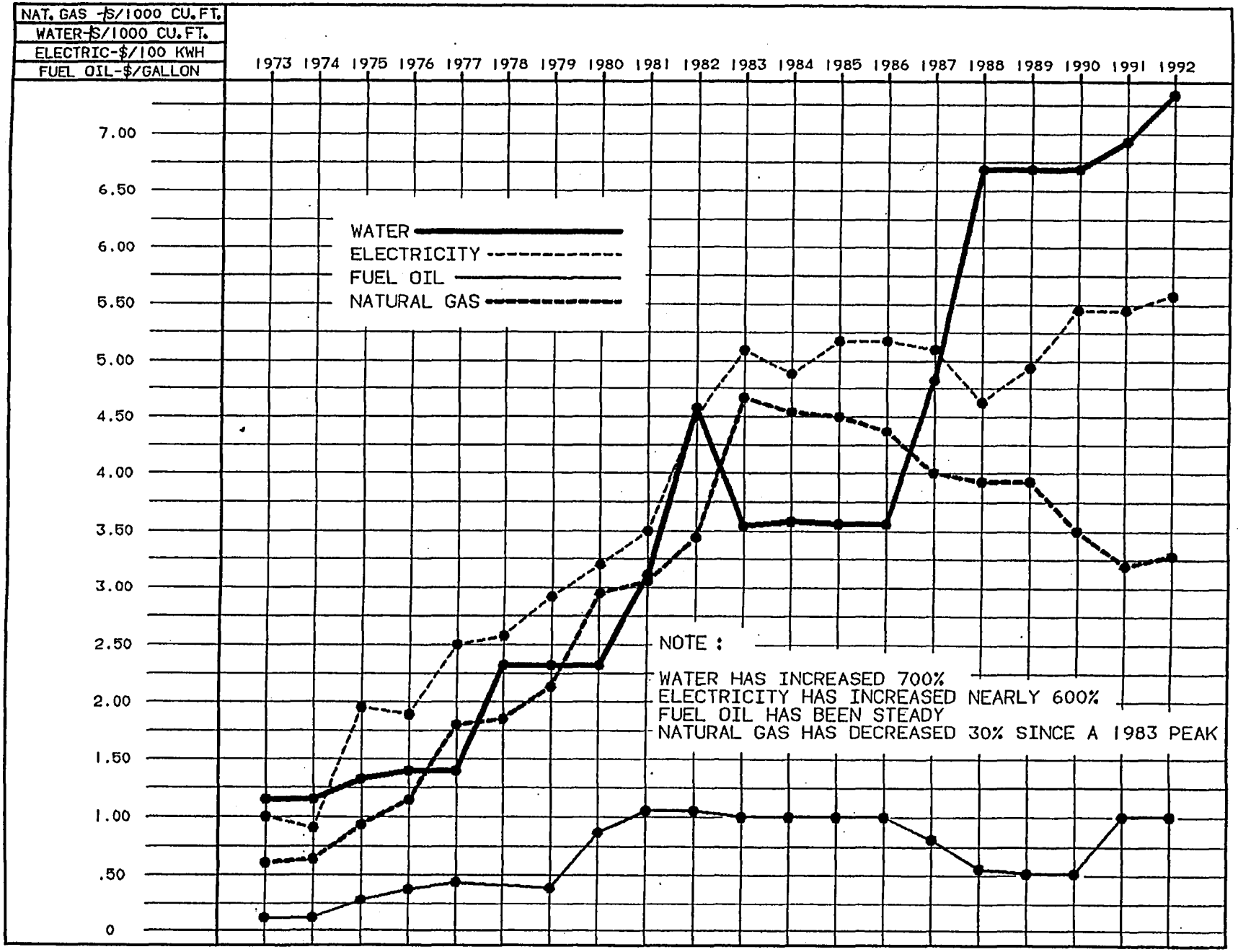
BUILDING 12 - STEAM GENERATED & STEAM UNIT COST



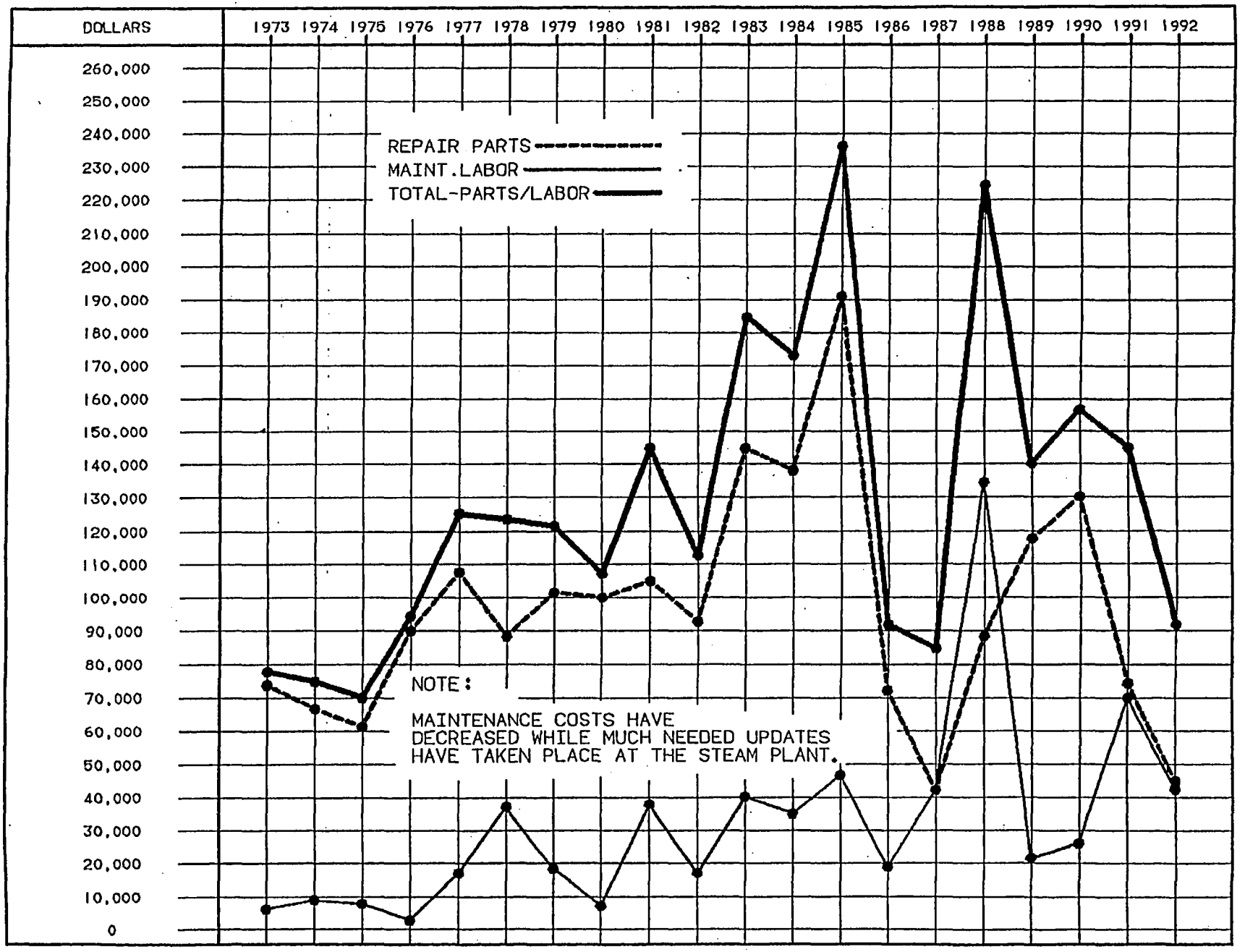
BUILDING 12 - BOILER FUEL



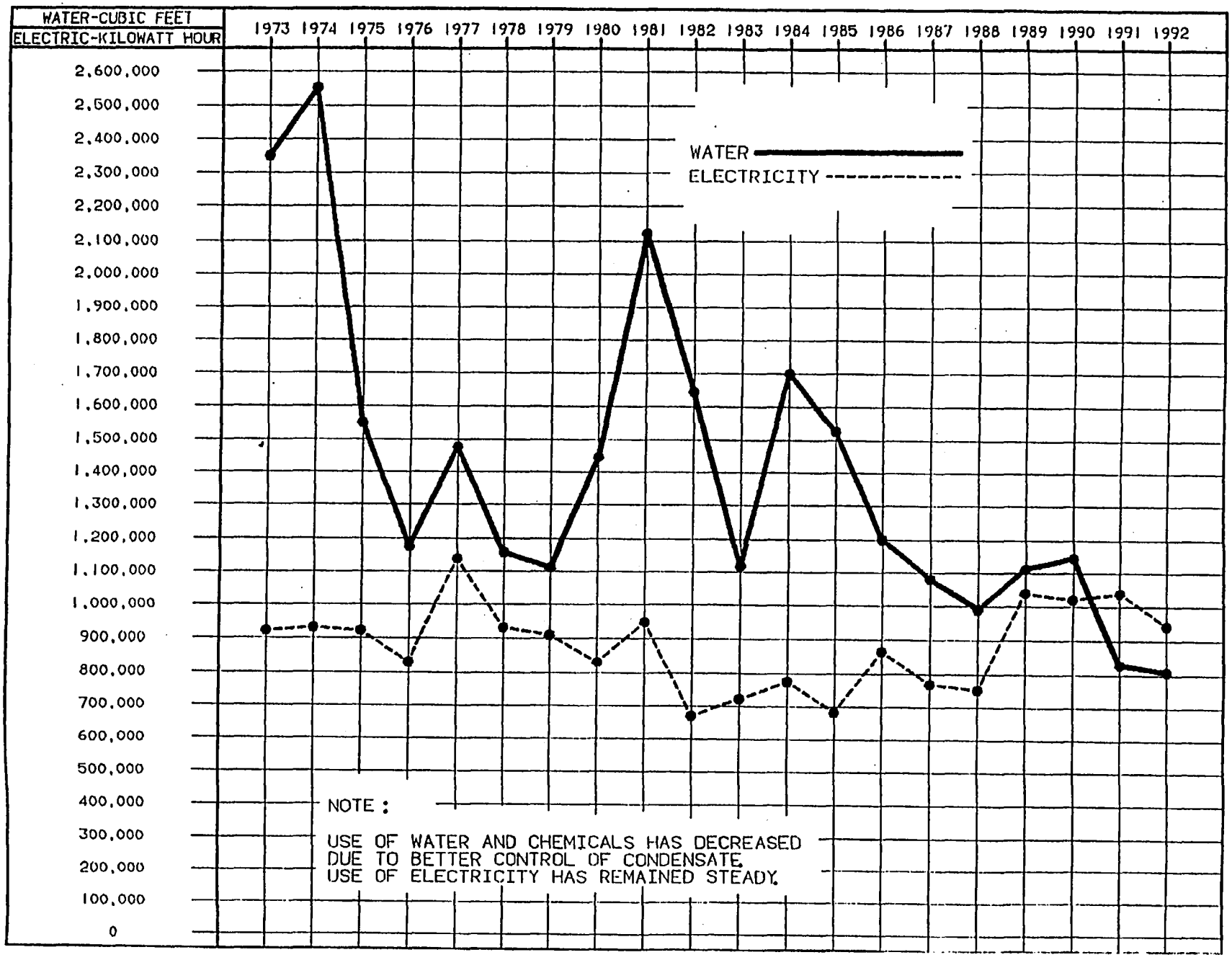
BUILDING 12 - UTILITY UNIT COSTS



BUILDING 12 - MAINTENANCE COSTS



BUILDING 12 - USE OF WATER AND ELECTRICITY



SURVEY OF CENTRAL HEATING PLANT OPERATIONS

Conducted by:

NASA

Lewis Research Center

Cleveland, Ohio

Survey Completed by:

Company Name	Langley Research Center
Division	Operations Support Division
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	Hampton, VA 23681-0001
Contact	Bill Wiley or Vince Foretich
Telephone	Bill: (804) 864-6994 Vince: (804) 864-6310

Survey
of Central Heating Plant Operations

I. General Information

1. Provide brief description of Heating Plant (Type of boilers, number of boilers, general setup of heating plant, etc.).

Heating Plant contains (3) - B&W "D" type water tube boilers & (1) English boiler & tube model ALL-50-SPL (2) 1000 CFM 110# air compressors & (1) 350#, 1000 CFM air comp. Steam is produced @ 350 PSI, 436°F, steam is reduced to 125 PSI in the steam plant. Steam is distributed @ both pressures and reduced more, if needed, at the point of use "building".

2. Provide numerical information about Boilers at Heating Plant:

Boiler #	1	2	3	5	
HP	100,000 pph	100,000 pph	50,000 pph	140,000 pph	
Operating Pressure	350	350	350	350	
BTU Input	120,000,000	130,000,000	60,000,000	175,000,000	
MFG.	Babcock&Wilcox	Babcock&Wilcox	English	Bobcock&Wilcox	
Install Date	1965	1971	1993	1963	
Fuel(s)	#4 Fuel Oil Natural Gas	#4 Fuel Oil	Natural Gas	#4 Fuel Oil	
Steam Output	100,000 pph	100,000 pph	50,000 pph	140,000 pph	

3. Provide brief description of distribution system (how many buildings or areas supplied, uses, piping arrangements, etc.)

Approx.

70 buildings are supplied with steam for heating/cooling/humidity control. (3) facilities use steam for ejectors - 1221, 1247B/D & 1267. Langley distributed steam thru (4) utility tunnels. Tunnels 2 & 3 have one steam line @ 125PSI. Utility tunnel #4 has one steam line @ 350 PSI and Utility Tunnel #1 has one steam line @ 125 PSI used for building heat and one steam line @ 350 PSI used for steam ejectors.

4. Provide description of the chemical treatment system (boiler blowdown, chemicals used, injection system, softeners, etc.)

Boiler blowdown is monitored & controlled by a UNI-LOC Model #92 Crane chemical injection pumps discharge chemicals to feedwater system. Chemicals used are Betz Entec 733, Betz Entec 504 "mixture", Betz Entec Opti-51 is used for steam line & condensate preservation and 50% sodium hydroxide for alkalinity control.
Softeners - Duplex Culligen 300,000 gallons per unit.

5. Provide description of condensate return system to the boilers (% return, economizer used, feedwater pumps, deairator tank)

Condensate return rate at present is 85% - 90% but this varies with steam ejector use and Recoup venting steam at low steam usage periods.
No economizers - Ljungstrom air pre-heaters are used on #1, 2 & 5 boilers.
Plant is equipped with (2) electric motor driven feedwater pumps, 4 stage Worthington "UNO" & has a new deaerator a Cochrane Uni-PAC rated @ 190,000 pph using straight city water @ 80".

6. Provide description of boiler and/or burner controls (flame safeguard, diagnostic capabilities, heating plant controls, energy monitoring, energy management system, etc.)

Boilers 1 & 2 have Keeler Flame Control Panels & Johnson-Yokogawa controls.
Boiler #3 is using Bristol-Babcock Controls & Honeywell Burner Control System.
Boiler #5 uses original Hayes Controls & Cleveland Controls designed the flame control. Feedwater controller has been upgraded to Johnson-Yokogawa & a new Copes-Vulcan feedwater control valve.

II. Loads and Costs Analysis. (THIS IS GENERATED AT 1218 ONLY) NOT RECOUP!

1. Heat Loads for Heating Plant

A. What is the average yearly load ? 105,633,300 lbs. (3 years Ave.)

B. What is the average summer load ? 32,800,000 (May - Sept.) "

C. What is the average winter load ? 72,833,300 (Oct. - Apr.) "

D. What is the maximum winter load ? 92,055,285 "

2. What is the yearly utility use ?

Fuels:

Natural gas newly installed (No data as of 7-6-94) M.Cu.FT.(1000 Cubic foot)@__ psig

Fuel Oil 1,041,070 Gallons

Electric 3,433,200 KWH

Heating Plant auxiliary or support utilities:

Propane ~~Natural gas~~ 3,000 gal. M.Cu.FT.(1000 Cubic foot)@__ psig

Fuel Oil 97,119 Gallons

Electric N/A KWH Condensate pumps/forced air furnace & remote boilers not metered. Power comes from users' facility.

3. What are the utility unit prices ?

Natural Gas $3.53 $/M.Cu.FT. @20 psig

Electric 1. Energy Charge .023 $/KWH 2.33764¢/KWH

2. Demand Charge 9.42 $/KW

Water .00143 $/gallon

Fuel Oil 0.467 $/gallon

4. What is the yearly costs for the following:

Chemical Costs (Total) $67,000.00 $ Rounded figure

Individual chemical costs $62,000.00

Boiler treatment $5,000.00 for water treating chemicals

Maintenance Costs $390,800.00 $

Breakdown labor $208,000 + 20,800

material 162,000

Water testing including all NASA cooling towers!!

Operation Personnel $208,000 $

Breakdown 5 operators x 2080 hrs. @ $20 per hour, which includes benefits

Major Repairs $60,000 $ Air Preheater rebuilding every 7 yr @$50,000.00

Breakdown 350# balance Bellows expansion joints for steam ejector supply piping 5-yr. replacement cycle @ $8,500 each.

Other costs $20,800 $

Description Administrative - parts ordering, etc.

5. Overall Costs

Total Costs	$746,600	$, year 1993
	709,000	$, year 1992
	675,000	$, year 1991
Steam Generated	101,544,798	lbs. or BTU, year 1993
	124,931,023	year 1992
	90,587,926	year 1991
Unit Cost	6.17	$/1,000 lbs..year 1993
	6.16	year 1992
	7.25	year 1991

III. Operations

1. Indicate in the following table the documentation that is used at the Heating Plant:

DOCUMENT	AVAILABLE YES	AVAILABLE NO	COMMENTS
DRAWINGS - SCHEMATICS BOILERS	X		This facility is under
MECHANICAL SYSTEMS	X		Configuration Management
ELECTRICAL BOILER ELEMENTARY	X		System.
BUILDING	X		
ISOMETRICS	X		
GENERAL BUILDING	X		
OTHER			
BOILER START-UP PROCEDURE	X		
PROCEDURE FOR STEAM DRUM ENTRY	X		
EMERGENCY CALL PROCEDURE	X		
HEATING PLANT EVACUATION PROCEDURE	X		
BOILER SAFETY OPERATION CHECKOUT PROCEDURE	X		
PROCEDURE FOR HANDLING CHEMICALS	X		
LIST OF CHEMICALS WITH MSDS	X		
CONFINED SPACE ENTRY PROCEDURE	X		
BOILER MAINTENANCE PROCEDURES	X		
EQUIPMENT MAINTENANCE PROCEDURES	X		

2. Provide information concerning the Heating Plant personnel.

a. Are personnel on duty at the Heating Plant
24 hours a day? Yes
365 days a year? Yes
other _____

b. Breakdown the personnel that are on duty at specific times.

1st Shift # of operators 2 # of supervisors 1

2nd Shift # of operators 1 # of supervisors 0

3rd Shift # of operators 1 # of supervisors 0

Are there any other personnel on duty besides operators, such as maintenance personnel? 2 Steamfitters, 2 mechanics, 1 work leader, 1 part-time water analyst.

c. What is the qualifications of the operators?

# of 1st Class Operators 5

# of 2nd Class Operators 0

# of 3rd Class Operators 0

Other qualifications _____

d. Do the operators receive training? Yes

What kind of training? On-the-job to start, factory training on all new equipment, monthly safety training.

3. Provide any information concerning engineering studies of the heating plant such as plant and/or boiler efficiencies, plant reliability/availability or other measurable function (please attach study). System Planning Corporation - has recently completed - "Evaluation of Steam Generation System Operations" and "Identification of Improvements with Potential Energy and Cost Savings".

Check forwarded for SPC reports

SURVEY OF CENTRAL HEATING PLANT OPERATIONS

Conducted by:

NASA

Lewis Research Center

Cleveland, Ohio

Building 4675

Survey Completed by:

Company Name	Marshall Space Flight Center I, BAMSI Inc.
Division	Plant Engineering
Address	P.O. Box 8395, Building 4251
	Redstone Arsenal, AL 35808
Contact	T. LeDuc, W. Alexander
Telephone	(205) 544–8132 and 544–6502

Survey
of Central Heating Plant Operations

I. General Information

1. Provide brief description of Heating Plant (Type of boilers, number of boilers, general setup of heating plant, etc.).

Building 4675 Boiler Facility consists of two primary and one standby fire tube boilers installed in series.

2. Provide numerical information about Boilers at Heating Plant:

Boiler #	1	2	3		
HP	100	100	100		
Operating Pressure	100 psi	100 psi	100 psi		
BTU Input	3.47×10^6	3.47×10^6	3.47×10^6		
MFG.	Raytherm	Raytherm	Raytherm		
Install Date	1962	1962	1962		
Fuel(s)	No. 2 Oil	No. 2 Oil	No. 2 Oil		
Steam Output	2932 lb/hr	2932 lb/hr	2932 lb/hr		

3. Provide brief description of distribution system (how many buildings or areas supplied, uses, piping arrangements, etc.)

The boiler plant at building 4675 currently provides steam to six (6) buildings with an approximate total area of 118,190 ft^2. The building types supplied consist of test stands, support buildings, and office buildings. The boilers in the facility are put out of service during the summer months (approx. May - Sept.)

4. Provide description of the chemical treatment system (boiler blowdown, chemicals used, injection system, softeners, etc.)

Chemical treatment consists of Phosphate injection. Boilers are blowndown every eight (8) hours max. Water softeners are utilized.

5. Provide description of condensate return system to the boilers (% return, economizer used, feedwater pumps, deairator tank)

Approximately 25% of the condensate in the 4675 system is currently returned. This number should increase in the near future due to a number of piping projects being worked. Feedwater pumps and deairators are utilized.

6. Provide description of boiler and/or burner controls (flame safeguard, diagnostic capabilities, heating plant controls, energy monitoring, energy management system, etc.)

Burner controls consist of "Flame Monitor Programmers" which allow for the control of the boiler firing rates and the ability to monitor the safety features of the boilers.
Combustion tests are performed regularly on the flue gases to monitor boiler efficiencies.

II. Loads and Costs Analysis

1. Heat Loads for Heating Plant

A. What is the average yearly load ? 1.375 x 10^6 BTUH (93)
1.6 x 10^6 BTUH (92)

B. What is the average summer load ? 0.0 (93)
0.0 (92)

C. What is the average winter load ? 2.47 x 10^6 BTUH (93)
2.96 x 10^6 BTUH (92)

D. What is the maximum winter load ? 4.16 x 10^6 BTUH (93)
4.24 x 10^6 BTUH (92)

2. What is the yearly utility use ?

Fuels:

Natural gas N/A M.Cu.FT.(1000 Cubic foot)@__ psig

Fuel Oil 115,160 (93)
133,145 (92) Gallons

Electric N/A KWH

Heating Plant auxiliary or support utilities:

Natural gas N/A M.Cu.FT.(1000 Cubic foot)@__ psig

Fuel Oil N/A Gallons

Electric 135,170 (93)
142,000 (92) KWH

3. What are the utility unit prices ?

Natural Gas N/A $/M.Cu.FT. @__psig

Electric 1. Energy Charge .0509 $/KWH

2. Demand Charge 0.0 $/KW

Water 0.0074 $/gallon

Fuel Oil 0.525 $/gallon

4. What is the yearly costs for the following:

Chemical Costs (Total) Not Available $

Individual chemical costs _____

_____

_____

Maintenance Costs Included in operation personnel $

Breakdown labor _____

material _____

Operation Personnel $65000/yr (approx.) $

Breakdown _____

_____

Major Repairs N/A $

Breakdown _____

_____

_____

Other costs N/A $

Description _____

_____

5. Overall Costs

Total Costs	132,340	$, year	1993
	142,130	$, year	1992
	Not Available	$, year	1991
Steam Generated	11,514,950	lbs. or BTU, year	1993
	13,265,535	year	1992
	Not Available	year	1991
Unit Cost	11.50	$/1,000 lbs., year	1993
	10.71	year	1992
	Not Available	year	1991

III. Operations

1. Indicate in the following table the documentation that is used at the Heating Plant:

DOCUMENT	AVAILABLE YES	AVAILABLE NO	COMMENTS
DRAWINGS - SCHEMATICS BOILERS	X		
MECHANICAL SYSTEMS		X	
ELECTRICAL BOILER ELEMENTARY	X		
BUILDING		X	
ISOMETRICS		X	
GENERAL BUILDING		X	
OTHER		X	
BOILER START-UP PROCEDURE	X		
PROCEDURE FOR STEAM DRUM ENTRY		X	Requires confined space entry permit.
EMERGENCY CALL PROCEDURE	X		
HEATING PLANT EVACUATION PROCEDURE	X		
BOILER SAFETY OPERATION CHECKOUT PROCEDURE	X		
PROCEDURE FOR HANDLING CHEMICALS	X		
LIST OF CHEMICALS WITH MSDS	X		
CONFINED SPACE ENTRY PROCEDURE	X		Requires permit
BOILER MAINTENANCE PROCEDURES	X		
EQUIPMENT MAINTENANCE PROCEDURES	X		

2. Provide information concerning the Heating Plant personnel.

a. Are personnel on duty at the Heating Plant
24 hours a day? No
365 days a year? No
other Personnel are based at boiler plant at 4660

b. Breakdown the personnel that are on duty at specific times.

1st Shift # of operators _____ # of supervisors _____

2nd Shift # of operators _____ # of supervisors _____

3rd Shift # of operators _____ # of supervisors _____

Are there any other personnel on duty besides operators, such as maintenance personnel? _____

c. What is the qualifications of the operators?

# of 1st Class Operators 4

# of 2nd Class Operators _____

# of 3rd Class Operators _____

Other qualifications _____

d. Do the operators receive training? Yes

What kind of training? Periodic training in the operation and control of boilers.

3. Provide any information concerning engineering studies of the heating plant such as plant and/or boiler efficiencies, plant reliability/availability or other measurable function (please attach study). _____

Not Available

SURVEY OF CENTRAL HEATING PLANT OPERATIONS

Conducted by:

NASA

Lewis Research Center

Cleveland, Ohio

Building 4660

Survey Completed by:

Company Name	Marshall Space Flight Center II, BAMSI Inc.
Division	Plant Engineering
Address	P.O. Box 8395, Building 4251
	Redstone Arsenal, AL 35808
Contact	T. LeDuc, W. Alexander
Telephone	(205) 544–8132 and 544–6502

Survey
of Central Heating Plant Operations

I. General Information

1. Provide brief description of Heating Plant (Type of boilers, number of boilers, general setup of heating plant, etc.).

Building 4660 Boiler Facility consists of two primary and one standby fire tube boilers installed in series.

2. Provide numerical information about Boilers at Heating Plant:

Boiler #	1	2	3		
HP	300	300	300		
Operating Pressure	100 psi	100 psi	100 psi		
BTU Input	12.48×10^6	12.48×10^6	12.48×10^6		
MFG.	Superior	Superior	Superior		
Install Date	1965	1965	1965		
Fuel(s)	No. 2 Oil	No. 2 Oil	No. 2 Oil		
Steam Output	8200 lb/hr	8200 lb/hr	8200 lb/hr		

3. Provide brief description of distribution system (how many buildings or areas supplied, uses, piping arrangements, etc.)

The boiler plant at building 4660 currently provides steam to twelve (12) buildings with an approximate total area of 115,000 ft^2. Steam use is primarily for general winter heating but 4660 also provides for any summer heating requirements in the area.

4. Provide description of the chemical treatment system (boiler blowdown, chemicals used, injection system, softeners, etc.)

Chemical treatment consists of Phosphate injection. Boilers are blowndown every eight (8) hours max. Water softeners are utilized.

5. Provide description of condensate return system to the boilers (% return, economizer used, feedwater pumps, deairator tank)

Appoximately 40% of the condensate in the 4660 system is currently returned. This number will drastically increase in the future due to a number of steam piping projects being worked. Feedwater pumps and a deairator are utilized.

6. Provide description of boiler and/or burner controls (flame safeguard, diagnostic capabilities, heating plant controls, energy monitoring, energy management system, etc.)

Burner controls consist of "Flame Monitor Programmers" which allows one to program the firing rate and monitor the safety features of the boiler.

Combustion tests are performed regularly on flue gases to monitor boiler efficiencies.

II. Loads and Costs Analysis

1. Heat Loads for Heating Plant

A. What is the average yearly load ? 3.02×10^6 BTUH (93) / 5.96×10^6 BTUH (92)

B. What is the average summer load ? 1.21×10^6 BTUH (93) / 2.59×10^6 BTUH (92)

C. What is the average winter load ? 4.6×10^6 BTUH (93) / 8.4×10^6 BTUH (92)

D. What is the maximum winter load ? 7.44×10^6 BTUH (93) 6,252 / 13.1×10^6 BTUH (92) 11,008

1190 Btu/hr

2. What is the yearly utility use ?

Fuels:

Natural gas ___N/A___ M.Cu.FT.(1000 Cubic foot)@__ psig

Fuel Oil 262250 (93) / 518000 (92) Gallons

Electric ___N/A___ KWH

Heating Plant auxiliary or support utilities:

Natural gas ___N/A___ M.Cu.FT.(1000 Cubic foot)@__ psig

Fuel Oil ___N/A___ Gallons

Electric 62480 (93) / 65600 (92) KWH

3. What are the utility unit prices ?

Natural Gas ___N/A___ $/M.Cu.FT. @__psig

Electric 1. Energy Charge ___.0509___ $/KWH

2. Demand Charge ___0.0___ $/KW

Water ___.0074___ $/gallon

Fuel Oil ___0.525___ $/gallon

4. What is the yearly costs for the following:

Chemical Costs (Total) Not Available $

Individual chemical costs _____

_____

_____

Maintenance Costs Included in operation personnel $

Breakdown labor _____

material _____

Operation Personnel $65000/yr (approx.)$

Breakdown _____

_____

Major Repairs N/A $

Breakdown _____

_____

_____

Other costs N/A $

Description _____

_____

5. Overall Costs

Total Costs	205,860	$, year	1993
	340,290	$, year	1992
	Not Available	$, year	1991
Steam Generated	26,156,500 lbs.	lbs. or BTU, year	1993
	49,911,750 lbs.	year	1992
	Not Available	year	1991
Unit Cost	7.87	$/1,000 lbs., year	1993
	6.82	year	1992
	Not Available	year	1991

III. Operations

1. Indicate in the following table the documentation that is used at the Heating Plant:

DOCUMENT	AVAILABLE		COMMENTS
	YES	NO	
DRAWINGS - SCHEMATICS BOILERS	X		
MECHANICAL SYSTEMS		X	
ELECTRICAL BOILER ELEMENTARY	X		
BUILDING		X	
ISOMETRICS		X	
GENERAL BUILDING		X	
OTHER		X	
BOILER START-UP PROCEDURE	X		
PROCEDURE FOR STEAM DRUM ENTRY		X	Requires confined space entry permit.
EMERGENCY CALL PROCEDURE	X		
HEATING PLANT EVACUATION PROCEDURE	X		
BOILER SAFETY OPERATION CHECKOUT PROCEDURE	X		
PROCEDURE FOR HANDLING CHEMICALS	X		
LIST OF CHEMICALS WITH MSDS	X		
CONFINED SPACE ENTRY PROCEDURE	X		Requires permit
BOILER MAINTENANCE PROCEDURES	X		
EQUIPMENT MAINTENANCE PROCEDURES	X		

2. Provide information concerning the Heating Plant personnel.

a. Are personnel on duty at the Heating Plant
24 hours a day? Yes
365 days a year? Yes
other Boiler personnel are based at Bldg.4660 and are rotated to Bldgs. 4567 and 4675.

b. Breakdown the personnel that are on duty at specific times.

1st Shift # of operators 1 # of supervisors 1

2nd Shift # of operators 1 # of supervisors _____

3rd Shift # of operators 1 # of supervisors _____

Are there any other personnel on duty besides operators, such as maintenance personnel? Always one (1) mechanic on each shift.

c. What is the qualifications of the operators?

# of 1st Class Operators 4

# of 2nd Class Operators _____

# of 3rd Class Operators _____

Other qualifications _____

d. Do the operators receive training? Yes

What kind of training? Periodic training in the operation and controls of boilers.

3. Provide any information concerning engineering studies of the heating plant such as plant and/or boiler efficiencies, plant reliability/availability or other measurable function (please attach study).

None Available

SURVEY OF CENTRAL HEATING PLANT OPERATIONS

Conducted by:

NASA

Lewis Research Center

Cleveland, Ohio

Building 4567

Survey Completed by:

Company Name	Marshall Space Flight Center III, BAMSI Inc.
Division	Plant Engineering
Address	P.O. Box 8395, Building 4251
	Redstone Arsenal, AL 35808
Contact	T. LeDuc, W. Alexander
Telephone	(205) 544–8132 and 544–6502

Survey
of Central Heating Plant Operations

I. General Information

1. Provide brief description of Heating Plant (Type of boilers, number of boilers, general setup of heating plant, etc.).

Building 4567 Boiler Facility consists of two primary and one standby fire tube boilers installed in series.

2. Provide numerical information about Boilers at Heating Plant:

Boiler #	1	2	3		
HP	200	300	350		
Operating Pressure	100	150	100		
BTU Input	6.77×10^6	9.56×10^6	11.85×10^6		
MFG.	Cleaver Brooks	Superior	Superior		
Install Date	1963	1985	1966		
Fuel(s)	No. 2 Oil	No. 2 Oil	No. 2 Oil		
Steam Output	5865 lb/hr	8280 lb/hr	10264 lb/hr		

3. Provide brief description of distribution system (how many buildings or areas supplied, uses, piping arrangements, etc.)

The boiler plant at building 4567 currently provides steam to fifteen (15) buildings with an approximate total area of 192,500 ft^2. The building types supplied consist of test stands, support buildings, and office buildings. The boilers in the facility are put out of service during the summer months (approx. May - Oct.).

4. Provide description of the chemical treatment system (boiler blowdown, chemicals used, injection system, softeners, etc.)

Chemical treatment consists of Phosphate injection. Boilers are blowndown every eight (8) hours max. Water softeners are utilized.

5. Provide description of condensate return system to the boilers (% return, economizer used, feedwater pumps, deairator tank)

Approximately 35% of the condensate in the 4567 system is currently returned. This number should increase in the near future due to a number of piping projects being worked. Feedwater pumps and deairators are utilized.

6. Provide description of boiler and/or burner controls (flame safeguard, diagnostic capabilities, heating plant controls, energy monitoring, energy management system, etc.)

Burner controls consist of "Flame Monitor Programmers" which allow one to program the firing rate and monitor the safety features of the boiler.

Combustion tests are performed regularly on the flue gases to monitor boiler efficiencies.

II. Loads and Costs Analysis

1. Heat Loads for Heating Plant

A. What is the average yearly load ? 2.8×10^6 BTUH (93) / 2.93×10^6 BTUH (92)

B. What is the average summer load ? 0.0 (93) / 0.0 (92)

C. What is the average winter load ? 5.12×10^6 BTUH (93) / 5.675×10^6 BTUH (92)

D. What is the maximum winter load ? 7.56×10^6 BTUH (93) / 8.3×10^6 BTUH (92) 6,352

1150 BTU/#

2. What is the yearly utility use ?

Fuels:

Natural gas N/A M.Cu.FT.(1000 Cubic foot)@__ psig

Fuel Oil 244300 (93) / 231800 (92) Gallons

Electric N/A KWH

Heating Plant auxiliary or support utilities:

Natural gas N/A M.Cu.FT.(1000 Cubic foot)@__ psig

Fuel Oil N/A Gallons

Electric 155900 (93) / 164000 (92) KWH

3. What are the utility unit prices ?

Natural Gas N/A $/M.Cu.FT. @__psig

Electric 1. Energy Charge .0509 $/KWH

2. Demand Charge 0.0 $/KW

Water 0.000091 $/gallon

Fuel Oil 0.525 $/gallon

4. What is the yearly costs for the following:

Chemical Costs (Total) Not Available $

Individual chemical costs _____

_____

_____

Maintenance Costs Included in operation personnel $

Breakdown labor _____

material _____

Operation Personnel $61000/yr (approx $)

Breakdown _____

_____

Major Repairs N/A $

Breakdown _____

_____

_____

Other costs N/A $

Description _____

_____

5. Overall Costs

Total Costs	197,193	$, year	1993
	191,050	$, year	1992
	Not Available	$, year	1991
Steam Generated	24,502,940	lbs. or BTU, year	1993
	23,061,260	year	1992
	Not Available	year	1991
Unit Cost	8.05	$/1,000 lbs., year	1993
	8.28	year	1992
	Not Available	year	1991

III. Operations

1. Indicate in the following table the documentation that is used at the Heating Plant:

DOCUMENT	AVAILABLE		COMMENTS
	YES	NO	
DRAWINGS - SCHEMATICS BOILERS	X		
MECHANICAL SYSTEMS		X	
ELECTRICAL BOILER ELEMENTARY	X		
BUILDING		X	
ISOMETRICS		X	
GENERAL BUILDING		X	
OTHER		X	
BOILER START-UP PROCEDURE	X		
PROCEDURE FOR STEAM DRUM ENTRY		X	Requires confined space entry permit.
EMERGENCY CALL PROCEDURE	X		
HEATING PLANT EVACUATION PROCEDURE	X		
BOILER SAFETY OPERATION CHECKOUT PROCEDURE	X		
PROCEDURE FOR HANDLING CHEMICALS	X		
LIST OF CHEMICALS WITH MSDS	X		
CONFINED SPACE ENTRY PROCEDURE	X		Requires permit
BOILER MAINTENANCE PROCEDURES	X		
EQUIPMENT MAINTENANCE PROCEDURES	X		

2. Provide information concerning the Heating Plant personnel.

a. Are personnel on duty at the Heating Plant
24 hours a day? No
365 days a year? No
other Personnel are based at boiler plant in 4660.

b. Breakdown the personnel that are on duty at specific times.

1st Shift # of operators _____ # of supervisors _____

2nd Shift # of operators _____ # of supervisors _____

3rd Shift # of operators _____ # of supervisors _____

Are there any other personnel on duty besides operators, such as maintenance personnel? _____

c. What is the qualifications of the operators?

# of 1st Class Operators 4

# of 2nd Class Operators _____

# of 3rd Class Operators _____

Other qualifications _____

d. Do the operators receive training? Yes

What kind of training? Periodic training in the operation and control of boilers.

3. Provide any information concerning engineering studies of the heating plant such as plant and/or boiler efficiencies, plant reliability/availability or other measurable function (please attach study). _____

Not Available.

SURVEY OF CENTRAL HEATING PLANT OPERATIONS

Conducted by:

NASA

Lewis Research Center

Cleveland, Ohio

Survey Completed by:

Company Name	NASA/GSFC/WFF
Division	229
Address	Building F–16
	Wallops Island, VA 23337
Contact	R. J. Givens
Telephone	(804) 824–1148

Survey
of Central Heating Plant Operations

I. General Information

1. Provide brief description of Heating Plant (Type of boilers, number of boilers, general setup of heating plant, etc.).
3 Firetube Boilers operated at 100-125 PSI -
See Attached DWG's. / O&M Manual

2. Provide numerical information about Boilers at Heating Plant:

Boiler #	208	209	210		
HP	700	500	700		
Operating Pressure	100 to 125	100 to 125	100 to 125	(Rated at 150 PSIG)	
BTU Input	29.29 MMBTUH	20.92 MMBTUH	29.29 MMBTUH		
MFG.	Cleaver Brooks	Cleaver Brooks	Cleaver Brooks	(in procurement)	
Install Date	1990	1973	1994		
Fuel(s)	#2 OR #6	#2 or #6	#2 OR #6		
Steam Output	24,000 lb/hr.	17,000 lb/hr	24,000 lb/hr.		

3. Provide brief description of distribution system (how many buildings or areas supplied, uses, piping arrangements, etc.)
Steam for heat Supplied to 11 Buildings - Aboveground & underground piping.

4. Provide description of the chemical treatment system (boiler blowdown, chemicals used, injection system, softeners, etc.).

Beaver Mod # 120BA-2TW H_2O Softner
Blowdown - Manual
Chemical - Sodium Sulfate - O_2 Removal
Polymeric Blend - Scaling & Sludge Control
Cyclohexamine - Condensate Inhibitor
Sodium Hydroxide - Alkalinity Scaling Control
Chellant - Dispersant - Sludge Control
(Fuel oil Treatment)

5. Provide description of condensate return system to the boilers (% return, economizer used, feedwater pumps, deairator tank)

92% Condensate Return
NO Economizer
3 Feed H_2O Pumps 2- 40 HP 131 GPM 1- 25 HP 90 GPM
3 Condensate Return Pumps 2- 10 HP 110 GPM 1- 5 HP 60 GPM
D/A Tank

6. Provide description of boiler and/or burner controls (flame safeguard, diagnostic capabilities, heating plant controls, energy monitoring, energy management system, etc.)

All Boilers have CB Hawk Flame Safeguard Control tied into A CB-Hawk Enhanced Boiler Management Control System.
EMCS - Johnson Controls DSC-8600 tied to TCI Metasys

II. Loads and Costs Analysis

1. Heat Loads for Heating Plant

A. What is the average yearly load ? 63,000,000 lb 12,500/lb/hr

B. What is the average summer load ? Plant shut down 5/15 - 10/14

C. What is the average winter load ? 63,000,000 lb

D. What is the maximum winter load ? 106,948,800 lb 21,220 lb/hr.

2. What is the yearly utility use ?

Fuels:

Natural gas N/A M.Cu.FT.(1000 Cubic foot)@__ psig

Fuel Oil 524,000 Gallons #6

Electric [redacted] KWH

Heating Plant auxiliary or support utilities:

37 Stand Alone Boilers At other facilities

Natural gas N/A M.Cu.FT.(1000 Cubic foot)@__ psig

Fuel Oil 334,000 Gallons #2

Electric [redacted] KWH

3. What are the utility unit prices ?

Natural Gas N/A $/M.Cu.FT. @__psig

Electric 1. Energy Charge [redacted] $/KWH

Peak - .022

Summer - .991

2. Demand Charge [redacted] $/KW

Water $1.60/1000 gal ~~$/gallon~~

Fuel Oil #2 [redacted] $/gallon

#6 0.51

4. What is the yearly costs for the following:

Chemical Costs (Total) 4K / 7mo $

Individual chemical costs N/A

Maintenance Costs 327,557.37 $

Breakdown labor $ 10,000

material $ 48,525.37

Operation Personnel 269,032 $

Breakdown Rated @ $21/hr Contract Maintenance Cost

Major Repairs 13K $

Breakdown Return 500 HP CB Boiler FY 92

Other costs 4000 $

Description Chemical Cost

5. Overall Costs

Total Costs	551,958	$, year 1993	440
	595,817	$, year 1992	526
	608,057	$, year 1991	550
Steam Generated	44,000,000	lbs. or BTU, year 1993	
?	52,600,000	year 1992	
	55,000,000	year 1991	
Unit Cost	12.54	$/1,000 lbs., year 1993	
	11.33	year 1992	
	11.06	year 1991	

III. Operations

1. Indicate in the following table the documentation that is used at the Heating Plant:

DOCUMENT	AVAILABLE YES	AVAILABLE NO	COMMENTS
DRAWINGS - SCHEMATICS BOILERS			
MECHANICAL SYSTEMS			
ELECTRICAL BOILER ELEMENTARY			
BUILDING			
ISOMETRICS		X	
GENERAL BUILDING			
OTHER			
BOILER START-UP PROCEDURE			
PROCEDURE FOR STEAM DRUM ENTRY		N/A	
EMERGENCY CALL PROCEDURE			
HEATING PLANT EVACUATION PROCEDURE			
BOILER SAFETY OPERATION CHECKOUT PROCEDURE			
PROCEDURE FOR HANDLING CHEMICALS			
LIST OF CHEMICALS WITH MSDS			
CONFINED SPACE ENTRY PROCEDURE			
BOILER MAINTENANCE PROCEDURES			
EQUIPMENT MAINTENANCE PROCEDURES			

2. Provide information concerning the Heating Plant personnel.

a. Are personnel on duty at the Heating Plant
24 hours a day? Yes
365 days a year? Yes
other _____

b. Breakdown the personnel that are on duty at specific times.

2 = operator & Helper

1st Shift # of operators 2 # of supervisors 1

2nd Shift # of operators 2 # of supervisors 0

3rd Shift # of operators 2 # of supervisors 0

Are there any other personnel on duty besides operators, such as maintenance personnel? NO

c. What is the qualifications of the operators?

# of 1st Class Operators 5

# of 2nd Class Operators 0

# of 3rd Class Operators 0

Other qualifications _____

d. Do the operators receive training? Yes

What kind of training? CB Hawk Engineer Training & EMCS

3. Provide any information concerning engineering studies of the heating plant such as plant and/or boiler efficiencies, plant reliability/availability or other measurable function (please attach study). See attached Study

SURVEY OF CENTRAL HEATING PLANT OPERATIONS

Conducted by:

NASA

Lewis Research Center

Cleveland, Ohio

Survey Completed by:

Company Name	Dryden Flight Research Center
Division	
Address	P.O. Box 273
	Edwards, California 93523–0273
Contact	Joe R. Almonte
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Survey
of Central Heating Plant Operations

I. General Information

1. Provide brief description of Heating Plant (Type of boilers, number of boilers, general setup of heating plant, etc.).

1 BOILER IN F/H-6 FOR 4800 (A963)
2 BOILERS IN 4886 FOR 4900 (TA-3)

15PSI

2. Provide numerical information about Boilers at Heating Plant:

Boiler #	4800 F/H-6	4886	4886	4840	
HP	250	120	120	100	
Operating Pressure	15 PSI	15PSI	15 PSI	15 PSI	
BTU Input	10.2 MBTU/HR	4.2MBTU/HR	4.2MBTU/HR	3.6MBTU/HR	= 22.2
MFG.	KENANEE	KENANEE	KENANEE	CLEAVER BROOKS	
Install Date	1953	1963	1963	1992	
Fuel(s)	NAT. GAS	NAT. GAS	NAT. GAS	NAT. GAS	
Steam Output	8625 lb/HR @ 212°F	4,140 lb/HR @ 212°F	4140 lb/HR @ 212°F	3500 lb/HR @ 212°F	

3. Provide brief description of distribution system (how many buildings or areas supplied, uses, piping arrangements, etc.)

4886 BOILERS PIPE SUPPLY & RETURN TO 4800 F/H-6 IS TIED INTO SAME MANIFOLD

4840 BOILER HEATS ONLY THAT BLDG.

4. Provide description of the chemical treatment system (boiler blowdown, chemicals used, injection system, softeners, etc.)

CLOSED LOOP SYSTEMS — ADJUST MONTHLY — ORGANO-PHOSPHATE PROGRAM

5. Provide description of condensate return system to the boilers (% return, economizer used, feedwater pumps, deairator tank)

100% FEEDBACK ALL SYSTEMS - ECONOMIZERS USED - NO DEAERATORS - FLASH OFF @ ECONOMIZERS TO RETURN CONDENSATE TO BOILER FEED

6. Provide description of boiler and/or burner controls (flame safeguard, diagnostic capabilities, heating plant controls, energy monitoring, energy management system, etc.)

ALL UNITS HAVE "FLAME GUARD" NO ENERGY MONITORING OR MGMT — LO PRESSURE 20 PSI MAX - NORM OUTPUT IS 15 PSI

II. Loads and Costs Analysis

1. Heat Loads for Heating Plant

	4800	4840
A. What is the average yearly load ?	55/60	45/50
B. What is the average summer load ?	5%	5%
C. What is the average winter load ?	65/75	75%
D. What is the maximum winter load ?	85%	95%

2. What is the yearly utility use ?

Fuels:

Note: Most GAS is used in boilers, an unknown portion is used for cooking but probably 10% of total.

XAE Natural gas 35960 M.Cu.FT.(1000 Cubic foot)@65 psig

Fuel Oil NONE Gallons

Electric N/A KWH

Heating Plant auxiliary or support utilities:

Natural gas N/A M.Cu.FT.(1000 Cubic foot)@__ psig

Fuel Oil NONE Gallons

Electric N/A KWH

XAE 3. What are the utility unit prices ?

Natural Gas 6.368 $/M.Cu.FT. @65psig

Electric 1. Energy Charge .063283 $/KWH

2. Demand Charge N/A $/KW

Water .00161 $/gallon

Fuel Oil N/A $/gallon

4. What is the yearly costs for the following:

Chemical Costs (Total) 8500 $

Individual chemical costs _____

CLOSED LOOPS ANNUAL REGEN. = APPROX $500

_____

_____

Maintenance Costs 75,000 $

Breakdown labor 50,000

material 25,000

Operation Personnel N/A $

Breakdown _____

_____

Major Repairs _____ $

Breakdown _____

_____

_____

Other costs _____ $

Description _____

_____

5. Overall Costs

Total Costs 108,500 $, year 1993
_____ $, year 1992
_____ $, year 1991

1164 BTU/lb

Steam Generated 25,691,000,000 lbs. of BTU, year 1993
22,243,000 lbs year 1992
year 1991

Unit Cost 105 $/1,000 lbs..year 1993
_____ year 1992
_____ year 1991

4800 INCL. F/A-6 AND 4886 AS BOTH HEAT 4800, 4801, 4802 COMPLEX

III. Operations

1. Indicate in the following table the documentation that is used at the Heating Plant: Bld. No.

DOCUMENT	AVAILABLE YES	AVAILABLE NO	COMMENTS	
DRAWINGS - SCHEMATICS MECHANICAL BOILERS	✓		SOME	4800
	✓			4840
SYSTEMS	✓		BASIC	4800
	✓			4840
ELECTRICAL BOILER ELEMENTARY	✓			4800
	✓			4840
BUILDING	✓			
ISOMETRICS N/A				
GENERAL BUILDING	✓			4800
	✓			4840
OTHER				
BOILER START-UP PROCEDURE	✓			
PROCEDURE FOR STEAM DRUM ENTRY	✓		TOTAL SYSTEM DOWN, DRAINED ONLY DONE OFF SEASON	
EMERGENCY CALL PROCEDURE	✓		911	
HEATING PLANT EVACUATION PROCEDURE	N/A			
BOILER SAFETY OPERATION CHECKOUT PROCEDURE	✓		INDUSTRY STDS. FOR 20 PSI SYSTEMS	
PROCEDURE FOR HANDLING CHEMICALS	✓		PER MSDS	
LIST OF CHEMICALS WITH MSDS	✓			
CONFINED SPACE ENTRY PROCEDURE	✓		PER NASA TRAINING	
BOILER MAINTENANCE PROCEDURES	✓			
EQUIPMENT MAINTENANCE PROCEDURES	✓		MONTHLY SHUTDOWNS -LO WATER/FLAME FAILURE OVERS; WINTER SEASON	

WATCH ENGINEER TOURS TOTAL FACILITY
NOT ON WATCH @ HEATING PLANT

2. Provide information concerning the Heating Plant personnel.

a. Are personnel on duty at the Heating Plant .
24 hours a day? NO
365 days a year? NO
other Heating plants are checked daily by roving watch engineers

b. Breakdown the personnel that are on duty at specific times.

1st Shift # of operators N/A # of supervisors ______

2nd Shift # of operators " # of supervisors ______

3rd Shift # of operators ______ # of supervisors ______

Are there any other personnel on duty besides operators, such as maintenance personnel? ______

c. What is the qualifications of the operators?

# of 1st Class Operators N/A

NONE # of 2nd Class Operators "

# of 3rd Class Operators "

Other qualifications ______

d. Do the operators receive training? YES

What kind of training? PASS-DOWN & OJT

WE UTILIZE WATCH ENGINEERS AND HVAC. TECH'S.

3. Provide any information concerning engineering studies of the heating plant such as plant and/or boiler efficiencies, plant reliability/availability or other measurable function (please attach study).

XAE

None available
Existing boilers schedule for replacement by FY 97 CoF program

SURVEY OF CENTRAL HEATING PLANT OPERATIONS

Conducted by:

NASA

Lewis Research Center

Cleveland, Ohio

Survey Completed by:

Company Name Company A

Division _____

Address _____

_____

Contact _____

Telephone _____

Survey
of Central Heating Plant Operations

I. General Information

1. Provide brief description of Heating Plant (Type of boilers, number of boilers, general setup of heating plant, etc.).
WE PRESENTLY HAVE (4) 80M LB/HR (RATED CAP) BOILERS FIRING #6 FUEL OIL. THESE BOILERS ALL FEED A COMMON HEADER WHICH IN TURN SUPPLIES THE SITE. THE STEAM PRESSURE IS 150PSI ALL BOILERS ARE WATER TUBE, (3) OF WHICH ARE FIELD ERECTED (1) OF WHICH IS A PKG BOILER. ALL (4) BOILERS ARE WATER TUBE. ALL BOILERS ARE LOCATED WITHIN THE BUILDING SITTING SIDE BY SIDE.

2. Provide numerical information about Boilers at Heating Plant:

Boiler #	1	2	3	4	
HP	2500	2500	2500	2500	
Operating Pressure	150	150	150	150	
BTU Input	150M BTU/GAL	150M BTU/GAL	150M BTU/GAL	150M BTU/GAL	
MFG.	B&W	B&W	B&W	B&W	
Install Date	BUILT 1948 MOD 1955	BUILT 1948 MOD 1955	BUILT 1957	BUILT 1967	
Fuel(s)	#6 OIL	#6 OIL	#6 OIL	#6 OIL	
Steam Output	3.02×10^8 LB/YR 35	79.8×10^6 LB/YR	3.10×10^6 LB/YR	1.21×10^8 LB/YR 14	
GALS					

3. Provide brief description of distribution system (how many buildings or areas supplied, uses, piping arrangements, etc.)
THE SITE CONSISTS OF SEVERAL LARGE BUILDINGS ON A CAMPUS LIKE SETTING. ALL LINES ARE UNDER-GROUND. THE SYSTEM CONSISTS OF (4) MAJOR LOOPS. THE STEAM IS GENERATED AT 150 PSIG AND IS REDUCED TO A LOWER PRESSURE FOR USE. THE STEAM IS USED MOSTLY FOR COMFORT HEATING WITH SOME USED FOR HUMIDITY CONTROL & SEMI-WORK USE. TOTAL NUMBER OF BUILDINGS IS 32 (OF MAJOR SIZE)

SILICA 120 ppm
SULFITE 20-30 ppm
PHOSPHATE 15-25 ppm

P ALK 100-200 ppm
M ALK 150-200 ppm
COND 2000-3000 MHOS

4. Provide description of the chemical treatment system (boiler blowdown, chemicals used, injection system, softeners, etc.)
WE HAVE (2) WATER SOFTENERS WITH ROHM & HAAS IR-120 RESIN TO REMOVE CALCIUM & MAGNESIUM CARBONATES. RATED CAPACITY IS 300,000 GAL AT 280 GPM EA. THIS WATER IS THEN SENT TO A DECARBONATOR RATED TO HANDLE 400 GPM, WATER IS ACID INJECTED WITH COUNTERFLOW FORCED DRAFT STRIPPING COL. WITH pH CONTROL. CHEMICAL TREATMENT BASICALLY CONSISTS OF THE ADDITION OF PHOSPHATE/POLYMER, CAUSTIC SODA & SODIUM SULFITE. SILICA CONTROL IS MAINTAINED BY BLOWDOWN WITH CONDUCTIVITY USED FOR SETPT. BOTTOM BLOWDOWN (1) PER SHIFT

5. Provide description of condensate return system to the boilers (% return, economizer used, feedwater pumps, deairator tank)
CONDENSATE IS RETURNED FROM THE SITE GENERALLY 40-60% OF THE TOTAL DEPENDING ON THE TIME OF THE YEAR. CONDENSATE IS FED TO A FILTREX TANK TO REMOVE IRON. WE HAVE (4) BOILER F.W. PUMPS ALL RATED AT 200 GPM AT 680 FT HD. THE BLOWDOWN HEAT EXCHANGER HAS BEEN REMOVED DUE TO ITS FAILURE. THE DEAERATOR UTILIZES 5 PSIG STM (240°F) TO REMOVE DISSOLVED OXYGEN IN THE F.W.
(1) BOILER HAS ECONOMIZER, (3) BOILERS HAVE AIR HTRS

6. Provide description of boiler and/or burner controls (flame safeguard, diagnostic capabilities, heating plant controls, energy monitoring, energy management system, etc.)
OF THE (4) BOILERS, (2) OF THESE PRESENTLY HAVE SOLID STATE CONTROLS, (1) IS IN THE PROCESS OF BEING UPGRADED WITH NEW CONTROLS, (1) STILL USES OLD PNEUMATIC CONTROLS. ALL BOILERS ARE BEING UPGRADED TO MEET NEW NOX REGULATIONS. WE LOG OUR RESULTS BY HAND IN A DAILY LOG SHEET MANUALLY. WE HOPE TO UTILIZE THE NEW SOLID STATE CONTROLLERS IN THE FUTURE TO CAPTURE THIS DATA ELECTRONICALLY. ALL BURNERS HAVE FLAME SCANNERS FOR SAFETY & UTILIZE AUTOMATIC PURGE OF THE BOILER BEFORE LIGHT OFF

II. Loads and Costs Analysis

1. Heat Loads for Heating Plant

A. What is the average yearly load ? .100 M #/HR.

B. What is the average summer load ? 60M #/HR

C. What is the average winter load ? 185M #/HR

D. What is the maximum winter load ? 250M #/HR.

2. What is the yearly utility use ?

Fuels:

Natural gas 0 M.Cu.FT.(1000 Cubic foot)@__ psig

Fuel Oil 6,400,000 Gallons #6

Electric — KWH UNABLE TO BREAK OUT OF OUR ELECTRIC USED FOR REFRIG,

Heating Plant auxiliary or support utilities:

Natural gas 0 M.Cu.FT.(1000 Cubic foot)@__ psig

Fuel Oil 10,000 Gallons #2 FUEL OIL USED FOR PEAK SHAVING ELECTRIC GENERATOR

Electric _____ KWH

GENERATOR IS A RENTAL & IS RATED AT 1 MEG WATT

3. What are the utility unit prices ?

Natural Gas 0 $/M.Cu.FT. @__psig (Not USED)

Electric 1. Energy Charge .049 $/KWH

2. Demand Charge .072 $/KW

Water .0181 $/gallon

Fuel Oil 0.37 $/gallon

4. What is the yearly costs for the following:

Chemical Costs (Total) 24,200 $

Individual chemical costs THIS IS A LUMP SUM CONTRACT FOR BOTH BOILER & COOLING SIDE, PRICE/LB IS NOT AVAILABLE.

* Maintenance Costs 155,000 $

Breakdown labor 125,000

material 30,000

Operation Personnel 650,000 $

Breakdown (12) OPERATORS, (3) EL (1) INSTR, (1) PF

Major Repairs 140,000 $

Breakdown REPAIR OF BOTH STACKS (80M)
REPAIR OF AIR TUBES (20M)
REPAIR OF BOILER BRICK (40M)

Other costs 10,000 $

Description GENERAL & MISC. REPAIRS/UPGRADES

5. Overall Costs

Total Costs	1,225,000	$, year	1993
	1,175,000	$, year	1992
	—	$, year	1991
Steam Generated	8.1 x 10^11	lbs. or (BTU), year	1993
	8.04 x 10^11	year	1992
	1145 BTU/#	year	1991
	677,824,267		
Unit Cost	2.34	$/1,000 lbs., year	1993
	2.34	year	1992
		year	1991

* DUE TO CUTBACKS IN OPERATING FUNDS 807,500,000 MOST MAINTENANCE IS BEING DELAYED.

III. Operations

1. Indicate in the following table the documentation that is used at the Heating Plant:

DOCUMENT	AVAILABLE YES	AVAILABLE NO	COMMENTS
DRAWINGS - SCHEMATICS BOILERS	X		GENERATED OUR OWN DWGS
MECHANICAL SYSTEMS	X		
ELECTRICAL BOILER ELEMENTARY	X		SOME DWGS ARE ON HAND
ELECTRICAL BUILDING	X		
ISOMETRICS		X	
GENERAL BUILDING	X		DRAWINGS ON FILE
OTHER	X		SMALL SYSTEMS
BOILER START-UP PROCEDURE	X		
PROCEDURE FOR STEAM DRUM ENTRY	X		
EMERGENCY CALL PROCEDURE	X		PART OF OUR SOP
HEATING PLANT EVACUATION PROCEDURE	X		
BOILER SAFETY OPERATION CHECKOUT PROCEDURE	X		
PROCEDURE FOR HANDLING CHEMICALS	X		
LIST OF CHEMICALS WITH MSDS	X		REQUIRED BY OSHA
CONFINED SPACE ENTRY PROCEDURE	X		
BOILER MAINTENANCE PROCEDURES	X		
EQUIPMENT MAINTENANCE PROCEDURES	X		

2. Provide information concerning the Heating Plant personnel.

a. Are personnel on duty at the Heating Plant
24 hours a day? YES
365 days a year? YES
other _____

b. Breakdown the personnel that are on duty at specific times. (WE RUN 12 HR SHIFTS)

1st Shift # of operators 3 # of supervisors 0

2nd Shift # of operators 3 # of supervisors 0

~~3rd Shift # of operators _____ # of supervisors _____~~

Are there any other personnel on duty besides operators, such as maintenance personnel? YES, THEY WORK A NORMAL 8 HR DAY SHIFT

c. What is the qualifications of the operators?

# of 1st Class Operators _____

# of 2nd Class Operators _____

# of 3rd Class Operators _____

Other qualifications STATE DOES NOT REQUIRE ANY LICENSES. A FEW DO HAVE CLASS 2

d. Do the operators receive training? YES

What kind of training? NORMAL SAFETY TRAINING & SPECIALIZED TRAINING WHEN REQUIRED.

3. Provide any information concerning engineering studies of the heating plant such as plant and/or boiler efficiencies, plant reliability/availability or other measurable function (please attach study). HAVE RAN NORMAL BOILER EFFICIENCIES ONLY. DUE TO FINANCIAL RESTRAINTS, THIS AREA IS NOT ACTIVE.

SURVEY OF CENTRAL HEATING PLANT OPERATIONS

Conducted by:

NASA

Lewis Research Center

Cleveland, Ohio

Survey Completed by:

Company Name Company B

Division _____

Address _____

_____

Contact _____

Telephone _____

Survey
of Central Heating Plant Operations

I. General Information

1. Provide brief description of Heating Plant (Type of boilers, number of boilers, general setup of heating plant, etc.).

See Above

2. Provide numerical information about Boilers at Heating Plant:

Boiler #	1	2	3	4	5	6
HP	D TYPE	D TYPE	D-TYPE	D. TYPE	D TYPE	A TYPE
Operating Pressure	280	280	280	280	280	280
BTU Input	45 MILLION BTU-HR	78 MIL	120 MILLION BTU-HR	180 MILLION BTU HR	180 MILLION BTU HR	219 MILLION BTU HR
MFG.	BROS	BROS	BROS	BROS	RILEY/BROS	NEBRASKA
Install Date	1957	1958	1960	1964	1972	1992
Fuel(s)	OIL/GAS	OIL GAS	OIL-GAS	OIL-GAS	OIL-GAS	#2 OIL-GAS
Steam Output	30,000	50,000	100,000	150,000	150,000	180,000 #/HR.

3. Provide brief description of distribution system (how many buildings or areas supplied, uses, piping arrangements, etc.)

THE HEATING PLANT PROVIDES STEAM TO 27 MAJOR BLDGS OR ABOUT 2,500,000 SQ. FT. THE STEAM PIPING IS SENT TO SITE IN FOUR DIFFERENT PIPING SYSTEMS. THEY CAN BE ISOLATED OR ALL CONNECTED.

4. Provide description of the chemical treatment system (boiler blowdown, chemicals used, injection system, softeners, etc.)

organic nonferrous boiler treatment for scale inhibition bisulfite and cobalt sulfate oxygen scavenger inhibitor for condensate routine piping steel softeners zeolite.

5. Provide description of condensate return system to the boilers (% return, economizer used, feedwater pumps, deairator tank)

95% condensate returned summer 85% in winter steam used for humidity control. 3-4-5 boilers preheaters #6 boiler economizer 4 boiler feed pumps which two are turbine drive. two deairator tanks

6. Provide description of boiler and/or burner controls (flame safeguard, diagnostic capabilities, heating plant controls, energy monitoring, energy management system, etc.)

Flame safeguard Fireye, Burner controls Boiler O2 trim on all boilers. No energy management system.

II. Loads and Costs Analysis

1. Heat Loads for Heating Plant

A. What is the average yearly load ? 1356737 M #

B. What is the average summer load ? 500000 M #

C. What is the average winter load ? 800000 M #

D. What is the maximum winter load ? 356,000 #/hr

2. What is the yearly utility use ?

Fuels:

Natural gas 1319972 M.Cu.FT.(1000 Cubic foot)@ 15 psig

Fuel Oil 1,500,000 Gallons

Electric 178524800 KWH Total site 12,000 people

Heating Plant auxiliary or support utilities:

Natural gas 19358 M.Cu.FT.(1000 Cubic foot)@ 30 psig

Fuel Oil _____ Gallons

Electric _____ KWH

3. What are the utility unit prices ?

Natural Gas $2.49 $/M.Cu.FT. @ psig

Electric 1. Energy Charge _____ $/KWH 0.0354 on Peak, 0.0258 OFF Peak

2. Demand Charge _____ $/KW 7.51 on Peak, .60 OFF PEAK

Water 1.50/1000 $/gallon

Fuel Oil .323 $/gallon

4. What is the yearly costs for the following:

Chemical Costs (Total) 175,000 $

Individual chemical costs _____

_____

_____

Maintenance Costs 500,000 $

Breakdown labor _____

material _____

Operation Personnel $1 400 000 $

Breakdown _____

_____

Major Repairs 150,000 $

Breakdown _____

_____

_____

Other costs _____ $

Description _____

_____

5. Overall Costs

Total Costs 6894,900 $, year 1993
5,083,100 $, year 1992
5320 274 $, year 1991

Steam Generated 1 356 737 M lbs. or BTU, year 1993
1298 165 M year 1992
1423006 M year 1991

Unit Cost $5.08 $/1,000 lbs., year 1993
3.92 year 1992
3.74 year 1991

III. Operations

1. Indicate in the following table the documentation that is used at the Heating Plant:

DOCUMENT	AVAILABLE YES	AVAILABLE NO	COMMENTS
DRAWINGS - SCHEMATICS BOILERS	X		
MECHANICAL SYSTEMS	X		
ELECTRICAL BOILER ELEMENTARY	X		
BUILDING	X		
ISOMETRICS			
GENERAL BUILDING			
OTHER			
BOILER START-UP PROCEDURE	X		
PROCEDURE FOR STEAM DRUM ENTRY	X		
EMERGENCY CALL PROCEDURE	X		
HEATING PLANT EVACUATION PROCEDURE	X		
BOILER SAFETY OPERATION CHECKOUT PROCEDURE	X		
PROCEDURE FOR HANDLING CHEMICALS	X		
LIST OF CHEMICALS WITH MSDS	X		
CONFINED SPACE ENTRY PROCEDURE	X		
BOILER MAINTENANCE PROCEDURES	X		
EQUIPMENT MAINTENANCE PROCEDURES	X		
Lockout / Tagout	X		

2. Provide information concerning the Heating Plant personnel.

a. Are personnel on duty at the Heating Plant
24 hours a day? yes
365 days a year? yes
other _____

b. Breakdown the personnel that are on duty at specific times.

1st Shift # of operators 3 TO 5 # of supervisors 1

2nd Shift # of operators 3 # of supervisors 1

3rd Shift # of operators 3 # of supervisors 1

Are there any other personnel on duty besides operators, such as maintenance personnel? None on 2nd OR 3 Rd SHIFT CALL IN IF Needed

c. What is the qualifications of the operators?

# of 1st Class Operators 13

# of 2nd Class Operators 1

# of 3rd Class Operators _____

Other qualifications Some FIRE PROTECTION OPERATE 22,000 Ton RFG PLANT ALONG WITH 400000 GAL THERM STOR

d. Do the operators receive training? yes

What kind of training? CONTROLS - SAFETY NEW EQUIPMENT SEMINARS

3. Provide any information concerning engineering studies of the heating plant such as plant and/or boiler efficiencies, plant reliability/availability or other measurable function (please attach study). _____

CENTER STEAM AND REFRIGERATION PLANT

The initial plant was constructed in 1957

Today it consist of:

7 Boilers:

#1 Boiler	35,000 PPH output	installed 1957
#2 Boiler	50,000 PPH output	installed 1958
#3 Boiler	100,000 PPH output	installed 1960
#4 Boiler	150,000 PPH output	installed 1964
#5 Boiler	150,000 PPH output	installed 1972
#6 Boiler	180,000 PPH output	installed 1993

450 KW diesel generator and motor generator for oil pumps

1500 GPM Natural gas fire pump and 1500 GPM electric fire pump

400,000 gallon underground fire reservoir

4 city water booster pumps

2 aboveground fuel oil storage tanks 600,000 gallon each

Condensate storage tanks and deareraters

4 boiler feed pumps, 2 electric and 2 steam turbine driven

4 electric condensate transfer pumps

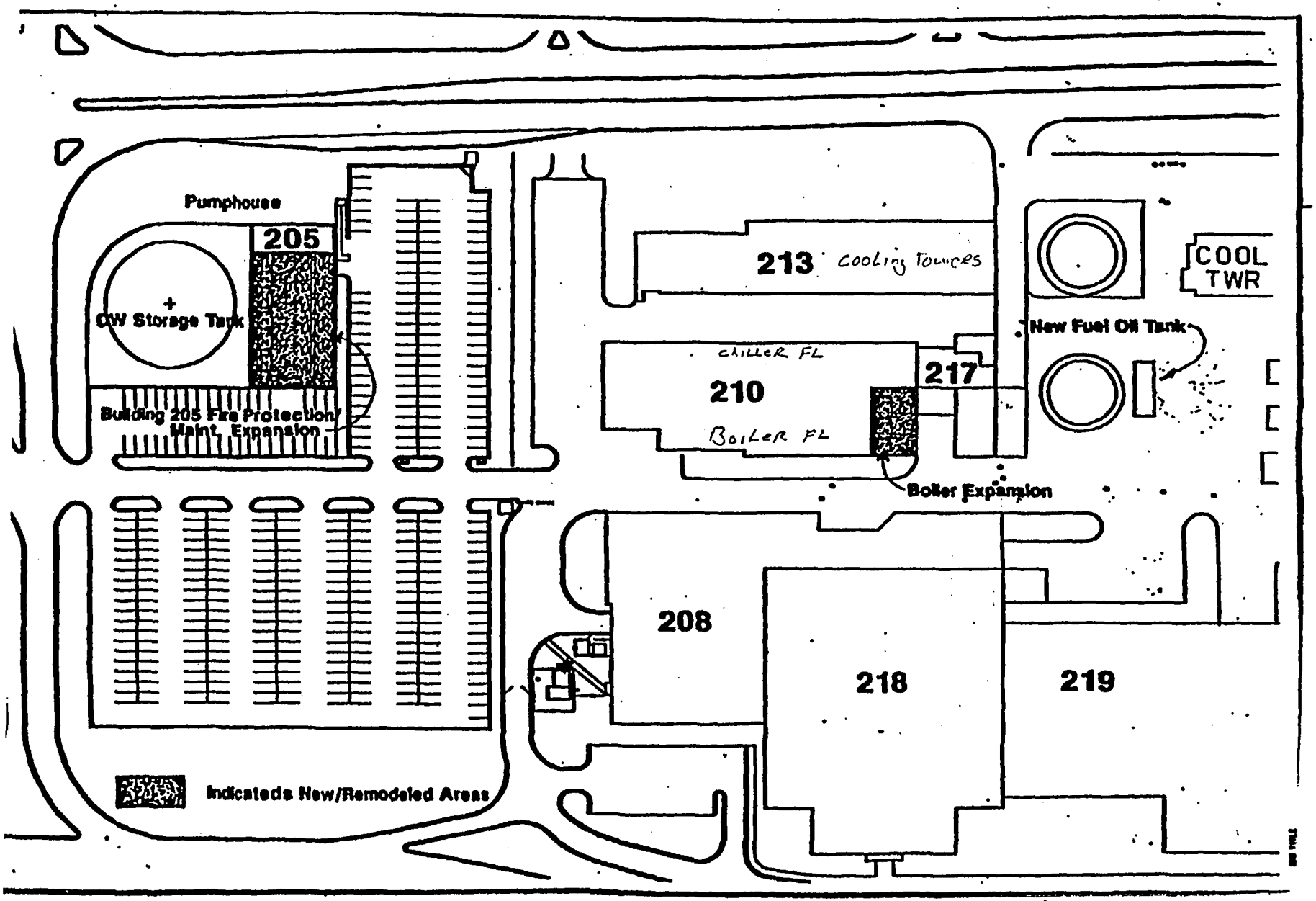
7 Chillers

#1 Chiller	2150 ton steam driven	installed 1958
#2 Chiller	2350 ton steam driven	installed 1960
#3 Chiller	3500 ton steam driven	installed 1963
#4 Chiller	3500 ton electric driven 4000 HP	installed 1965
#5 Chiller	3500 ton steam driven	installed 1968
#6 Chiller	3500 ton steam driven	installed 1969
#7 Chiller	5000 ton steam driven	installed 1976

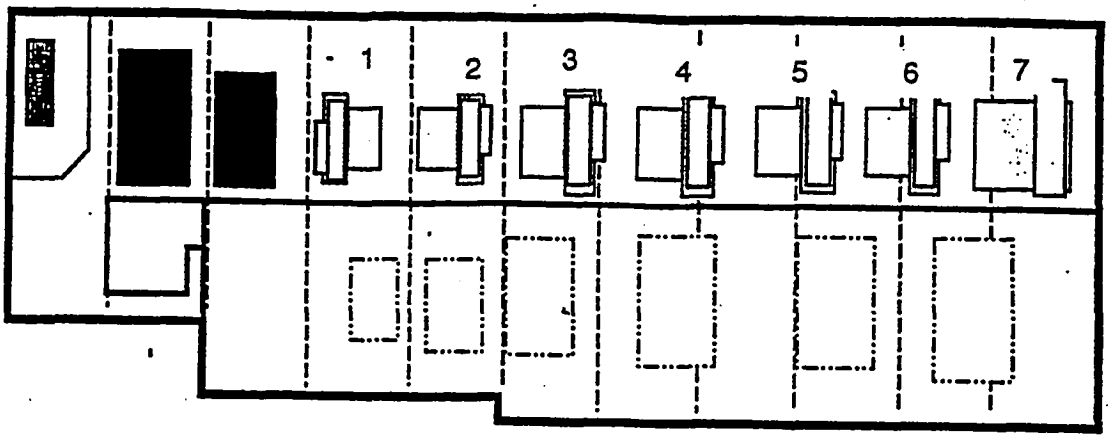
7 chilled water pumps

Cooling towers and condensing water pumps 67,000 GPM

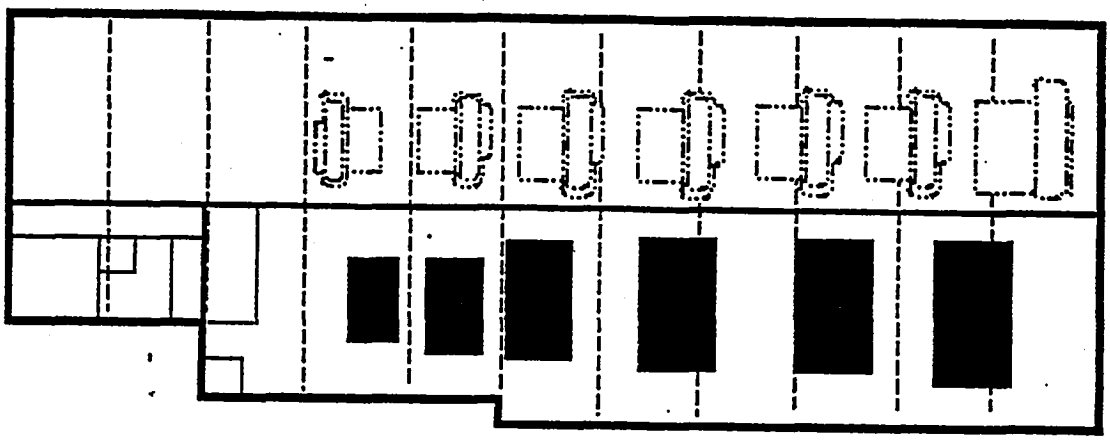
4,000,000 chilled water storage tank Rated capacity 3500 tons


Pumphouse
205
CW Storage Tank
Building 205 Fire Protection/
Maint. Expansion
213 Cooling Towers
COOL
TWR
New Fuel Oil Tank
CHILLER FL
210
BOILER FL
217
Boiler Expansion
208
218
219
Indicateds New/Remodeled Areas

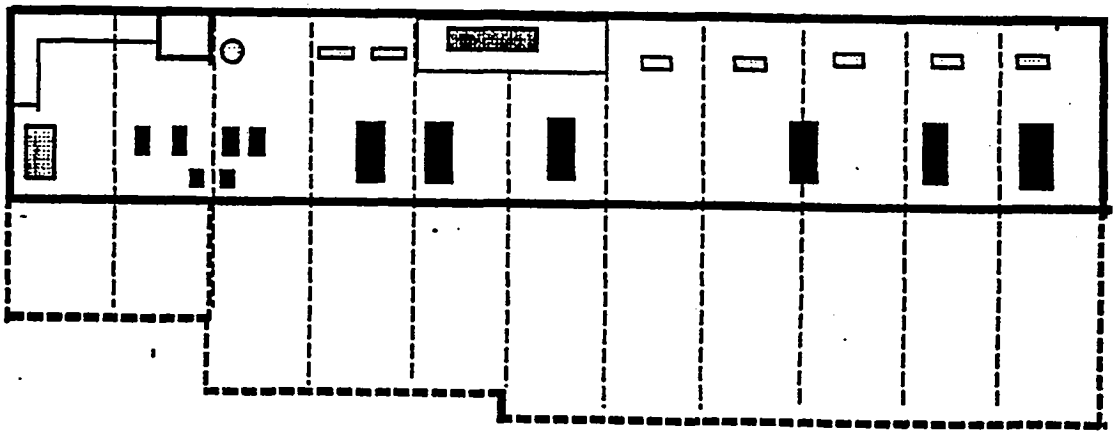
UTILITY PLANT BLDG. 210



CHILLER FLOOR



BOILER FLOOR



PUMPING & STEAM CONDENSING FLOOR

SECTION 5
STAFFING CHANGES

Existing Staffing

The has one (1) shift supervisor and three (3) operators per shift. The 7-day operation, with three (3) shifts per day, requires twenty-one (21) shift positions per week to be filled. Four (4) crews working five (5) shifts per week will only provide twenty (20) shift positions per week. Therefore, there are also two (2) relief operators working five (5) days per week for ten (10) man-days to fill the extra 21st position, which is three (3) man-days. The other seven (7) man-days of relief operator time fills in for vacations, military leaves, illness, and general maintenance. See Existing Staffing in Appendix 'D'. The existing total staff is five (5) salaried and fourteen (14) operating individuals.

Existing staffing is providing all maintenance on the following equipment with the exception of electrical and instrumentation work:

Boilers and Related Equipment
Steam Turbines and Related Equipment
Cooling Towers and Related Equipment

Annual amount of direct labor provided by the operating engineers and assistant operator for maintenance is 7,435, or 3.5 individuals.

Annual amount of direct labor provided by the operating engineers and assistant operator for housekeeping is 1,902 man-hours, or 0.91 individuals.

Shift supervisors provide supervision and assistance in many areas. A plant is normally only as good as its first level of maintenance. This plant is in excellent physical condition and great care has been taken by all present and past shift supervision. Shift foreman responsibilities include:

1. Spare parts inventory for all equipment in the plant.
2. Production of steam and chilled water to meet system demand.
3. Directing and implementing a plant safety program in the plant:

Personnel
Feedwater Quality* and Quantity*
Boiler Flame Safety System
Turbine Start-up and Shutdown*
Condenser Start-up and Shutdown*
Centrifugal Chiller Start-up and Shutdown*
Cooling Tower Start-up and Shutdown*

* Critical to Life Extension of Equipment

Correspondence

er - 220-13C
n - 42-5W #18

[redacted]

S. W. SKADSBERG - DIVISION ENGINEERING - 42-5W #18

RFEES RA-802, COMPUTER OPTIMIZATION OF INDUSTRIAL BOILER CONTROLS

NOVEMBER 29, 1978

In June of this year a representative of the Measurex Company contacted Mr. Muellers' office and requested a meeting to discuss a control system they had developed for optimizing industrial boiler performance. The request was referred to R. L. Aspenson and eventually to Division Engineering for review.

In response to subject RFEES, Measurex was invited to perform a preliminary economic analysis for computerized control of No's 3, 4, and 5 boilers at . This proposal was carefully reviewed by Division Engineering, Central Engineering and Maintenance. It was concluded that the Measurex system was an excellent control system with many desirable features but the proposed cost savings and installation costs produced a trial investment index of only 12% with a capital cost of about $400,000. Additional efforts will be deferred until changes in fuel mix and fuel prices indicate that better return on investment can be achieved.

In large part, the reason Measurex could not significantly improve the boiler plant efficiency is that we currently are operating very near optimum for these boilers. Measurex commented several times that this plant was one of the best operated and well maintained industrial systems they had visited throughout the United States. We will, of course, continue to investigate the latest available technology but it is doubtful significant improvements can be made to the steam generating efficiency at

Unless there are additional comments from you or Mr. Mueller, we will close this request.

SWS/skk

SURVEY OF CENTRAL HEATING PLANT OPERATIONS

Conducted by:

NASA

Lewis Research Center

Cleveland, Ohio

Survey Completed by:

Company Name Company C

Division _____

Address _____

_____

Contact _____

Telephone _____

Survey
of Central Heating Plant Operations

I. General Information

1. Provide brief description of Heating Plant (Type of boilers, number of boilers, general setup of heating plant, etc.).
1 OIL FIRED 80,000 PPH BOILER (N°2 F.O. ONLY)
2. GAS FIRED 80,000 PPH BOILERS W/ N°2 FUEL OIL BACK UP, AND 2 SOLID WASTE FIRED BOILERS IN AN ATTACHED INCINERATOR BUILDING. WASTE BOILERS BASE LOAD THE STEAM SYSTEM & GAS BOILERS SWING WITH LOAD. ANNUAL STEAM PRODUCTION IS 80% HEATING 20% PROCESS

2. Provide numerical information about Boilers at Heating Plant:

Boiler #	2	3	4	WBLR 1	WBLR 2
HP					
Operating Pressure	150 PSIG	→	→	→	→
BTU Input					
MFG.	UNION IRON WORKS	→	→	RILEY-BEARD/RICHMOND	
Install Date	1960	1960	1960		
Fuel(s)	N°2 OIL	GAS/OIL	GAS/OIL	SOLID WASTE	
Steam Output	80,000	80,000	80,000	20,000	20,000

3. Provide brief description of distribution system (how many buildings or areas supplied, uses, piping arrangements, etc.) S.H.
STEAM SUPPLIES COMFORT HEATING DURING COOL SEASONS AND PROCESS STEAM YEAR ROUND.
AUTOMATIC STEAM VALVES INSIDE 3,000,000 ft² BUILDING WILL ISOLATE EITHER SYSTEM

4. Provide description of the chemical treatment system (boiler blowdown, chemicals used, injection system, softeners, etc.)

BOILER HAVE AUTOMATIC BLOWDOWN CONTROLS AND MAINTAIN CONDUCTIVITY AT 2500-3000 UMHOS. USE CHELANT TYPE WATER TREATMENT W/ SULFITE OXYGEN SCAVENGERS AND D.A. TANK TO REMOVE NON-CONDENABLE GASES. CHEMICALS ARE INJECTED INTO FEED WATER PIPING. PRETREATMENT IS FROM ZEOLITE SOFTENERS

5. Provide description of condensate return system to the boilers (% return, economizer used, feedwater pumps, deairator tank)

APPROX 18 CONDENSATE RETURN STATIONS, 5 LARGE ONES ARE AIR POWERED. AN AMINE AND OXYGEN SCAVENGER IS ADDED TO STEAM TO MAINTAIN PH AND MINIMIZE ACID GENERATION. ANNUALLY 60% CONDENSTATE IS RETURNED. FROM 85% IN WINTER TO 45% IN SUMMER. COND. TEMP IN WINTER IS 190°F AND SUMMER IS 135°F

6. Provide description of boiler and/or burner controls (flame safeguard, diagnostic capabilities, heating plant controls, energy monitoring, energy management system, etc.)

COMBINATION PNEUMATIC AND ELECTRONIC BAILEY BOILER CONTROLS BEING UPGRADED AND FIREYE SAFETY CONTROLS ON MAIN BOILERS. HONEYWELL BOILER CONTROLS AND FLAME SAFETY ON WASTE BOILERS NO ENERGY MGT. SYSTEMS.

II. Loads and Costs Analysis

1. Heat Loads for Heating Plant

A. What is the average yearly load ? 425,000,000 lb

B. What is the average summer load ? 20,000 PPH

C. What is the average winter load ? 85,000 PPH

D. What is the maximum winter load ? 146,000 PPH

2. What is the yearly utility use ?

Fuels:

Natural gas 209,000 M.Cu.FT.(1000 Cubic foot)@ 15 psig

Fuel Oil 2,500,000 Gallons

Electric _____ KWH

Heating Plant auxiliary or support utilities:

Natural gas _____ M.Cu.FT.(1000 Cubic foot)@ 6 psig

Fuel Oil _____ Gallons

Electric 2,172,000 KWH

3. What are the utility unit prices ?

Natural Gas 3.95 $/M.Cu.FT. @ 15 psig

			SUMMER	WINTER
Electric	1. Energy Charge	$/KWH	@14.42	@8.32
	2. Demand Charge	$/KW	0.0263	0.0185
	3. FUEL CHARGE		0.01296	0.01296
Water		$/gallon		
Fuel Oil	0.625	$/gallon		

4. What is the yearly costs for the following:

Chemical Costs (Total) @ 140,000 $

Individual chemical costs _____

N/A

Maintenance Costs _____ $

Breakdown labor N/A

material _____

Operation Personnel 1,041,856 $

Breakdown Supv. 111,660

Hovey 930,196

Major Repairs N/A $

Breakdown _____

Other costs N/A $

Description _____

5. Overall Costs

Total Costs	2,283,068	$, year	1993
	2,481,095	$, year	1992
	2,205,770	$, year	1991
Steam Generated	431,000,000	lbs. or BTU, year	1993
	465,000,000	year	1992
	392,000,000	year	1991
Unit Cost	5.29	$/1,000 lbs., year	1993
	5.33	year	1992
	5.63	year	1991

III. Operations

1. Indicate in the following table the documentation that is used at the Heating Plant:

DOCUMENT	AVAILABLE		COMMENTS
	YES	NO	
DRAWINGS - SCHEMATICS — BOILERS	X		
MECHANICAL — SYSTEMS	X		
ELECTRICAL — BOILER ELEMENTARY	X		
ELECTRICAL — BUILDING	X		
ISOMETRICS		X	
GENERAL BUILDING	X		
OTHER			
BOILER START-UP PROCEDURE	X		
PROCEDURE FOR STEAM DRUM ENTRY	X		
EMERGENCY CALL PROCEDURE	X		
HEATING PLANT EVACUATION PROCEDURE	X		
BOILER SAFETY OPERATION CHECKOUT PROCEDURE	X		
PROCEDURE FOR HANDLING CHEMICALS	X		
LIST OF CHEMICALS WITH MSDS	X		
CONFINED SPACE ENTRY PROCEDURE	X		
BOILER MAINTENANCE PROCEDURES	X		
EQUIPMENT MAINTENANCE PROCEDURES	X		

2. Provide information concerning the Heating Plant personnel.

a. Are personnel on duty at the Heating Plant
24 hours a day? YES
365 days a year? YES
other _____

b. Breakdown the personnel that are on duty at specific times.

1st Shift # of operators 9 # of supervisors 1

2nd Shift # of operators 4 # of supervisors 1

3rd Shift # of operators 4 # of supervisors 0

Are there any other personnel on duty besides operators, such as maintenance personnel? _____

c. What is the qualifications of the operators?

# of 1st Class Operators 19

# of 2nd Class Operators _____

# of 3rd Class Operators _____

Other qualifications STATE OF MD. INCINERATOR OPERATING CERTIFICATE

d. Do the operators receive training? YES

What kind of training? ANNUAL

3. Provide any information concerning engineering studies of the heating plant such as plant and/or boiler efficiencies, plant reliability/availability or other measurable function (please attach study). _____

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13. ABSTRACT ***(Maximum 200 words)***

In recent years, Total Quality Management has swept across the country. Many companies and the Government have started looking at every aspect on how business is done and how money is spent. The idea or goal is to provide a service that is better, faster and cheaper. The first step in this process is to document or measure the process or operation as it stands now. For Lewis Research Center, this report is the first step in the analysis of heating plant operations. This report establishes the original benchmark that can be referred to in the future. The report also provides a comparison to other organization's heating plants to help in the brainstorming of new ideas. The next step is to propose and implement changes that would meet the goals as mentioned above. After the changes have been implemented the measuring process starts over again. This provides for a continuous improvement process.

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