

AD-A126 645

LIFE-CYCLE COST DATABASE VOLUME II APPENDICES E F AND G 1/3

SAMPLE DATA DEVELOPMENT (U) CONSTRUCTION ENGINEERING

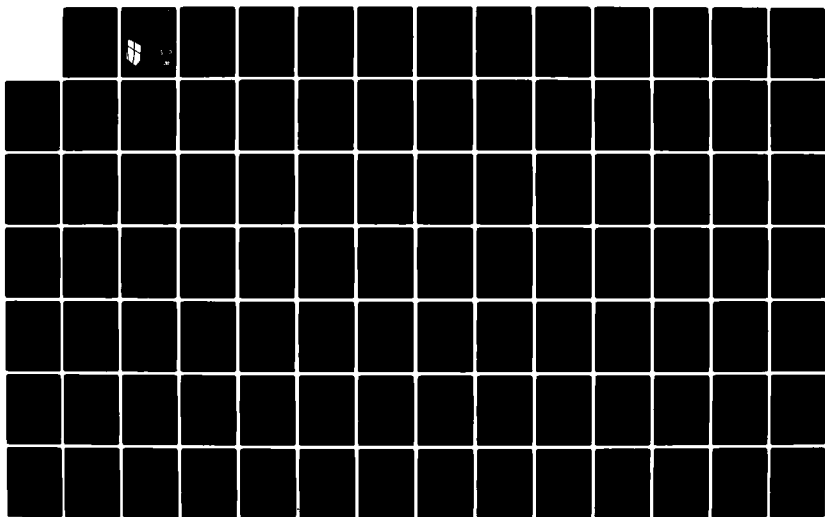
RESEARCH LAB (ARMY) CHAMPAIGN IL R D NEATHAMMER JAN 83

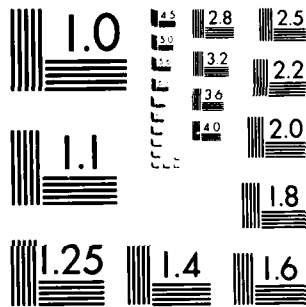
CERL-TR-P-139-VOL-2

F/G 9/2

NL

UNCLASSIFIED





MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS 1963-A

12

construction  
engineering  
research  
laboratory



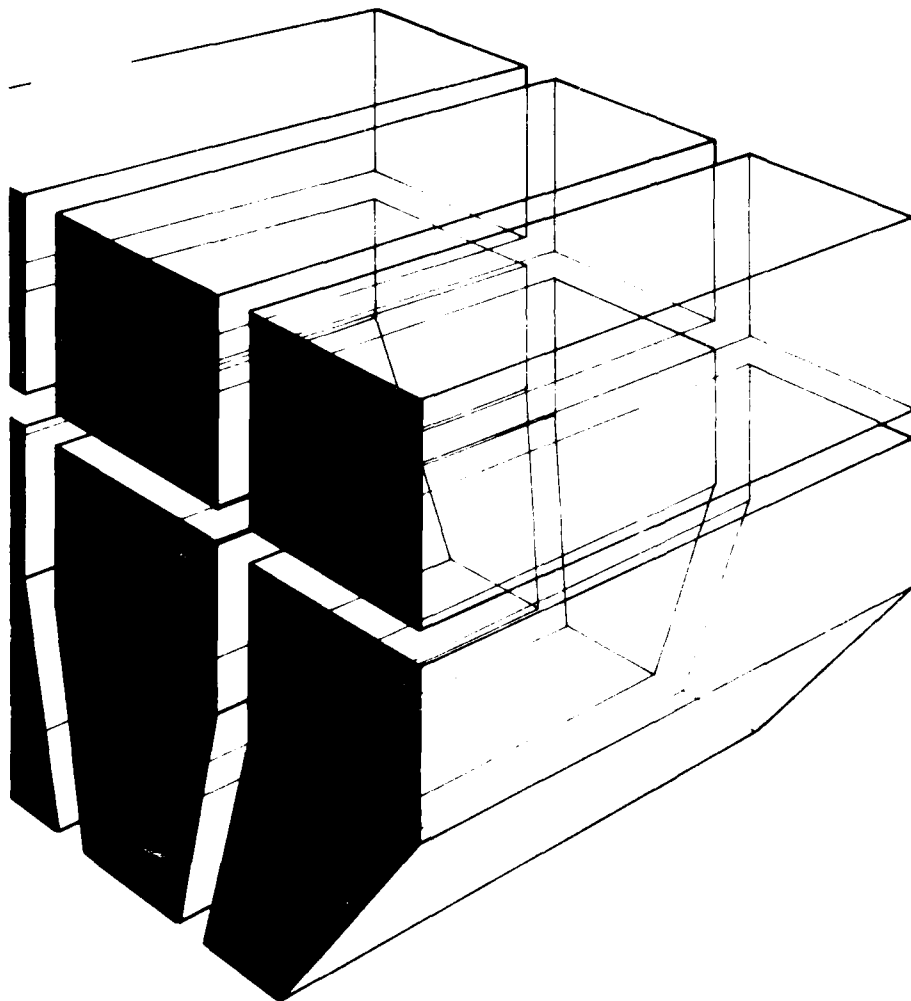
United States Army  
Corps of Engineers  
...Serving the Army  
...Serving the Nation

Technical Report P-139  
January 1983

ADA 126645

LIFE-CYCLE COST DATABASE:  
VOLUME II, APPENDICES E, F, AND G—  
SAMPLE DATA DEVELOPMENT

by  
R. D. Neathammer



DTIC  
ELECTE  
APR 12 1983  
S B D



DTIC FILE COPY

Approved for public release; distribution unlimited.

83 04 12 102

The contents of this report are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official indorsement or approval of the use of such commercial products. The findings of this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

*DESTROY THIS REPORT WHEN IT IS NO LONGER NEEDED  
DO NOT RETURN IT TO THE ORIGINATOR*

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM	
1. REPORT NUMBER CERL-TR-P-139	2. GOVT ACCESSION NO. AD A126645	3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle) LIFE-CYCLE COST DATABASE: VOLUME II, APPENDICES E, F, AND G -- SAMPLE DATA DEVELOPMENT		5. TYPE OF REPORT & PERIOD COVERED FINAL	
		6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s) R. D. Neathammer		8. CONTRACT OR GRANT NUMBER(s)	
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. ARMY CONSTRUCTION ENGINEERING RESEARCH LABORATORY P.O. BOX, CHAMPAIGN, IL 61820		10. PROGRAM ELEMENT PROJECT, TASK AREA & WORK UNIT NUMBERS 4A762731AT41-A-033	
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE January 1983	
		13. NUMBER OF PAGES 282	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified	
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE	
16. DISTRIBUTION STATEMENT (of this Report)  Approved for public release; distribution unlimited.			
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)			
18. SUPPLEMENTARY NOTES  Copies are obtainable from the National Technical Information Service Springfield, VA 22161			
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)  life cycle costs buildings data bases			
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)  This report provides sample data developed for life-cycle cost (LCC) databases for use in computing design alternatives for military construction. Sample data was developed for heating, ventilating, and air-conditioning systems, floor covering systems, and cooling generating systems.  Volume I of this report documented the research done to design the LCC databases and investigated the feasibility of using analytical methods to			

DD FORM 1473  
1 JAN 73

EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

BLOCK 20. (CONT'D)

develop information for the databases. This analysis showed that use of Engineered Performance Standards is the best way to obtain the data.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

FOREWORD

This research was conducted for the Assistant Chief of Engineers, under RDT&E Program 6.27.31A, Project 4A762731AT41, "Military Facilities Engineering Technology"; Task A, "Planning and Design"; Work Unit 033, "Military Facilities Life Cycle Cost Data Base Design."

This work was performed by the Facilities Systems Division (FS) of the U.S. Army Construction Engineering Research Laboratory (CERL), and under contract by Bendix Field Engineering Corporation, Planned Maintenance, Inc., and Service Engineering Associates.

Dr. Larry Schindler, DAEN-ECE-G, was the Technical Monitor. Administrative support was provided by Mr. E. A. Lotz, Chief of FS.

COL Louis J. Circeo is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.

By _____	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
<b>A</b>	



CONTENTS

	<u>Page</u>
DD FORM 1473	1
FOREWORD	3
APPENDIX E: Bendix Field Engineering Report on HVAC Systems	5
APPENDIX F: Planned Maintenance, Inc., Report on Floor Covering Systems	53
APPENDIX G: Service Engineer Associates, Inc., Report on Cooling Generating Systems	71
DISTRIBUTION	



APPENDIX E

BENDIX FIELD ENGINEERING REPORT ON HVAC SYSTEMS

Prepared by:

Bendix Field Engineering Corporation  
Columbia, Maryland 21045

## CONTENTS

	<u>Page</u>
GENERAL	8
Introduction	
Objective	
Engineering Survey	
SYSTEM DESCRIPTION	8
General	
Air Handling Unit	
Unit Heater	
Exhaust Fans	
Heat Exchanger	
Boiler	
Air Separator, Compression Tank	
Electric Hot-Water Heating	
Dual-Temperature Pump	
MAINTENANCE OF HEATING SYSTEMS	11
General	
Task Time Worksheet	
Preventive Maintenance Task Time Sheets	
Repair Time Task Sheets	
MAINTENANCE AND REPAIR REQUIREMENTS MASTER SCHEDULES	45
CONCLUSION	48
REFERENCES	49

TABLES

<u>Number</u>		<u>Page</u>
4.1	Manpower Requirements	46
4.2	Material Requirements	47
E1	Travel Time	50
E2	Craft Allowance	51

HEATING SYSTEM MAINTENANCE AND REPAIR REQUIREMENTS  
U.S. ARMY ADMINISTRATION BUILDING

1. GENERAL

1.1 INTRODUCTION

The selection of any system should be based on a compromise between its performance and its economic merits. The system selected is usually determined by the application, designer's experience, code requirements, construction costs, energy usage, and the projected operating costs. Most often, the maintenance and repair portion of the operating costs are not clearly identified. The Department of the Army, Construction Engineering Research Laboratory conducted research to determine maintenance and repair requirements at a number of their facilities. It was found that available historical data is not adequate for determination of these requirements. The presented approach analyzes typical U.S. Army Administrative Building heating system maintenance and repair requirements on the basis of Army Engineered Performance Standards TB 420-2, 8, and 9 and manufacturer's procedures.

1.2 OBJECTIVE

The overall objective of the analysis is to generate manpower and material data base requirements for the maintenance and repair of a heating system in a typical administrative type building over a 25-year period.

1.3 ENGINEERING SURVEY

An on-site survey was conducted by Bendix Field Engineering Corporation of the Administration and Supply Building Number 25424 at Fort Gordon, Georgia. The building and equipment description and data are summarized in section 2.

2. SYSTEM DESCRIPTION

2.1 GENERAL

The typical company administrative and storage building is a one-story concrete masonry structure of approximately 24,000

square feet. Of this, 5,000 square feet are air conditioned. The building is divided into five identical units and a common mechanical room. The total exterior wall area of 6,000 square feet includes 2,000 square feet of uninsulated glass windows. Generally, the building is occupied by 10 people, Monday through Friday, from 7:30 a.m. to 5:00 p.m.

Chilled water and hot water are supplied from a central power plant. A heat exchanger and pumping system are provided in the mechanical room. The administrative offices are air conditioned by an air-handling unit. The unit storage and training areas are only heated and six unit heaters are provided for this purpose. Exhaust fans provide ventilation for equipment and toilet rooms. Electric hot-water heaters are furnished for lavatories. This report includes analysis on an alternate hot water boiler. Since the design features of equipment vary with the manufacturer, specific technical details are not covered.

## 2.2 AIR-HANDLING UNIT

The air-handling unit used for heating and cooling consists of a 3/4 hp, 1845 cfm @ 0.4" SP fan section; a 48,700 Btuh cooling and 25,000 Btuh heating dual temperature coil; and an outdoor air economizer arrangement.

Throw-away filters are provided. The motor has a V-belt drive. Centrifugal fan shaft bearings are self-aligning ball bearings and are grease lubricated. The motor has oiling sleeve bearings.

Automatic controls consist of a room temperature controller, a changeover thermostat, a modulating 3-way water valve, an economizer thermostat, and modulating dampers.

## 2.3 UNIT HEATERS

Six propeller fan unit heaters (down-blow type) are furnished in the storage area. Heaters have a 10,000 Btuh hot water coil and a 1/30 hp blower.

Motor bearings require repacking every ten years with electric motor ball bearing grease. If a sleeve bearing motor is provided, periodic oiling is not required. The unit heater thermostat provides on-off operation. The hot water valve is controlled by an aquastat on the water supply.

#### 2.4 EXHAUST FANS

Roof ventilators are used for toilet and storage areas. A centrifugal wall exhaust is used for the common mechanical room.

<u>Area Served</u>	<u>CFM</u>	<u>S.P.</u>	<u>REMARKS</u>
Toilets	150	0.10"	Roof type 2/B.D. dampers
Mechanical room	960	0.10"	Wall type w/B.D. damper and grille
Storage room	3125	0.10"	Roof type w/B.D. dampers

All the motors have V-belt drive. Ventilator bearings are permanently lubricated. The motors have oiling sleeve bearings.

#### 2.5 HEAT EXCHANGER (Not applicable if alternate is used)

A shell and tube heat exchanger is provided to heat 55-gal/min low-temperature water from 180<sup>0</sup> to 200<sup>0</sup> F and to transfer 550,000 Btuh from high-temperature water furnished from a central plant at 230<sup>0</sup> F.

A manual changeover switch provides selection of heating and cooling mode and switches ports on a 3-way valve to select hot-water or chilled water, respectively. A dual-bulb thermostat resets hot-water temperature as the ambient temperature varies.

#### 2.6 BOILER (Alternate)

An 18.6 hp sectional cast iron boiler is used if hot water is not available from the central plant. The boiler requires a 5.55 gal/hr light oil burner and a 2000 gallon fuel oil storage tank. The boiler is of the same capacity if an electric, gas, or coal fired burner is used. In addition to the controls discussed for the heat exchanger (paragraph 2.5), controls to include a draft control, a feed water regulator, a low-water fuel cut-off, a safety valve, and combustion safeguards.

## 2.7 AIR SEPARATOR, COMPRESSION TANK, ETC.

The air separator/strainer, compression tank, make-up water valves, etc. are designed to last the entire life of the system. Only an operational check is required to determine water level and ensure that the system is free of air.

## 2.8 ELECTRIC HOT-WATER HEATERS

Two 10-gallon, 9-kW electric heaters are provided for the lavatories.

## 2.9 DUAL-TEMPERATURE PUMP

A centrifugal dual-temperature pump is furnished and has a 7.5 hp motor and a capacity of 55 gal/min at 100 ft-hd. The casing and bearing housing are cast iron with mechanical shaft seals, bronze impeller and shaft sleeve, ball bearings, and closed coupled pump motor.

A magnetic starter on the pump is interlocked with the converter.

# 3. MAINTENANCE OF HEATING SYSTEMS

## 3.1 GENERAL

The maintenance and repair requirements, manpower, and material for a heating system of a typical U.S. Army administration building are presented. The analysis is based on the U.S. Army Engineered Performance Standards, manufacturer's recommendations, and established trade practices.

In order to develop the required data, maintenance and repair tasks of each system are tabulated for the type, quantity, steps in operations from the beginning of work to its completion, leveled times, and the frequency of occurrence. Total manhours include adjustments for travel time, craft allowance, and job preparation.

The repair frequencies are listed for the average life of the components for 24 hours a day cyclical operation. All the heating equipment is assumed to operate 187 days a year based on the average weather information for 40 major U.S. cities (Reference: Air Force Manual 88-29). Air handling equipment, dual temperature pump and temperature controls are listed for year around operation.

## 3.2 TASK TIME WORKSHEET

### 3.2.1 Selection of Tasks

Maintenance and repair tasks were selected based on the Department of the Army technical manuals TM 5-643, Preventive Maintenance for Heating Plants and Systems; TB 420-8, Heating, Cooling, & Ventilating Handbook; TB 420-9, Heating, Cooling, & Ventilating Formulas; equipment manufacturer's maintenance and service manuals; and experience.

### 3.2.2 Operations

Depending on the task description, work content and the required operations were identified. The operations include the effects of variables representative of the task area; e.g., size, quantity, capacity, and duty cycle under average operating conditions. Extreme conditions may affect the tasks and frequencies.

### 3.2.3 Task Time

The work content of the tasks and operations was compared with the tasks listed in U.S. Army Engineered Performance Standards handbook, formulas based on the statement of the operation, and the variables which make up each task. Time for the particular task and operation was calculated using the rate of occurrence. Manhours were computed in terms of leveled time for a heating mechanic. Leveled time is the time required for a qualified craftsman, following a prescribed method and working at a normal pace without interrupting delays, to complete the work.

### 3.2.4 Lost-Time Allowance

The leveled time of the task was adjusted for allowances for travel, job preparation and craft allowance from Tables E1, E2, and E3. A percentage adjustment was used for scheduled activities and straight manhours were applied for emergency repairs. Using an average of 0.85 hour round trip travel time and 0.3 hour job preparation allow-



ance for a heating mechanic, 1.15 hours or 17 percent of an 8-hour day was added to 18 percent craft allowance giving a total 35 percent lost time.

$$\begin{aligned} \text{Lost Time} &= \text{Travel Time} + \text{Job Preparation} \\ &\quad + \text{Craft Allowance} \\ &= 0.85 \text{ hr} + 0.3 \text{ hr} + 0.18 (\text{Task Time}) \end{aligned}$$

Thus, for an eight-hour day:

$$\begin{aligned} \text{Task Time} &= 8 \text{ Hours} - \text{Lost Time} \\ \text{Task Time} &= 8 - 0.85 - 0.3 - 0.18 \times \text{Task Time} \\ &= 6.85 - 0.18 \times \text{Task Time} \\ &= \frac{6.85}{1.18} = 5.81 \text{ Hours} \end{aligned}$$

Lost Time = 2.19 Hours or 27.4%

Example

$$\text{Leveled Unit Time} = t$$

$$\begin{aligned} \text{Quantity (number of units)} &= n \\ &(\text{number of units}) \end{aligned}$$

$$\text{Task Time} = t \times n$$

Scheduled Maintenance (Preventive Maintenance):

$$\text{Lost Time Allowance} = 0.274 \times t \times n$$

$$\begin{aligned} \text{Total Time} &= \text{Task Time} + \text{Lost} \\ &\quad \text{Time Allowance} \end{aligned}$$

$$= 1.274 \times t \times n$$

Unscheduled Maintenance (Repairs):

$$\text{Craft Allowance} = 0.18 \times t \times n$$

$$\text{Job Preparation} = 0.3$$

$$\text{Travel Time} = 0.85 (0.9)$$

$$\text{Total Time} = 1.2 + 0.18 \times t \times n$$

3.3 PREVENTIVE MAINTENANCE TASK TIME SHEETS

PRECEDING PAGE BLANK-NOT FILMED

TITLE: Air-handling Unit AHU-1

TYPE: 4-ton Cooling & Heating

QUANTITY: 5

TASK:

I. PRESEASON MAINTENANCE

Task includes: Spring and Fall cleaning, lubricating, filters and belt replacement, adjusting, and operational check.

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Move scaffold	0.040
2	Climb up and down scaffold	0.114
3	Start/stop unit	0.026
4	Remove and reinstall screws	0.321
5	Remove and reinstall panels	0.036
6	Remove and reinstall belt guard	0.026
7	Loosen and tighten motor mounting bolts	0.054
8	Clean fan	0.388
9	Clean heating and cooling coils	0.548
10	Clean air plenum	0.210
11	Inspect fan and motor	0.084
12	Grease bearings	0.024
13	Remove and replace belts	0.026
14	Adjust fan pulley	0.071
15	Adjust belt tension	0.013
16	Clean and lubricate dampers	0.177
17	Remove and reinstall disposable filters	0.052
18	Check and adjust thermostat and controls	0.168
19	Check operation	0.016
20	Fill out inspection report	0.014
	Unit Time	2.408
	Task Time	12.04
	Lost Time Allowance (27.4%)	3.29
		15.33

Materials:

<u>Item</u>	<u>Quantity</u>
Filters	5 set
Belts	5 matching sets

## II. MIDSEASON PREVENTIVE MAINTENANCE

Task includes: Minor cleaning, lubricating, minor adjustment, and inspection.

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Move scaffold	0.040
2	Climb up and down scaffold	0.114
3	Remove and reinstall screws	0.285
4	Remove and reinstall panels	0.036
5	Inspect fan and motor	0.084
6	Grease bearings	0.024
7	Adjust belt tension	0.071
8	Replace disposable filters	0.052
9	Fill out inspection report	0.014
	Unit Time	0.720
	Task Time	3.6
	Lost Time Allowance	<u>0.99</u>
	Total Time	4.59

### Materials:

<u>Item</u>	<u>Quantity</u>
Filters	5 sets

- Reference:
1. Technical Bulletin TB 420-8, VT-37, VT-38, and VT-51.
  2. Airtherm Bulletin 01-ISM, Installation, Start-up and Maintenance Instructions.

TITLE: Unit Heaters UH-1 to 6

TYPE: 10 MBH Electric

QUANTITY: 30

TASK:

I. PRE AND MIDSEASON MAINTENANCE

Task includes: Clean and inspect unit heater in place.

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Move scaffold	0.020
2	Climb up and down scaffold	0.057
3	Remove and reinstall screws	0.178
4	Remove and reinstall panel	0.059
5	Lubricate motor	0.012
6	Clean motor	0.084
7	Wire brush coils	0.084
8	Clean housing	0.084
9	Check and adjust thermostat and controls	0.084
10	Fill out inspection report	<u>0.014</u>
	Unit Time	0.676
	Task Time	20.28
	Lost Time Allowance	<u>5.56</u>
	Total Time	25.84

- Reference:
1. Technical Bulletin TB 420-8, VT-277.
  2. Modine Bulletin 1-501.6, Installation and Maintenance.

TITLE: Exhaust Fan EF-1 to -3

TYPE: Fractional hp with Backdraft Damper

QUANTITY: 16

TASK:

I. SEMI-ANNUAL PREVENTIVE MAINTENANCE

Task includes: Cleaning, lubricating, belt replacement, and inspection.

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Move ladder	0.020
2	Climb up and down ladder	0.071
3	Remove and reinstall screws	0.285
4	Remove and reinstall cover	0.036
5	Loosen and tighten motor mounting bolts	0.054
6	Remove and replace belt	0.026
7	Inspect fan and motor	0.084
8	Clean fan	0.388
9	Lubricate bearings	0.024
10	Adjust fan pulley	0.071
11	Adjust belt tension	0.013
12	Start/stop unit	0.026
13	Check operation	0.008
14	Clean and lubricate backdraft damper	0.059
15	Fill out inspection report	0.014
	Unit Time	1.179
	Task Time	18.86
	Lost Time Allowance	5.17
	Total Time	24.03

Materials:

<u>Item</u>	<u>Quantity</u>
Belts	16

TITLE: Exhaust Fan EF-1 to -3

TYPE: Fractional hp with Backdraft Damper

QUANTITY: 16

TASK:

I. MIDSEASON PREVENTIVE MAINTENANCE

Task includes: Cleaning, lubricating, and inspection.

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Move ladder	0.020
2	Climb up and down ladder	0.071
3	Remove and reinstall screws	0.285
4	Remove and reinstall cover	0.036
5	Inspect fan and motor	0.084
6	Clean fan	0.388
7	Lubricate bearings	0.024
8	Adjust fan pulley	0.071
9	Clean and lubricate backdraft damper	0.059
10	Fill out inspection report	0.014
	Unit Time	<u>1.052</u>
	Task Time	16.83
	Lost Time Allowance	<u>4.61</u>
	Total Time	21.44

- Reference:
1. Technical Bulletin, TB 420-8, VT-49.
  2. Carnes 1302-G, Maintenance Instructions.
  3. Pace-DD Cabinet Exhaust Units, Installation-Maintenance-Parts List.

TITLE: Dual Temperature Pump DTP-1

TYPE: 7-1/2 hp Base-mounted Centrifugal

QUANTITY: 1

TASK:

I. QUARTERLY PREVENTIVE MAINTENANCE

Task includes cleaning, lubricating, and operational check.

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Clean, lubricate, and inspect motor	0.096
2	Clean, lubricate, and inspect pump	0.096
3	Clean strainer	0.022
4	Fill out inspection report	0.014
	Task Time	<u>0.228</u>
	Lost Time Allowance	<u>0.062</u>
	Total Time	0.290

Reference: 1. Technical Bulletin, TB 420-8, VT-72.

2. Paco Instruction Sheet, 1404-610 and Parts List A1d.1.



TITLE: Heat Exchanger, Piping, Valves, and Controls

TYPE: 550 MBH Water-to-water

QUANTITY: 1

TASK:

I. QUARTERLY HEATING SEASON MAINTENANCE

Task includes inspection, adjustments, and operational checks.

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Check for water leaks and damage	0.063
2	Open/close all valves (10)	0.430
3	Check/adjust thermostat	0.084
4	Inspect mechanical room for cleanliness. Correct hazardous conditions.	0.028
5	Fill out inspection report	0.014
	Task Time	0.619
	Lost Time Allowance	0.170
	Total Time	0.789

Reference: 1. Technical Bulletin, TB 420-8, VT-280.

2. The Sims Co. Drawing No. 8876X.

TITLE: Hot-water Boiler

TYPE: 18.6 HP Sectional CI

QUANTITY: 1

TASK:

I. END OF HEATING SEASON MAINTENANCE

Task would include inspection, adjustment, and operational checks.

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Drain, flush, and fill boiler	0.56
2	Clean external (fireside) surfaces	1.19
3	Clean backdraft damper and breeching	0.21
4	Clean and overhaul burner and accessories	0.88
5	Test all automatic controls including feed-water regulator, low-water fuel cut-off, safety valve, and combustion safeguards	0.54
6	Inspect for leaks and hot spots and fill out inspection report	0.67
	Task Time	4.05
	Lost Time Allowance	1.11
	Total Time	5.16

- Reference:
1. Technical Bulletin TB 420-8, VT-204, 205, and 233.
  2. Technical Bulletin TB 420-9, PWV-13.
  3. Factory Mutual Publication No. P6503.

II. PRE & MIDSEASON INSPECTION

Task includes inspection and operational checks.

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Test all automatic controls including feed-water regulator, low-water cut off, safety valve, and combustion safeguard	0.54

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
2	Fill out inspection report	<u>0.014</u>
	Task Time	0.554
	Lost Time Allowance	<u>0.152</u>
	Total Time	0.706

Note: Warmup period is not included because the mechanic can do other jobs in the mechanical room during this time.

- Reference:
1. Technical Bulletin TB 420-8, VT-204.
  2. Weil McLain No. 76 Boiler Service Instructions.
  3. Factory Mutual Publication No. P6503.

### III. ASSIST BOILER INSPECTOR

Task includes assisting boiler inspector in internal, external, hydrostatic and operating test inspections.

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	External inspection	0.310
2	Internal inspection	0.577
3	Hydrostatic test	0.907
4	Operating test	<u>0.344</u>
	Task Time	2.138
	Lost Time Allowance	<u>.586</u>
	Total Time	2.724

- Reference:
1. Technical Bulletin TB 420-9, PWV-14.
  2. Factory Mutual Publication No. P6503.

TOOLS AND SUPPLIES ARE NOT LISTED

SUMMARY OF PREVENTIVE MAINTENANCE REQUIREMENTS  
( IN MANHOURS )

Equipment Description	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Annual
Air-handling Unit	15.33	4.59	15.33	4.59	39.84
Unit Heaters	25.84	-	25.84	25.84	77.52
Exhaust Fan	24.03	21.44	24.03	21.44	90.94
Heat Exchanger	0.79	-	0.79	0.79	2.37
Pump	0.29	0.29	0.29	0.29	1.16
Hot-water Boiler	<u>5.16</u>	<u>2.73</u>	<u>0.71</u>	<u>0.71</u>	<u>9.31</u>
Totals	71.44	29.05	66.99	53.66	221.14

3.4 REPAIR TASK TIME SHEETS

PRECEDING PAGE BLANK-NOT FILMED

TITLE: Air Handling Unit AHU-1

TYPE: 4-ton Cooling/Heating

QUANTITY: 5

TASK: Repairs - Remove and reinstall components

I. REPLACE MOTOR

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Move scaffold	0.040
2	Climb up and down scaffold	0.057
3	Remove and reinstall screws	0.071
4	Remove and reinstall panel	0.026
5	Start/stop unit	0.026
6	Disconnect wiring to motor	0.009
7	Remove and reinstall base bolts	0.087
8	Remove and reinstall motor	0.018
9	Remove and reinstall belt	0.026
10	Check operation of motor	0.167
11	Special material handling	0.110
12	Fill out service report	<u>0.014</u>
	Task Time	0.651
	Craft Allowance	0.117
	Job Preparation	0.3
	Travel Time	<u>0.9</u>
	Total Time	1.968

Frequency of Occurrence: 10 years

- Reference:
1. Technical Bulletin TB 420-8, VT-7.
  2. Airtherm Bulletin 01-ISM, Installation Start-up and Maintenance Instructions.

II. REPLACE BEARINGS

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Move scaffold	0.040
2	Climb up and down scaffold	0.057
3	Remove and reinstall screws	0.071
4	Remove and reinstall panel	0.026
5	Stop/start unit	0.026
6	Remove and reinstall bearing bolts	0.131
7	Remove and reinstall shaft bearings	0.146
8	Check operation of unit	0.167
9	Special material handling	0.110
10	Fill out service report	<u>0.014</u>
	Task Time	0.788
	Craft Allowance	0.142
	Job Preparation	0.3
	Travel Time	<u>0.9</u>
	Total Time	2.13

Frequency of Occurrence: 3 years

Reference: 1. Technical Bulletin TB 420-8, VT-18.

2. Airtherm Bulletin 01-ISM, Installation, Start-up and Maintenance Instructions.

III. REPLACE PULLEY/SHEAVE

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Move scaffold	0.040
2	Climb up and down scaffold	0.114
3	Remove and reinstall screws	0.036
4	Remove and reinstall belt guard	0.026

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
5	Loosen and tighten motor bolts	0.054
6	Remove and reinstall belt	0.026
7	Remove and reinstall pulley shaft bearings	0.073
8	Remove and reinstall pulley	0.146
9	Adjust fan motor pulley	0.071
10	Check operation of unit	0.167
11	Special material handling	0.110
12	Fill out service report	<u>0.014</u>
	Task Time	0.877
	Craft Allowance	0.158
	Job Preparation	0.3
	Travel Time	<u>0.9</u>
	Total Time	2.235

Frequency of Occurrence: 10 years

- Reference:
1. Technical Bulletin TB 420-8, VT-18.
  2. Airtherm Bulletin 01-ISM, Installation, Start-up and Maintenance Instructions.

IV. REPLACE THERMOSTAT

(Applicable for AHU, Economizer, UH and Heat Exchanger)

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Remove and reinstall cover screws	0.036
2	Remove and reinstall thermostat cover	0.004
3	Remove and reinstall thermostat mounting screws	0.072
4	Disconnect/connect wiring	0.018
5	Wait for unit to cycle	0.167



<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
6	Calibrate thermostat	0.026
7	Check operation of unit	0.167
8	Special material handling	0.110
9	Fill out service report	<u>0.014</u>
	Task Time	0.614
	Craft Allowance	.111
	Job Preparation	0.3
	Travel Time	<u>0.9</u>
	Total Time	1.925

Frequency of Occurrence: 10 years, Quantity 10

Reference: Technical Bulletin TB 420-8, VT-294.

V. REPLACE ACTUATOR (Valve/Damper)

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Move scaffold	0.040
2	Climb up and down scaffold	0.057
3	Remove and reinstall mounting bolts (including actuator arm)	0.026
4	Disconnect/connect wiring	0.036
5	Adjust travel	0.071
6	Check operation of units	0.167
7	Special material handling	0.110
8	Fill out service report	<u>0.014</u>
	Task Time	0.521
	Craft Allowance	0.094
	Job Preparation	0.3

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
	Travel Time	<u>0.9</u>
	Total Time	1.815

Frequency of Occurrence: 5 years, Quantity 20

Reference: Technical Bulletin TB 420-8.

VI. REPLACE ELECTRICAL RELAYS/CONTACTORS/COILS

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Remove and reinstall cover	0.026
2	Disconnect/connect wiring	0.018
3	Remove and reinstall relay/contactors/coils	0.026
4	Check unit operation	0.167
5	Special material handling	0.110
6	Fill out service report	<u>0.014</u>
	Task Time	0.361
	Craft Allowance	0.065
	Job Preparation	0.3
	Travel Time	<u>0.9</u>
	Total Time	1.626

Frequency of Occurrence: 4 years, Quantity 20

Reference: Technical Bulletin TB 420-8.

TITLE: Unit Heaters UH-1 to -6

TYPE: 10 MBH Electric

QUANTITY: 30

TASK: Repairs - Remove and Reinstall Components

I. REPLACE MOTOR

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Move scaffold	0.02
2	Climb up and down scaffold	0.114
3	Remove and reinstall screws	0.178
4	Remove and reinstall motor mountings	0.146
5	Remove and reinstall assembly and fan	0.381
6	Clean housing	0.137
7	Remove and reinstall motor and fan	0.381
8	Turn unit off/on	0.026
9	Disconnect/reconnect wiring to motor	0.018
10	Check operation of motor	0.167
11	Special material handling	0.110
12	Fill out service report	<u>0.014</u>
	Task Time	1.692
	Craft Allowance	.305
	Job Preparation	0.3
	Travel Time	<u>0.9</u>
	Total Time	3.197

Frequency of Occurrence: 5 years

Reference: 1. Technical Bulletin TB 420-8, VT-280.

2. Modine Bulletin 1-501.6, Installation and Maintenance.

- II. REPLACE THERMOSTAT  
Same as AHU, Quantity 15  
(Refer to page 21)
- III. REPLACE ACTUATOR  
Same as AHU, Quantity 5  
(Refer to page 22)
- IV. CONTACTOR/RELAYS  
Same as AHU, Quantity 5  
(Refer to page 23)

TITLE: Exhaust Fan EF-1 to -3

TYPE: Fractional HP with Backdraft Damper

QUANTITY: 16

TASK: Repairs - Remove and Reinstall Components

I. REPLACE MOTOR

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Move ladder	0.020
2	Climb up and down ladder	0.071
3	Remove and reinstall screws	0.071
4	Remove and reinstall cover	0.026
5	Start/stop unit	0.026
6	Disconnect/reconnect to motor	0.009
7	Remove and reinstall base bolts	0.087
8	Remove and reinstall motor	0.018
9	Remove and reinstall belt	0.026
10	Check operation of motor	0.167
11	Special material handling	0.110
12	Fill out service report	<u>0.014</u>
	Task Time	0.645
	Craft Allowance	0.116
	Job Preparation	0.3
	Travel Time	<u>0.9</u>
	Total Time	1.961

Frequency of Occurrence: 5 years

- Reference:
1. Technical Bulletin TB 420-8, VT-7.
  2. Carnes 1302-G, Maintenance Instructions.
  3. Pace-DD Cabinet Exhaust Units, Installation-Maintenance-Parts List.

## II. REPLACE BEARINGS

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Move ladder	0.020
2	Climb up and down ladder	0.071
3	Remove and reinstall screws	0.071
4	Remove and reinstall cover	0.026
5	Stop/start units	0.026
6	Remove and reinstall bearing bolts	0.131
7	Remove and reinstall shaft bearings	0.146
8	Check operation of unit	0.167
9	Special material handling	0.110
10	Fill out service report	<u>0.014</u>
	Task Time	0.782
	Craft Allowance	0.141
	Job Preparation	0.3
	Travel Time	<u>0.9</u>
	Total Time	2.123

Frequency of Occurrence: 3 years

- Reference:
1. Technical Bulletin TB 420-8, VT-18.
  2. Carnes 1302-G, Maintenance Instructions.
  3. Pace-DD Cabinet Exhaust Units, Installation-Maintenance-Parts List.

### III. REPLACE PULLEY/SHEAVE

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Move ladder	0.020
2	Climb up and down ladder	0.071
3	Remove and reinstall screws	0.036
4	Remove and reinstall cover	0.026
5	Loosen and tighten motor bolts	0.054
6	Remove and reinstall bolts	0.026
7	Remove and reinstall pulley shaft bearing	0.073
8	Remove and reinstall pulley	0.146
9	Adjust fan motor pulley	0.071
10	Check operation of unit	0.167
11	Special material handling	0.110
12	Fill out service report	<u>0.014</u>
	Task Time	0.814
	Craft Allowance	0.147
	Job Preparation	0.3
	Travel Time	<u>0.9</u>
	Total Time	2.161

Frequency of Occurrence: 10 years

- Reference:
1. Technical Bulletin TB 420-8, VT-18.
  2. Carnes 1302-G, Maintenance Instructions.
  3. Pace-DD Cabinet Exhaust Units, Installation-Maintenance-Parts List.

IV. REPLACE SWITCH

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Remove and reinstall screws	0.036
2	Disconnect and reconnect wires	0.018
3	Remove and install switch	0.026
4	Check operation of unit	0.014
5	Fill out service report	<u>0.014</u>
	Task Time	0.108
	Craft Allowance	0.019
	Job Preparation	0.3
	Travel Time	<u>0.9</u>
	Total Time	1.327

Frequency of Occurrence: 5 years

Reference: 1. Technical Bulletin TB 420-8.



TITLE: Dual Temperature Pump DTP-1

TYPE: 7-1/2 HP Centrifugal

QUANTITY: 1

TASK: Repairs - Remove and Reinstall Components

I. REPLACE COUPLING

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Turn power off and on	0.004
2	Remove bolts on motor and reinstall	0.178
3	Loosen and tighten coupling screws	0.108
4	Remove and reinstall coupling	0.184
5	Check/adjust coupling alignment	0.102
6	Check pump operation	0.008
7	Special material handling	0.110
8	Fill out service report	<u>0.014</u>
	Task Time	0.708
	Craft Allowance	0.127
	Job Preparation	0.3
	Travel Time	<u>0.9</u>
	Total Time	2.035

Frequency of Occurrence: 2 years

Reference: 1. Technical Bulletin TB 420-8, VT-72.

2. Paco Instruction Sheet - 1404-610  
Parts List Ald.1.

II. REPLACE SEALS AND BEARINGS

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Turn power off and on	0.004
2	Close and open valve	0.034
3	Remove and reinstall drain plug	0.022
4	Secure water lines in position	0.180

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
5	Remove and reinstall strainer section	0.174
6	Remove and reinstall shock absorber	0.174
7	Remove and reinstall bolts in housing	0.178
8	Remove and reinstall housing and gasket	0.146
9	Remove and reinstall mounting bolts	0.087
10	Loosen and tighten coupling screws	0.108
11	Remove and reinstall coupling	0.184
12	Align coupling	0.102
13	Align impeller hub	0.088
14	Align impeller	0.196
15	Align seals	0.368
16	Align bearing bolts	0.131
17	Align shaft bearings	0.584
18	Check pump operation	0.008
19	Special material handling	0.220
20	Fill out service report	<u>0.014</u>
	Task Time	2.912
	Craft Allowance	0.524
	Job Preparation	0.3
	Travel Time	<u>0.9</u>
	Total Time	4.636

Frequency of Occurrence: 3 years

- Reference: 1. Technical Bulletin TB 420-8, VT-72.  
2. Paco Instruction Sheet - 1404-610 and Parts List Ald.1.

III. REPLACE IMPELLER & SHAFT

Procedure is similar to Task II.

Frequency of Occurrence: 10 years

IV. REPLACE MOTOR

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Turn power off and on	0.004
2	Remove and reinstall wirings	0.018
3	Remove and reinstall mounting bolts	0.178
4	Remove and reinstall motor	0.018
5	Check and adjust coupling alignment	0.102
6	Check operation of motor	0.167
7	Special material handling	0.22
8	Fill out service report	<u>0.014</u>
	Task Time	0.721
	Craft Allowance	0.130
	Job Preparation	0.3
	Travel Time	<u>0.9</u>
	Total Time	2.051

Frequency of Occurrence: 5 years

- Reference:
1. Technical Bulletin TB 420-8, VT-7.
  2. Paco Instruction Sheet 1404-610 and Parts List Ald.1.

TITLE: Hot Water Boiler B-1

TYPE: 18.6 HP Cast Iron Sectional

QUANTITY: 1

TASK: Repairs - Remove and reinstall components

I. REPLACE SECTION AND PUSH NIPPLES

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Open and close valve	0.119
2	Remove and reinstall flange nut	0.785
3	Remove and reinstall bolt	0.785
4	Remove and reinstall gasket	0.323
5	Remove and reinstall union	0.498
6	Remove and reinstall pipe sections	0.438
7	Remove and reinstall drain nut	0.087
8	Remove and reinstall drain bolt	0.293
9	Remove and reinstall boiler section	0.469
10	Remove and reinstall nipple	0.147
11	Clean nipple seat	0.822
12	Lubricate nipple seal	0.086
13	Fabricate gasket	0.206
14	Lubricate gasket	0.082
15	Special material handling	<u>0.550</u>
	Task Time	5.69
	Craft Allowance	1.024
	Job Preparation	0.3
	Travel Time	<u>0.9</u>
	Total Time	7.914

Frequency of Occurrence: 5 years

Reference: 1. Technical Bulletin TB 420-8, VT-276.

2. Weil McLain No. 76 Boiler Service Instructions.

II. ADJUST BURNER AND CONTROLS

<u>Step</u>	<u>Operation</u>	<u>Leveled Time</u>
1	Adjust burner and controls as required	0.54
2	Fill out inspection report	<u>0.014</u>
	Task Time	0.554
	Craft Allowance	0.1
	Job Preparation	0.3
	Travel Time	<u>0.9</u>
	Total Time	1.854

Frequency of Occurrence: 2 years

- Reference: 1. Technical Bulletin TB 420-8, VT-285.  
2. Weil McLain No. 76 Boiler Service Instructions.

REPLACEMENT KITS REQUIRED FOR EACH TASK

TOOLS AND SUPPLIES ARE NOT LISTED

SUMMARY OF REPAIR REQUIREMENTS  
(IN MANHOURS)

Equipment	Year											
	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
<b>Compressor</b>												
Motors												
Bearings												
Control Panels												
Thermistats												
Subtotal												
<b>Water Heater</b>												
Motors												
Thermistats												
Relays												
Subtotal												
<b>EXPANSION</b>												
Motors												
Bearings												
Pulley Sheave												
Switch												
Subtotal												
<b>Heat Exchanger</b>												
Accuator												
Relays												
Thermistats												
Subtotal												
<b>PAPE</b>												
Control Panels												
Relays												
Thermistats												
Subtotal												
<b>Water Heater</b>												
Motors												
Thermistats												
Relays												
Subtotal												

4. MAINTENANCE AND REPAIR REQUIREMENTS MASTER SCHEDULES

4.1 MANPOWER REQUIREMENTS (IN MANHOURS)

Activity	Year											
	74	75	76	77	78	79	80	81	82	83	84	85
Construction	100	100	100	100	100	100	100	100	100	100	100	100
Operation	100	100	100	100	100	100	100	100	100	100	100	100
Maintenance	100	100	100	100	100	100	100	100	100	100	100	100
Management	100	100	100	100	100	100	100	100	100	100	100	100
Other	100	100	100	100	100	100	100	100	100	100	100	100
<b>Total</b>	<b>500</b>	<b>500</b>	<b>500</b>	<b>500</b>	<b>500</b>	<b>500</b>	<b>500</b>	<b>500</b>	<b>500</b>	<b>500</b>	<b>500</b>	<b>500</b>



4.2 MATERIAL REQUIREMENTS

Description of Equipment & Items (Replacement Kits)	Year																										Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		
Air Handling Units																											
Belts (sets)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
Filter (sets)	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	
Motor			5			5			5			5			5			5			5			5			
Bearings																											
Pulley/Sheave																											
Thermostat																											
Actuator																											
Relays/Contactors				20				20																			
Unit Heater																											
Motor					30																						
Thermostat																											
Actuator					5																						
Relays/Contactors				5				5																			
Exhaust Fan																											
Belts	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	
Motor																											
Bearings																											
Pulley/Sheave																											
Switch																											
Heat Exchanger																											
Actuator					2																						
Relays				4																							
Thermostats																											
Pump																											
Coupling																											
Seals & Bearings																											
Impeller & Shaft																											
Motor																											
Relay/Contactor																											
Hot Water Boiler																											
Section & Push Nipples																											
Tune-Up Kit																											

5. CONCLUSION

Expenses for labor and material to make repairs as well as cleaning, painting, inspection, testing, etc. are important in determining total operating costs. Generally, routine maintenance requirements will be met by an operating engineer on staff. If the responsibility of the group extends to facilities beyond the heating system, the subject of this report, only an equitable share of the group's time should be allocated to the maintenance on the system being evaluated. Extraordinary repairs are often handled by maintenance divisions and the expenses are allocated back to the system's maintenance costs. In other cases, some of the maintenance is handled by outside service firms and is considered maintenance costs. These costs vary considerably with the type of system and the proficiency of the servicing organization. The annual maintenance allowance should be based on the entire amortization period under study, rather than early years with associated shakedown problems or later years when higher costs are usually experienced. The reliability of equipment was not a factor in the study; maintenance and repair requirements were based on routine maintenance and the failure rate of equipment.

## REFERENCES

1. Technical Bulletin TB 420-1, Engineered Performance Standards, Public Works Maintenance, "Engineer's Manual."
2. Technical Bulletin TB 420-2, Engineered Performance Standards, Public Works Maintenance, "General Handbook."
3. Technical Bulletin TB 420-3, Engineered Performance Standards, Public Works Maintenance, "General Formulas."
4. Technical Bulletin TB 420-8, Engineered Performance Standards, Public Works Maintenance, "Heating, Cooling and Ventilating Handbook."
5. Technical Bulletin TB 420-9, Engineered Performance Standards, Public Works Maintenance, "Heating, Cooling and Ventilating Formulas."
6. Technical Manual TM 5-643, Repairs and Utilities, "Preventive Maintenance for Heating Plants and Systems."
7. "Maintenance Engineering Handbook," L. C. Morrow, Editor, McGraw-Hill Book Company.
8. "Modern Air Conditioning, Heating and Ventilating," W. H. Carrier, R. E. Cherne, W. A. Grant and W. H. Roberts, Pitman Publishing Corporation.
9. "Mechanical and Electrical Equipment for Buildings," W. J. McGuinness and B. Stein, John Wiley and Sons, Inc.
10. "ASHRAE Handbook - 1980 Systems Volume", American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.
11. "ASHRAE Handbook - 1979 Equipment Volume," American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.
12. "Standard Plant Operators' Manual," S. M. Elonka, McGraw-Hill Book Company.
13. Air Force Manual 88-29, "Engineering Weather Data."

TABLE E1. TRAVEL TIME\*

TRAVEL TIME		
Zone No.	Group Range Round Trip Time Dec. Hrs.	Allowed Time Round Trip Time Dec. Hrs.
1	0 - .20	.16
2	.21 - .30	.25
3	.31 - .40	.35
4	.41 - .50	.45
5	.51 - .60	.55
6	.61 - .70	.65
7	.71 - .80	.75
8	.81 - .90	.85
9	.91 - 1.10	1.00
10	1.11 - 1.30	1.20
11	1.31 - 1.50	1.40
12	1.51 - 1.70	1.60
13	1.71 - 1.90	1.80
14	1.91 - 2.10	2.00
15	2.11 - 2.30	2.20

NOTE: Zone 1 is walking time only. All other zones involve vehicle times and constant K1. For travel between zones allow .10 hours per zone through zone 8 and .20 hours per zone for zones 9 through 15.

\*Material extracted from U.S. Army Technical Bulletin, TB 420-2, Table 6.

TABLE E2. CRAFT ALLOWANCE\*

CRAFT	PERSONAL	UNAVOIDABLE DELAY	BALANCING DELAY	PLANNING	USE OF ALLOWANCE %	
					ONE MAN	MULTI-MAN
CARPENTRY						
General	10	2	7	4	16	23
Roofing	12	2	7	4	18	25
ELECTRICAL, ELECTRONIC	10	4	2	5	19	21
HEATING	10	4	2	4	18	20
COOLING, VENTILATING	10	4	2	5	19	21
JANITORIAL	10	.5	2	.5	11	13
MACHINE SHOP	10	5	1	8	23	24
MACHINE REPAIR	12	6	8	10	28	36
MASONRY	13	1	8	1	15	23
Purchased Concrete	13	9	8	1	23	31
BOILER WORK	16	6	10	1	23	33
MOVING, RIGGING	13	8.9	12.1	6.1	28	40
PAINTING						
General	10	1.5	.4	2.6	14	15
Spray	12	1.5	.4	2.6	16	17
PIPEFITTING, PLUMBING	10	4	2	4	18	20
ROADS, GROUNDS						
General	10	4	2	4	18	20
Laborers	13	4	2	4	21	23
PEST CONTROL	10	4	3	-	14	17
SHEETMETAL	10	5	6	5	20	26
STRUCTURAL IRON, WELDING	10	6	4	4	20	24
TRACKAGE	13	1	7	1	-	22
WHARFBUILDING	13	4.1	8	6.4	24	32

\*Material extracted from U.S. Army Technical Bulletin, TB 420-2, Table 5.

Craft or Type of Work	Reference	Description	Hours	Application
Heating, Cooling, and Ventilating	Interim	I. Job Preparation ... per man/day	.3	I applies to the preparatory work, job site preparation and clean-up, and assembly and return of tools and equipment. Not included is travel and material handling.

\*Material extracted from U.S. Army Technical Bulletin for TB 420-2, Table 3.

APPENDIX F

PLANNED MAINTENANCE, INC., REPORT ON FLOOR COVERING SYSTEMS

Prepared by:

Planned Maintenance Systems  
Suite 307  
2001 Jefferson Davis Highway  
Arlington, Virginia 22202

CONTENTS

	<u>Page</u>
GENERAL	55
Introduction	
Analysis Criteria	
Flooring: Maintenance, Repair and Operations Life-Cycle Chart	
CHART NOTES	66



FLOOR SYSTEM MAINTENANCE, REPAIR  
AND OPERATIONS REQUIREMENTS

GENERAL

1.0 Introduction

In the early stages of building design, the designer has several factors to consider in choosing the proper floor coverings for the various areas of a facility. These factors include functional and aesthetic considerations, the initial cost of the system, and the life cycle cost of the flooring's maintenance, repair and operations requirements.

Because of the lack of sufficiently organized data on maintenance, repair and operations of floor covering systems, the Construction Engineering Research Laboratory has awarded this contract to gather and organize the appropriate data into reliable life-cycle cost information.

1.1 Objective

The overall objective of the work to be performed under the contract is to determine the maintenance, repair and operation requirements (manpower and material) for floor covering systems widely used in military construction and to prepare a format usable for life-cycle cost calculations of military facilities.

A further objective has been to simplify the actual work involved in determining life-cycle cost, by grouping both floor types and area uses where applicable and by keeping forms to a minimum and instructions brief.

1.3 Sources of Information

Most information contained in this report comes from military engineering or maintenance publications. Other information, which could not be found in military publications,

has been obtained from the commercial sector or the personal experience of the contractors. All information is noted as to its source.

## 2.0 Analysis Criteria

In this report, more than a dozen different factors are considered to determine maintenance, repair and operations costs of flooring systems. The following is a listing of these factors, with an explanation as to definition of terms, source of information, a listing or example of the information used and the location of the information on the charts included in the report.

### Total Listing:

2.1 Floors Considered	2.9 Tasks
2.2 Floor Groups	2.10 Yearly Task Times
2.3 Expected Service Life	2.11 Man Hours - Yearly, Total Task
2.4 Surface Preparation	2.12 Man Hours - Overhead
2.5 General Area Categories	2.13 Man Hours - Material, Supply Factor
2.6 Obstruction Level	2.14 Man Hours - Craft Allowance
2.7 Frequencies	2.15 Man Hours - Total Yearly
2.8 Frequency Multiplier	2.16 Man Hours - 25-Year Life Cycle

### Individual Listing

#### 2.1 Floors Considered

Definition:

All floor types included in this report are typical of flooring currently being specified for military applications. A point has been made not to add any specialty flooring systems that are not commonly used throughout the Army.

Information Source: Contract RFP

Corps of Engineers Guide Specifications for  
Military Construction

Location on Charts: Combined into (2.2) Floor Groups, located on Life-Cycle Chart and Task Chart.

## 2.2 Floor Groups

### Definition:

All specified floor types, with slight additions, have been grouped into one of four FLOOR GROUPS according to their similarities of maintenance. If the tasks required to clean a particular floor are similar in both technique and time, then all floors of that type are put into one group. The exception is Group #4, in which each flooring type is detailed individually.

Information Source: Contract RFP

Military Custodial Services Manual, TM 5-609  
Contractor's Experience

Location on Charts: Located on both the Life-Cycle Chart and the Task Chart

### Listing:

Floor Group #1 - Carpeted Flooring  
- Carpet w/integrated padding  
- Carpet w/padding

Floor Group #2 - Hard Flooring  
- Ceramic Tile - Mudset  
- Ceramic Tile - Over Wood  
- Ceramic Tile - Thinset  
- Quarry Tile - Mudset  
- Quarry Tile - Thinset  
- Terrazzo

Floor Group #3 - Resilient Flooring  
- Sheet Vinyl  
- Vinyl Asbestos Tile  
- Rubber Tile

Floor Group #4 - Other Flooring Types  
- Maple Floor, Rough, Unsealed  
- Maple Floor, Sealed  
- Wood Parquet  
- Concrete, Rough, Not Treated  
- Concrete, Smooth

### 2.3 Expected Service Life

Definition: For each floor type, information has been gathered concerning the expected life of the floor material. These are averages only, because no two information sources were identical.

Information Source: Carpet Specifiers Handbook, The Carpet and Rug Institute, Third Edition  
Concrete Floors on Ground, Portland Cement Association  
Economics of Carpeting and Resilient Flooring, University of Pennsylvania  
Armstrong Cork, "A Fresh Look At Flooring Costs"

Example: Carpet, Office = 8 Years Expected Service Life

Location on Charts: On Life Cycle Chart

### 2.4 Surface Preparation

Definition: The covering applied to a floor to protect it (seal, finish) greatly affects the time required to maintain it. In several cases on the chart, we have shown the flooring both finished/sealed or unfinished/unsealed.

Information Source: Military Custodial Manual  
Contractor's Experience

Location on Chart: Located on the Life-Cycle Chart

### 2.5 General Area Categories

Definition: Since many of the area uses are similar in use and maintenance characteristics, they are grouped into four General Area Categories. Each General Area Category dictates the frequency of maintenance for a particular cleaning task.

Information Source: General Area Categories #1-#3, TM 5-609,  
the Military Custodial Services Manual  
General Area Category #4, Contractor Addition

Listing: General Area Category #1 - Administrative/  
Personnel  
General Area Category #2 - Production/Industrial  
General Area Category #3 - Storage  
General Area Category #4 - Special Use

Location on Charts: Located on the Life-Cycle Chart

<u>Area Use</u>	<u>General Area Category</u>	<u>Area Type</u>	<u>General Area Category</u>
BEQ - Circulation Area	1	Family Housing	1
BEQ - Lounge	1	Industrial Use - Machine and	
BEQ - Sleeping Room	1	Maintenance Shops	2
BOQ - Dining Facility	1	Industrial Use - Warehousing,	
BOQ - Living/Sleeping		Storage	3
Rooms	1	Laboratories - Chemical	2
BOQ - Public Area	1	Laboratories - Electronic	2
BOQ - Sleeping Rooms	1	Laboratories - Mechanical	2
Chapels	1	Libraries	1
Classrooms	1	Lobbies	1
Clubs	1	Offices (Administration)	1
Computer Rooms	1	Offices (Dental, Medical)	1
Conference Rooms	1	Sick Rooms, Hospital Rooms	1
Consulting, Medical Exam	1	Sport Facilities - Bowling	
Corridors	1	Alleys	4
Dining Area/Dining Halls	1	Sport Facilities - Gym/Games	4
		Sport Facilities - Light Games	4
		Stairs	4

2.6 Obstruction Level

Definition: Obstruction Level is a means of increasing or decreasing the time allotted for a given cleaning task, according to the amount of impedance found in the room.

Information Source: TM 5-609, Military Custodial Services Manual

Example: Task-Buff 1,000 square feet

<u>Obstruction Level</u>	<u>Task Time</u>
1. Unobstructed	19 minutes
2. Slightly Obstructed	25 minutes
3. Obstructed	27 minutes
4. Heavily Obstructed	30 minutes

Location on Charts: Located on the Life-Cycle Chart

2.7 Frequencies

Definition: Frequencies are the average number of times a task is performed in a given year. For this report, there are ten frequencies used.

Information Source: TM 5-609, Military Custodial Services Manual

Listing: Daily                      Every Two Months  
Twice Weekly                  Every Three Months  
Weekly                          Every Four Months  
Monthly                         Every Six Months  
Twice Monthly                 Yearly

Location on Charts: Located on the Task Chart

2.8 Frequency Multiplier

Definition: For the purposes of this analysis, a numeric multiplier was added to each frequency to allow for multiplication of individual unit times for each task. This gives a yearly task/time total.

Information Source: Contractor

TM 5-609, Military Custodial Services Manual

<u>Listing:</u>	<u>Frequency</u>	<u>Frequency Multiplier</u>
	Daily	260
	Twice Weekly	104
	Weekly	52
	Monthly	12
	Twice Monthly	24
	Every Two Months	6
	Every Three Months	4
	Every Four Months	3
	Every Six Months	2
	Yearly	1

Location on Charts: Located on the Task Chart as part of (2.9) task times.

## 2.9 Tasks

Definition: Tasks are the individual cleaning/repair operations performed on the flooring types. Not all tasks are performed on a given floor type. Obstruction levels, frequencies and total floor size also influence which tasks are performed.

Information Source: TM 5-609, Military Custodial Services Manual Contractor Experience

Listing:	Sweep	Machine Vac and Buff
	Dust Mop	Machine Vac, Finish
	Damp Mop	and Buff
	Buff	Routine Vacuum
	Strip and Refinish	Heavy Duty Vacuum
	Machine, Scrub and	Surface Shampoo
	Pick Up	Extraction Clean
		Repair

Location on Charts: Located on the Task Chart

## 2.10 Yearly Task Times

**Definition:** Task Times are the average time required to perform a cleaning task once. For the purpose of this analysis, task times have been multiplied by the frequency multiplier to indicate a yearly task time in hours.

**Information Source:** TM 5-609, Military Custodial Services Manual

**Example:** Sweep 1,000 Square Feet, Unobstructed, daily  
Task Time (7 minutes) x 260 yearly task repetitions = 1820 ÷ 60 = 30.33 hours  
(Yearly Task Time)

**Location on Charts:** Located on Task Chart as a Combination (2.7, 2.9)

## 2.11 Man Hours - Yearly Total Task

**Definition:** For the purposes of this report, all task times for any floor type combination are added to acquire a Total Yearly Man Hours.

**Information Source:** TM 5-609, Military Custodial Services Manual

**Example:** Office carpet, unobstructed

<u>Task</u>	<u>Yearly Task Time</u>
Routine Vac	52.00 hours
Heavy Duty Vac	4.40 hours
Surface Shampoo	8.00 hours
Extraction Clean	<u>2.00 hours</u>
Total Yearly Man Hours	66.40 hours

**Location on Charts:** Located on the Life-Cycle Charts and the Task Chart

## 2.12 Man Hours - Overhead

**Definition:** For the purpose of this report, an overhead rate of 14% has been applied to the yearly, total task man hours. This rate has been calculated by determining that the % of a buildings operation that is floor care related is equal to 40%. Using an average government overhead % of 35%, then 35% of 40% = 14% overhead applied to floor care in a typical operation.



Information Source: TM 5-609, Military Custodial Services Manual  
Contractor Experience

Location on Charts: Located on Life-Cycle Chart

### 2.13 Man Hours - Material, Supply Factor

Definition: For the purpose of this report, material supply costs have been averaged and converted to a percentage of labor cost factor. This percentage factor is then applied to each yearly task total to yield a Man Hours - Material, Supply Factor. The percentages range from 3% to 21%.

Information Source: Sample calculations of current material, supply costs from Commerce Business Daily award reports.

Contractor Experience

Example: Vinyl Asbestos Tile, In Office, Unobstructed, 1,000 square feet.

Material, Supply % Factor over 25 years = 18% of labor man hours.

Location on Charts: Located on the Life-Cycle Chart

### 2.14 Man Hours - Craft Allowance

Definition: For the purpose of this report, a craft allowance of 14 1/2% was determined and applied to the total yearly task hours.

Information Source: Determined during contractor/government meetings

Location on Charts: Located on the Life-Cycle Chart

### 2.15 Man Hours - Total Yearly

Definition: The sum of the man hours of yearly, total task; overhead; material, supply factor; and craft allowance.

Information Source: Life-Cycle Chart, Task Chart

Location on Charts: Located on the Life-Cycle Chart

### 2.16 Man Hours - 25 Year Life Cycle

Definition: The multiplication of the total yearly man hours by 25, which is the determined building life for this report.

Information Source: Contract requirements

Location on Charts: Located on the Life-Cycle Chart

### 3.0 Flooring: Maintenance, Repair and Operations Life-Cycle Chart

This chart has been designed to allow for quick determination of a floor types man hours expenditures over 25 years. Individual task analysis information has been left off this chart to simplify it and is found on the Task Analysis Chart.

#### 3.1 Instructions for Use - Life-Cycle Chart

- 1) Locate the appropriate floor group lines (2.2) on the chart.

Example: Resilient (Lines 19-29)

- 2) Locate the appropriate General Area Category (2.5)

Example: Admin/Personnel (Lines 19-22)

- 3) Locate the appropriate Obstruction Level (2.6)

Example: Unobstructed (Line 19)

- 4) Once the three criteria are found (floor group, general area category and obstruction level), reading the chart from left to right will give all the appropriate information concerning the Life-Cycle analysis.

Example: See Line 19. The key measure is Column (2.16).

#### Notes:

- A) All calculations are per 1,000 square feet.
- B) If either a hard flooring or resilient flooring over 3,000 square feet, with minor obstruction, is being considered (Example: Cafeteria Flooring), then use Lines 18 and 29 for calculation purposes. These lines allow for the use of automatic cleaning equipment in large open spaces.

### 3.2 Task Chart

This chart gives a detailed breakdown of the yearly task times and frequencies for each task. All times are yearly per 1,000 square feet. The combined task times equal the Yearly, Task Time Total located on the Life-Cycle Chart.

### 3.3 Instructions for Use - Task Chart

- 1) After using the Life-Cycle Chart and determining the proper information line, find the same line number on the Task Chart.
- 2) Reading the appropriate line from left to right will give all appropriate individual task times.

#### CHART NOTES

Color - For all task times in this study, it was assumed that the color of the chosen flooring was of a medium, non-dirt-showing color. This is particularly important with carpeted and resilient flooring types. For example, a very light or very dark carpet will show dirt much more readily than one of a medium hue. Although the frequency of cleaning might not be increased, the time to do each task could increase by as much as 10%. Therefore, if either a very light or very dark carpet or resilient flooring type is chosen, it is suggested that the 25-year life-cycle man-hour total (2.16) be increased by 10%.

Pattern - Pattern is the artistic decorative design on the surface of a flooring type. It can be printed, impregnated, or woven. As with color, the pattern chosen can affect the life-cycle cost of the flooring. For the task times in this study, it is assumed that mixed, non-dirt-showing patterns are in use. Generally, a solid pattern shows dirt more than a mixed pattern. The time to do each task could be increased if a solid pattern is chosen. Therefore, if a solid pattern is chosen for the flooring type, it is suggested that the figures in the 25-year life-cycle man-hour total be increased by 5%.

Sweeping/Mopping - For the purpose of this report, the tasks of sweeping and dust mopping are incorporated in the same column called sweep/dust mop. The rationale behind this is that, in most installations, one or the other tasks will be performed on a floor, but not usually both. The time standards for sweeping and mopping found in the Army Custodial Manual have been averaged for this new, joint column listing.

Furniture Moving - For the purpose of this report, time required for moving furniture is not included. This additional time would be most apparent with carpeting, which requires complete furniture removal for the tasks of shampooing and extraction.

Repair - The times allotted for repair range from .10 hours to .50 hours per year. This range is indicative of the differences of expected repairs of the various floor types. For example, carpet generally requires more repair over its lifetime than a resilient floor. Therefore, we have given carpet an annual time of .50 per 1,000 square feet compared to .30 for resilient flooring.

Overhead - For the purpose of this report, overhead includes supervision only.

Heavily Used/High Visibility Areas - Not addressed in this report are areas which require a very high level of appearance and are heavily used, high visibility, or both. To adjust the total time to be more reflective of this condition, we suggest that the 25-year life-cycle total be increased by 10%.

Abbreviations Used -

LN#	-	Line Number
FQ	-	Frequency
D	-	Daily
W	-	Weekly
M	-	Monthly
M2	-	Every Two Months
M3	-	Every Three Months
M6	-	Every Six Months
Y2	-	Every Other Year
Y	-	Yearly
V	-	Varied

FLOORING: MAINTENANCE, REPAIR & OPERATIONS LIFE-CYCLE ANALYSIS CHART

LN	FLOOR GROUPS	EXPEC- TED SERVICE LIFE	(2.3)	SURFACE PREPAR- ATION	(2.4)	GENERAL AREA CATEGORIES	(2.5)	OBSTRUCTION LEVEL	(2.6)	MAN HOURS YEARLY TOTAL TASK	(2.11)	MAN HOURS OVERHEAD 14%	(2.12)	MAN HOURS MATERIAL, SUPPLIES, FACTOR	(2.13)	MAN HOURS CRAFT ALLOWANCE	(2.14)	MAN HOURS TOTAL YEARLY	MAN HOURS 25 YEAR LIFE CYCLE	
																				14.5%
01	CARPET	8 YRS	(2.3)	NONE	(2.4)	ADMIN/PERS.	(2.5)	UNOBSTRUCTED	(2.6)	64.90	(2.11)	9.08	(2.12)	9.73	(2.13)	9.41	(2.14)	93.12	2,328.00	01
02	CARPET	8 YRS	(2.3)	NONE	(2.4)	ADMIN/PERS.	(2.5)	SLIGHT	(2.6)	96.63	(2.11)	13.52	(2.12)	14.49	(2.13)	14.01	(2.14)	138.65	3,466.25	02
03	CARPET	8 YRS	(2.3)	NONE	(2.4)	ADMIN/PERS.	(2.5)	OBSTRUCTED	(2.6)	119.30	(2.11)	16.70	(2.12)	17.90	(2.13)	17.30	(2.14)	171.20	4,280.00	03
04	CARPET	8 YRS	(2.3)	NONE	(2.4)	PROD/INDUS.	(2.5)	HEAVY	(2.6)	132.90	(2.11)	18.60	(2.12)	19.94	(2.13)	19.27	(2.14)	190.71	4,767.76	04
05	CARPET	8 YRS	(2.3)	NONE	(2.4)	PROD/INDUS.	(2.5)	UNOBSTRUCTED	(2.6)	16.70	(2.11)	2.34	(2.12)	.83	(2.13)	2.42	(2.14)	22.29	557.25	05
06	CARPET	8 YRS	(2.3)	NONE	(2.4)	PROD/INDUS.	(2.5)	SLIGHT	(2.6)	17.17	(2.11)	2.40	(2.12)	.86	(2.13)	2.49	(2.14)	22.97	573.00	06
07	CARPET	8 YRS	(2.3)	NONE	(2.4)	PROD/INDUS.	(2.5)	OBSTRUCTED	(2.6)	17.50	(2.11)	2.45	(2.12)	.88	(2.13)	2.54	(2.14)	22.37	584.25	07
08	CARPET	8 YRS	(2.3)	NONE	(2.4)	PROD/INDUS.	(2.5)	HEAVY	(2.6)	17.70	(2.11)	2.48	(2.12)	.89	(2.13)	2.57	(2.14)	23.64	591.00	08
09	HARD FLOOR	25 YRS	(2.3)	SEALED	(2.4)	ADMIN/PERS.	(2.5)	UNOBSTRUCTED	(2.6)	49.71	(2.11)	6.96	(2.12)	3.48	(2.13)	7.21	(2.14)	67.36	1,684.00	09
10	HARD FLOOR	25 YRS	(2.3)	SEALED	(2.4)	ADMIN/PERS.	(2.5)	SLIGHT	(2.6)	66.56	(2.11)	9.37	(2.12)	4.66	(2.13)	9.65	(2.14)	90.24	2,256.00	10
11	HARD FLOOR	25 YRS	(2.3)	SEALED	(2.4)	ADMIN/PERS.	(2.5)	OBSTRUCTED	(2.6)	79.24	(2.11)	11.09	(2.12)	5.55	(2.13)	11.49	(2.14)	107.37	2,684.25	11
12	HARD FLOOR	25 YRS	(2.3)	SEALED	(2.4)	ADMIN/PERS.	(2.5)	HEAVY	(2.6)	96.63	(2.11)	13.53	(2.12)	6.76	(2.13)	14.01	(2.14)	130.93	3,273.25	12
13	HARD FLOOR	25 YRS	(2.3)	SEALED	(2.4)	PROD/INDUS.	(2.5)	UNOBSTRUCTED	(2.6)	43.44	(2.11)	6.08	(2.12)	3.04	(2.13)	6.30	(2.14)	58.86	1,471.50	13
14	HARD FLOOR	25 YRS	(2.3)	SEALED	(2.4)	PROD/INDUS.	(2.5)	SLIGHT	(2.6)	59.03	(2.11)	8.26	(2.12)	4.13	(2.13)	8.56	(2.14)	79.98	1,999.50	14
15	HARD FLOOR	25 YRS	(2.3)	SEALED	(2.4)	PROD/INDUS.	(2.5)	OBSTRUCTED	(2.6)	71.17	(2.11)	9.96	(2.12)	4.98	(2.13)	10.32	(2.14)	96.43	2,410.75	15
16	HARD FLOOR	25 YRS	(2.3)	SEALED	(2.4)	PROD/INDUS.	(2.5)	HEAVY	(2.6)	87.63	(2.11)	12.27	(2.12)	6.13	(2.13)	12.71	(2.14)	118.74	2,968.50	16
17	HARD FLOOR	25 YRS	(2.3)	NONE	(2.4)	STORAGE	(2.5)	OBSTRUCTED	(2.6)	18.50	(2.11)	2.59	(2.12)	.79	(2.13)	2.68	(2.14)	24.56	614.00	17
18	HARD FLOOR (OVER 3,000 SQUARE FEET)	25 YRS	(2.3)	SEALED	(2.4)	PROD/INDUS.	(2.5)	SLIGHT	(2.6)	21.60	(2.11)	3.02	(2.12)	1.51	(2.13)	3.13	(2.14)	29.26	731.50	18
19	RESILIENT	18 YRS	(2.3)	FINISHED	(2.4)	ADMIN/PERS.	(2.5)	UNOBSTRUCTED	(2.6)	49.91	(2.11)	6.99	(2.12)	8.98	(2.13)	7.24	(2.14)	73.12	1,828.00	19
20	RESILIENT	18 YRS	(2.3)	FINISHED	(2.4)	ADMIN/PERS.	(2.5)	SLIGHT	(2.6)	66.76	(2.11)	9.35	(2.12)	12.01	(2.13)	9.68	(2.14)	97.80	2,445.00	20
21	RESILIENT	18 YRS	(2.3)	FINISHED	(2.4)	ADMIN/PERS.	(2.5)	OBSTRUCTED	(2.6)	79.44	(2.11)	11.12	(2.12)	14.30	(2.13)	11.52	(2.14)	116.38	2,909.50	21
22	RESILIENT	18 YRS	(2.3)	FINISHED	(2.4)	ADMIN/PERS.	(2.5)	HEAVY	(2.6)	96.83	(2.11)	13.56	(2.12)	17.43	(2.13)	14.04	(2.14)	141.86	3,546.50	22
23	RESILIENT	18 YRS	(2.3)	FINISHED	(2.4)	PROD/INDUS.	(2.5)	UNOBSTRUCTED	(2.6)	43.64	(2.11)	6.11	(2.12)	4.80	(2.13)	6.33	(2.14)	60.88	1,522.00	23
24	RESILIENT	18 YRS	(2.3)	FINISHED	(2.4)	PROD/INDUS.	(2.5)	SLIGHT	(2.6)	59.23	(2.11)	8.29	(2.12)	6.52	(2.13)	8.59	(2.14)	82.63	2,065.75	24
25	RESILIENT	18 YRS	(2.3)	FINISHED	(2.4)	PROD/INDUS.	(2.5)	OBSTRUCTED	(2.6)	71.37	(2.11)	9.99	(2.12)	7.86	(2.13)	10.35	(2.14)	99.56	2,489.00	25
26	RESILIENT	18 YRS	(2.3)	FINISHED	(2.4)	PROD/INDUS.	(2.5)	HEAVY	(2.6)	87.83	(2.11)	12.30	(2.12)	9.66	(2.13)	12.73	(2.14)	122.52	3,063.00	26
27	RESILIENT	18 YRS	(2.3)	UNFIN.	(2.4)	STORAGE	(2.5)	SLIGHT	(2.6)	16.30	(2.11)	2.28	(2.12)	.47	(2.13)	2.36	(2.14)	21.41	535.25	27
28	RESILIENT	18 YRS	(2.3)	UNFIN.	(2.4)	STORAGE	(2.5)	HEAVY	(2.6)	21.50	(2.11)	3.01	(2.12)	.62	(2.13)	3.12	(2.14)	28.25	706.25	28
29	RESILIENT (OVER 3,000 SQUARE FEET)	18 YRS	(2.3)	FINISHED	(2.4)	ADMIN/PERS.	(2.5)	SLIGHT	(2.6)	21.80	(2.11)	3.05	(2.12)	2.40	(2.13)	3.16	(2.14)	30.41	760.25	29
30	MAPLE FLR.	25 YRS	(2.3)	NONE	(2.4)	STORAGE	(2.5)	SLIGHT	(2.6)	30.43	(2.11)	4.26	(2.12)	1.52	(2.13)	4.41	(2.14)	40.62	1,015.50	30
31	MAPLE FLR. (UNSEALED & UNFINISHED)	25 YRS	(2.3)	SEALED	(2.4)	GYMNASIUM	(2.5)	UNOBSTRUCTED	(2.6)	24.24	(2.11)	3.39	(2.12)	2.42	(2.13)	3.51	(2.14)	33.56	839.00	31
32	WOOD PARQT	25 YRS	(2.3)	SEALED	(2.4)	LOBBIES	(2.5)	SLIGHT	(2.6)	32.96	(2.11)	4.61	(2.12)	3.30	(2.13)	4.78	(2.14)	45.65	1,141.25	32
33	CONCRETE, UNTREATED	25 YRS	(2.3)	NONE	(2.4)	VARIED	(2.5)	SLIGHT	(2.6)	59.03	(2.11)	8.26	(2.12)	2.95	(2.13)	8.56	(2.14)	78.80	1,970.00	33
34	CONCRETE TREATED	25 YRS	(2.3)	SEALED	(2.4)	VARIED	(2.5)	SLIGHT	(2.6)	61.56	(2.11)	8.62	(2.12)	6.16	(2.13)	8.93	(2.14)	85.27	2,131.25	34

TASK ANALYSIS CHART

FLOOR GROUPS	FQ. SWEEP/ DUST MOP	FQ. DAMP MOP	FQ. STRIP & REFIN.	FQ. AUTO MAC. SCRUB & PIC/UP VAC & BUFF	FQ. AUTO MACH. VAC/ FIN & BUFF	FQ. ROU- TINE VAC	FQ. HVY DUTY VAC	FQ. SUR- FACE SHAMPOO	FQ. EX- TRACTION	FQ. RE- PAIR	MAN HOURS YEARLY TOTAL TASK
(2.2)	(2.7,2.9)	(2.7,2.9)	(2.7,2.9)	(2.7,2.9)	(2.7,2.9)	(2.7,2.9)	(2.7,2.9)	(2.7,2.9)	(2.7,2.9)	(2.7,2.9)	(2.7,2.9)
01	CARPET					D 52.00 M	2.40	M3 8.00	Y 2.00	V .50	64.90
02	CARPET					D 82.33 M	3.80	M3 8.00	Y 2.00	V .50	96.53
03	CARPET					D 104.00 M	4.80	M3 8.00	Y 2.00	V .50	119.30
04	CARPET					D 117.00 M	5.40	M3 8.00	Y 2.00	V .50	132.90
05	CARPET					W 10.40 M3	.80	M6 4.00	Y2 1.00	V .50	16.70
06	CARPET					W 10.40 M3	1.27	M6 4.00	Y2 1.00	V .50	17.17
07	CARPET					W 10.40 M3	1.60	M6 4.00	Y2 1.00	V .50	17.50
08	CARPET					W 10.40 M3	1.80	M6 4.00	Y2 1.00	V .50	17.70
09	HARD	D 21.67	W 21.67	M 3.80	M6 2.47						49.71
10	HARD	D 30.33	W 28.60	M 5.00	M6 2.53						66.56
11	HARD	D 39.00	W 32.07	M 5.40	M6 2.67						79.24
12	HARD	D 52.00	W 35.53	M 6.00	M6 3.00						96.63
13	HARD	D 21.67	W 21.67								43.44
14	HARD	D 30.33	W 28.60								59.03
15	HARD	D 39.00	W 32.07								71.17
16	HARD	D 52.00	W 35.53								87.63
17	HARD	C 3.60	W 14.80								18.50
18	HARD										21.60
19	RESLNT	D 21.67	W 21.67	M 3.80	M6 2.47						49.91
20	RESLNT	D 30.33	W 28.60	M 5.00	M6 2.53						66.76
21	RESLNT	D 39.00	W 32.07	M 5.40	M6 2.67						79.44
22	RESLNT	D 52.00	W 35.53	M 6.00	M6 3.00						96.83
23	RESLNT	D 21.67	W 21.67								43.64
24	RESLNT	D 30.33	W 28.60								59.23
25	RESLNT	D 39.00	W 32.07								71.37
26	RESLNT	D 52.00	W 35.53								87.83
27	RESLNT	DM 2.80	2M 13.20								16.30
28	RESLNT	2M 4.60	2M 16.40								21.50
29	RESLNT										21.80
30	MAPLE, D	30.33									30.43
31	UNSEALED MAPLE, D	21.67									24.24
32	SEALFD PAROT	D 30.33									32.96
33	CONCRT	D 30.33	W 28.60								59.03
34	UNTREATED CONCRT	D 30.33	W 28.60								61.56
	TREATED										

APPENDIX G

SERVICE ENGINEER ASSOCIATES, INC., REPORT ON COOLING GENERATING SYSTEMS

Prepared by:

Service Engineering Associates, Inc.  
3960 Peachtree Road  
Atlanta, Georgia 30319

PRECEDING PAGE BLANK-NOT FILMED



TABLE OF CONTENTS

	<u>PAGE NO.</u>
Objective	76
Maintenance of Cooling Systems	76
Geographic Engineering Weather Data for The Augusta, Georgia Vicinity	78
Job - Building Blocks of Time	79
Table 3 (Heating, Cooling & Ventilating)	80
Table 5 (Craft Allowance Percentage)	81
Table 6 (Travel Zones)	82
Selection of Tasks	83
Operation	83
Task	83
Leveled Time	83
Lost Time Allowances	83
Overall Summary Profile of Fifteen Air-Conditioning Systems - Twenty-Five Year Life Cycle Preventive Maintenance, Repairs and Replacement of Systems in Man-Hours (Exhibit 1)	85
Overall Summary Profile of Fifteen Air-Conditioning Systems - Twenty-Five Year Life Cycle Preventive Maintenance, Repairs and Replacement of System Components in Man-Hours (Exhibit 2)	86 - 88
Cooling Systems Categories	89
Maintenance and Repair Requirements for Cooling Systems	90
<u>Category 1</u>	91
Equipment Type	92
Overall Time Summary - By System	93

-continued next page-

TABLE OF CONTENTS - Continued

	<u>PAGE NO.</u>
<u>Category 1</u> (Continued)	
Time Summary - By Component	94
Task Summaries	95 - 99
<u>Category 2</u>	100
Equipment Type	101 - 102
Overall Time Summary - By System	103
Time Summary - By Component	104
Task Summaries	105 - 109
<u>Category 3A-100 Ton Open Reciprocating Compressor</u>	110
Equipment Type	111
Overall Time Summary - By System	112
Time Summary - By Component	113 - 116
Task Summaries	117 - 125
<u>Category 3B-98.8 Ton Hermetic Reciprocating Compressor</u>	
Equipment Type	126
Overall Time Summary - By System	127
Time Summary - By Component	128 - 131
Task Summaries	132 - 140
<u>Category 3C - Air Cooled Condenser</u>	
Equipment Type	141
Overall Time Summary - By System	142
Time Summary - By Component	143
Task Summaries	144 - 147
<u>Category 3D - Evaporative Condenser</u>	
Equipment Type	148

-continued next page-

TABLE OF CONTENTS - Continued

	<u>PAGE NO.</u>
<u>Category 3D (Continued)</u>	
Overall Time Summary - By System	148
Time Summary - By Component	149
Task Summaries	150 - 155
<u>Category 3D - 100 Ton Cooling Tower</u>	
Equipment Type	156
Overall Time Summary - By System	157
Time Summary - By Component	158
Task Summaries	159 - 164
<u>Category 4A - Centrifugal/Hermetic Compressor</u>	
Equipment Type	166 - 168
Overall Time Summary - By System	169
Time Summary - By Component	170 - 173
Task Summaries	174 - 184
<u>Category 4B - Screw Type Compressor</u>	
Equipment Type	185 - 187
Overall Time Summary - By System	188
Time Summary - By Component	189 - 192
Task Summaries	193 - 202
<u>Category 4C - Centrifugal Liquid Chiller</u>	
Equipment Type	203 - 204
Overall Time Summary - By System	205
Time Summary - By Component	206 - 209
Task Summaries	210 - 219

-continued next page-

TABLE OF CONTENTS - Continued

	<u>PAGE NO.</u>
<u>Category 4D - Evaporative Condenser</u>	
Equipment Type	221
Overall Time Summary - By System	222
Time Summary - By Component	223
Task Summaries	223 - 229
<u>Category 4E - 300 Ton Cooling Tower</u>	
Equipment Type	230
Overall Time Summary - By System	231
Time Summary - By Component	232
Task Summaries	233 - 237
<u>Category 5A - Centrifugal/Hermetic Compressor</u>	
Equipment Type	239 - 241
Overall Time Summary - By System	242
Time Summary - By Component	243 - 246
Task Summaries	247 - 256
<u>Category 5B - Centrifugal Liquid Chiller</u>	
Equipment Type	257 - 258
Overall Time Summary - By System	259
Time Summary - By Component	260 - 263
Task Summaries	264 - 274
<u>Category 5C - Cooling Tower</u>	
Equipment	275
Overall Time Summary - By System	276
Time Summary - By Component	277
Task Summaries	278 - 282

MAINTENANCE AND REPAIR  
REQUIREMENTS FOR COOLING SYSTEM

OBJECTIVE

The objective of this study is to establish a comprehensive data bank to enable CERL to perform life cycle costing analysis on various configurations of cooling system for facilities located in Fort Gordon, Georgia.

Life cycle costing, in relationship to this study, is defined as all costs over a finite period of time -- twenty five (25) years -- associated with the:

1. Operations of cooling systems.
2. Preventive maintenance of cooling systems.
3. Repair/replacement maintenance of cooling systems.
4. Materials and supplies required for the two types of maintenance mentioned above.
5. Cost of replacement of components within each system.

MAINTENANCE OF COOLING SYSTEMS

General -

To determine a realistic life cycle cost of the cooling systems to be analyzed, life cycle costing guidelines were established; they are as follows:

1. The cooling systems would be used for "normal" cooling, that is in a building which operates approximately five (5) days per week, with one (1) normal work shift during each of the five days.
2. The equipment will be located in one climatic zone, defined by CERL (Fort Gordon, Georgia). This was necessary because the geographical location of the cooling system would determine its run time on an annual basis, therefore allowing it to be extended on a twenty-five year basis. See Heating Degree Days Technical Data for Augusta, Georgia on the following page.
3. Air Conditioning Operating Hours

Estimating air conditioning loads (loads can vary widely depending on climate, type of building and activity within the building). NOTE: For a single-story commercial building, the variation may be from 300 square feet per ton in the desert areas to 850 square feet per ton in the coastal regions. The particular climatic zone in which these cooling systems were analyzed was in the Augusta, Georgia vicinity, a semi-coastal region. Normal number of cooling hours ranges from 1,000 to 1,500 hours/year. For estimating preliminary design purposes 475 square feet per ton is a conservative system average.

4. Equipment (Air Conditioning) % Running Time Analysis

The percent on-time of the air conditioning equipment per season/year is dependent on the building, number of occupants, and climatic (ambient atmospheric conditions) loads.

-continued next page-

MAINTENANCE OF COOLING SYSTEMS (Continued)

Since the cooling loads are established by use demand, a standard day to day on-time ratio cannot be easily established.

When determining the load percentage (0 to 100%) operating efficiency, the industry standard practice is to use 25% equivalent full load (100% full horsepower motor use) operating hours, including seasonal extended daylight hours. Example: System may operate 3,600 hours per cooling season. During this on-time operational mode, system varies from low load conditions to full load conditions. The system usage demand limit (amperage draw, due to load increase on system motor drive) varies considerably anywhere from 35% to 95% load. As a practical method of determining amperage and kilowatt usage during a cooling season, the 25% factor is used to determine 100% full load hours. (During cooling season, system is operating at 100% only 25% of the total 3,600 hours of operating on-time.) NOTE: In most cooling systems (100 to 1000 tons) its required "crank" or start-up procedure uses up to 35 to 40% of its total full load amps for motor turning or energizing.

GEOGRAPHIC ENGINEERING WEATHER DATA FOR THE AUGUSTA, GEORGIA VICINITY

Location:

Latitude 33° 22N  
Longitude 81° 58W  
Elevation 182 feet

Heating Design Data:

Dry Bulb 99% = 20°F  
97% = 23°F

Air Conditioning Criteria Data:

Dry Bulb 1% = 97°F  
2-1/2% = 95°F  
5% = 93°F  
10% = 90°F

Wet Bulb 1% = 80°F  
2-1/2% = 79°F  
5% = 78°F  
10% = 77°F

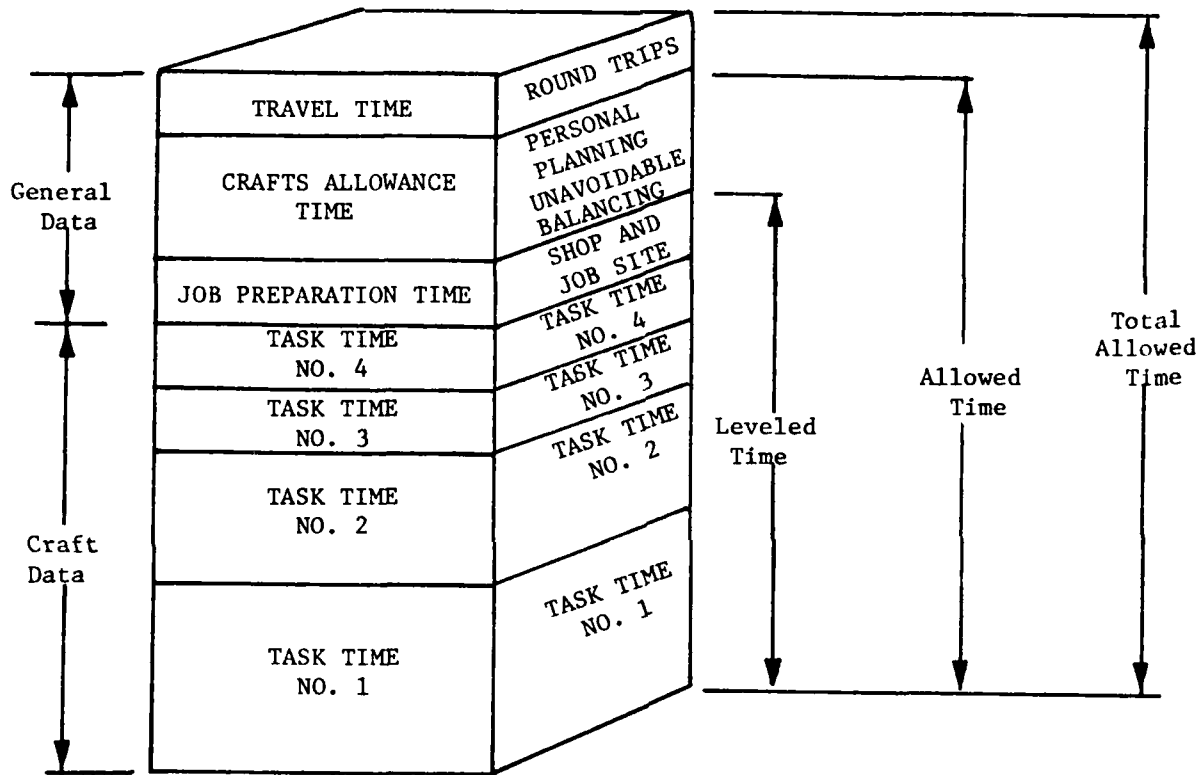
Air Conditioning Design Data:

Dry Bulb = 93°F = 174 hours  
80°F = 1431 hours  
Wet Bulb = 73°F = 1445 hours  
67°F = 2912 hours

NOTE: The above listed data are:

1. Heating Design Data. Those dry bulb temperatures (F°) which are equalled or exceeded 99% and 97-1/2% of the time, on the average, during coldest consecutive three months as determined by the mean dry bulb temperature (December, January, February).
2. Air Conditioning Design Data. Those dry bulb and wet bulb temperatures (F°) which are equalled or exceeded by 1, 2-1/2, 5, and 10% of the time, on the average, during the warmest consecutive four months or determined by the mean wet bulb temperature (June through September).
3. Air Conditioning Criteria Data. The number of hours on the average, that the dry bulb temperatures 93°F and 80°F and the wet bulb temperatures of 73°F and 67°F are equalled or exceeded during the warmest consecutive six months as determined by the mean wet bulb temperatures (May through October).

JOB - BUILDING BLOCKS OF TIME



TOTAL ALLOWED TIME FOR THE JOB

Specifications data, derived from NAVDOCKS P-701.0



TABLE 3

<u>CRAFT OR TYPE OF WORK</u>	<u>FORMULA REFERENCE</u>	<u>DESCRIPTION</u>	<u>HOURS</u>	<u>APPLICATION</u>
Heating, Cooling and Ventilating	Interim	Job preparation per man/day	.3	Applies to the pre- paratory work, job site preparation and clean-up, and assembly and return of tools and equipment. Not included is travel and material handling.

(Specification Data derived from NAVDOCKS P-701.0)

TABLE 5

CRAFT ALLOWANCE PERCENTAGE

Allowance percent or craft allowance: The applicable value under the "Craft Allowance Percent" column is added to the leveled craft time by means of the Nomograph.

	Craft	
	<u>Allowance Percent</u>	
	One Man	Multi-Man
Carpentry - General	16	23
- Roofing	18	25
Electrical, Electronic	19	21
Heating	18	20
Cooling, Ventilating	19	21
Janitorial	11	13
Machine Shop	23	24
Machine Repair	28	36
Masonry	15	23
with purchased concrete	23	31
Boiler Work	23	33
Moving, Rigging	28	40
Painting - General	14	15
- Spray	16	17
Pipefitting, Plumbing	18	20
Roads, Grounds - General	18	20
- Laborer	21	23
Pest Control	14	17
Sheetmetal	20	26
Structural Iron, Welding	20	24
Trackage	--	22
Wharfbuilding	24	32

(Specification data derived from NAVDOCKS P-701.0)

TABLE 6

TRAVEL ZONES

<u>ZONE NO.</u>	<u>GROUP RANGE FOR ROUND TRIP TIME</u>	<u>TRAVEL TIME ROUND TRIP HOURS/MAN/ R.T.</u>	<u>HEAVY EQUIPMENT TRAVEL TIME REQUIRED HOURS/MAN/ R.T.</u>
1	0 - 0.20	0.16	0
2	.21 - 0.30	0.25	0
3	.31 - 0.40	0.35	0
4	.41 - 0.50	0.45	.11
5	.51 - 0.60	0.55	.19
6	.61 - 0.70	0.65	.27
7	.71 - 0.80	0.75	.35
8	.81 - 0.90	0.85	.43
9	.91 - 1.10	1.00	.55
10	1.11 - 1.30	1.20	.71
11	1.31 - 1.50	1.40	.87
12	1.51 - 1.70	1.60	1.03
13	1.71 - 1.90	1.80	1.19
14	1.91 - 2.10	2.00	1.35
15	2.11 - 2.30	2.20	1.51

(Specification data derived from NAVDOCKS P-701.0)

### SELECTION OF TASKS

Maintenance and repair tasks were selected based on the Department of the Army technical manuals: TB-520-2 Engineered Performance Standard Public Work Maintenance General Handbook; TB-420-8 Engineered Performance Standard Public Works Maintenance Heating Cooling Ventilating Handbook (NAVFAC P-704.0); Technical Bulletin TB-420-9 Engineered Performance Standards Public Works Maintenance Heating Cooling Ventilating Formulas (NAVDOKS P-704.1); Equipment Manufacturer's Maintenance Service Manual and S-E-A's experience in HVAC systems concerning facility maintenance.

### OPERATION

An operation is a series of actions by a craftsman that results in a desirable change in location of the condition of maintenance materials, parts, or craftsmen.

### TASK

A task is the combination of operations required to accomplish the work that is defined in the description of the task.

### LEVELED TIME

Leveled time is the time required for a qualified craftsman, following a prescribed method and working at a normal pace without interrupting delays, to complete the work in an operation or task. It should be understood that additional time must be added to the leveled time or task, such as allowances for travel, preparation and delay time, in order to obtain the total allowed time to complete a job.

### LOST TIME ALLOWANCES

The leveled time of the task was adjusted for allowances for travel, job preparation and craft allowance from NAVDOCKS P-701.0 Tables 3, 5, and 6. A percentage adjustment was used for scheduled activities and straight man-hours were applied for emergency repairs.

Using an average of 0.85 hour round trip travel time and 0.3 hour job preparation allowance for a HVAC mechanic 1.15 hours or 14.4% of an eight-hour day was added to 19% craft allowance giving a total of 33.4% lost time.

$$\begin{aligned} \text{Lost Time} &= \text{Travel Time} + \text{Job Preparation} + \text{Craft Allowance} \\ &= 0.85 \text{ hr.} + 0.3 \text{ hr.} + 0.19 \text{ (task time)} \end{aligned}$$

-continued next page-

For an Eight-Hour Day:

$$\begin{aligned}\text{Task Time} &= 8 \text{ hrs.} - \text{lost time} \\ &= 8 - 0.85 - 0.3 - 0.19 \times \text{task time} \\ &= 6.85 - 0.19 \times \text{task time}\end{aligned}$$

$$\text{Task Time} = \frac{6.85}{1.19} = 5.76 \text{ hrs.}$$

$$\text{Lost Time} = 2.24 \text{ hrs.} = 28\%$$

Example:

$$\text{Leveled Time} = t$$

$$\text{Frequency} = f$$

$$\text{Task Time} = t \times f$$

Scheduled Maintenance (Preventive Maintenance):

$$\text{Lost Time Allowance} = 0.28 \times t \times f$$

$$\begin{aligned}\text{Total Time} &= \text{task time} + \text{lost time allowance} \\ &= (t \times f) + .28 (t \times f) \\ &= 1.28 (t \times f)\end{aligned}$$

Unscheduled Maintenance (Repairs):

$$\text{Craft Allowance} = 0.19 \times t$$

$$\text{Job Preparation} = 0.30$$

$$\text{Travel Time} = 0.85$$

$$\text{Total Time} = t + 1.15 + 0.19 \times t$$

NOTE: Task summary data derived from:

1. G.S.A. Material Specifications criteria
2. NAVFAC P-704.0, NAVDOCKS P-704.1
3. S-E-A material specifications criteria

LEGEND:

"1." Shown as GSA

"2." Shown as N

"3." Shown as S-F-A



OVERALL SUMMARY PROFILE OF FIFTEEN AIR-CONDITIONING SYSTEMS - TWENTY-FIVE YEAR LIFE CYCLE  
 PREVENTIVE MAINTENANCE, REPAIRS AND REPLACEMENT OF SYSTEM COMPONENTS IN MAN-HOURS

EXHIBIT 2  
 (Page 1 of 3)

Systems/Components	YEAR																									TOTAL MAN-HOURS T = TOTAL	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		
1. One Ton Window Mounted Air-Conditioner	2.26									5.16										5.16							10.32 T 66.82 161.25
1 - A.C. Unit									4.79																		4.79
2. Four Ton Pad Mounted Package Cooling Unit	6.43														6.50												6.50 T 172.54 225.25
1 - Replace Condenser Unit																											4.79
2 - Replace A.C. Unit																											6.50
3a 100 Ton - Open Reciprocating Compressor Chiller	9.01																										225.25
1 - Compressor			2.94							2.94	4.56	2.94															25.14
2 - Evaporator	6.69																										167.25
3 - Condenser	6.69																										167.25
4 - Motor/Starters	4.61																										115.25
5 - Control/Control Panel	2.56																										64.00 T 764.14 200.00
3b 100 Ton - Hermetic Reciprocating Compressor Chiller	8.00																										200.00
1 - Compressor Motor			2.94							2.94	4.56	2.94															31.05
2 - Condenser	6.69																										167.25
3 - Cooler	6.69																										167.25
4 - Motor Starter	3.86																										96.00
5 - Controls/Control Panel	2.56																										64.00 T 725.55 144.25
3c 94 Ton Air Cooled Condenser	5.77																										144.25
1 - Motor																											7.10
3d 100 Ton Evaporative condenser	17.66																										7.10 T 151.75 441.50
1 - Motor - Fan																											3.53
2 - Motor - Shaft Bearings																											3.53 T 448.56

OVERALL SUMMARY PROFILE OF FIFTEEN AIR-CONDITIONING SYSTEMS - TWENTY-FIVE YEAR LIFE CYCLE  
PREVENTIVE MAINTENANCE, REPAIRS AND REPLACEMENT OF SYSTEM COMPONENTS IN MAN-HOURS

EXHIBIT 2  
 (Page 2 of 3)

Systems/Components	YEAR																									TOTAL MAN-HOURS T = TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
3e 1.0 Ton Cooling Tower	17.66																									441.50
1 - Fan Motor								3.53			5.32															3.53
2 - Fan Shaft Bearings																										5.32
3a 2.75 Ton Centrifugal Hermetic Compressor	8.74																									218.50
1 - Compressor Motor																										31.05
2 - Condenser																										288.50
3 - Evaporator																										288.50
4 - Motor Starter																										96.00
5 - Controls/Control Panel																										64.00
4b 2.5 Ton Screw Type Compressor	8.74																									218.50
1 - Compressor Motor																										25.14
2 - Condenser																										288.50
3 - Evaporator																										288.50
4 - Controls/Control Panel																										64.00
5 - Motor Starter																										96.00
4c 300 Ton Open Drive Compressor/Centrifugal	10.02																									250.50
1 - Motor Starter																										115.25
2 - Compressor																										25.14
3 - Evaporator																										288.50
4 - Condenser																										288.50
5 - Controls/Control Panel																										64.00
4d 300 Ton Evaporative Condenser	25.16																									629.00
1 - Fan Motor																										4.72
2 - Fan Shaft Bearings																										5.91
4e 300 Ton Cooling Tower	25.16																									629.00
1 - Fan Motor																										4.72
																										633.72



OVERALL SUMMARY PROFILE OF FLEET AIR-CONDITIONING SYSTEMS - TWENTY-FIVE YEAR LIFE CYCLE  
PREVENTIVE MAINTENANCE, REPAIRS AND REPLACEMENT OF SYSTEM COMPONENTS IN MAN-HOURS

EXHIBIT 2  
 (Page 3 of 3)

SYSTEMS COMPONENTS	YEAR																									TOTAL MAN-HOURS T = TOTAL	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		
5a 300 Ton Centrifugal Hermetic Compressor	10.66																										266.50
1 - Compressor Motor						2.94			2.94	4.56		2.94	5.91		2.94						2.94				2.94		31.05
2 - Condenser	23.04		2.94																								576.00
3 - Evaporator	23.04																										576.00
4 - Motor Starter	3.84																										96.00
5 - Controls/Control Panel	2.56																										64.00
TOTAL																											1609.55
5b 300 Ton Centrifugal Open Drive Compressor	12.32																										308.00
1 - Compressor						2.94			2.94	4.56		2.94	5.91		2.94										2.94		31.05
2 - Condenser	23.04		2.94																								576.00
3 - Evaporator	23.04																										576.00
4 - Motor Starter	4.61																										115.25
5 - Controls/Control Panel	2.56																										64.00
TOTAL																											1670.30
5c 900 Ton Cooling Tower	30.42																										760.50
1 - Fan Motor										7.10																	7.10
TOTAL																											767.60

MAINTENANCE AND REPAIR REQUIREMENTS  
FOR  
COOLING SYSTEMS

15 SYSTEM/25 YEAR LIFE CYCLE STUDY

COOLING SYSTEMS CATEGORIES

CATEGORY 1 (1) System One ton A/C window unit

CATEGORY 2 (1) System Four ton pad A/C package system

CATEGORY 3 (5) Systems / A thru E

- (A) 100 ton (Trane) open reciprocating compressor
- (B) 98.8 ton (York) hermetic reciprocating compressor
- (C) 94 ton air cooled condenser (York)
- (D) 100 ton evaporative condenser (B.A.C.)
- (E) 100 ton cooling tower (Marley)

CATEGORY 4 (5) Systems / A thru E

- (A) 279 ton centrifugal/hermetic compressor (Trane)
- (B) 284 ton screw type compressor (Dunham-Bush)
- (C) 300 ton open drive compressor/centrifugal (York)
- (D) 306 ton evaporative condenser (B.A.C.)
- (E) 300 ton cooling tower (Marley)

CATEGORY 5 (3) Systems / A thru C

- (A) 977 ton centrifugal/hermetic compressor (Trane)
- (B) 900 ton centrifugal open drive compressor (York)
- (C) 900 ton cooling tower (Marley)

15 SYSTEM/25 YEAR LIFE CYCLE STUDY

COOLING SYSTEMS CATEGORIES

CATEGORY 1      (1) System      One ton A/C window unit

LIFE CYCLE COST STUDY (25 YEAR CYCLE)

MAINTENANCE-REPAIRS / TIME-MATERIALS

PHASE I - EQUIPMENT TYPE

CATEGORY 1:

- 1.1 One (1) Ton Window Mounted Unit - Industrial Type York Model BUHC - 110-6B, cooling capacity 11,000/10,700 BTUH, E.E.R. = 6.5/6.4 dehumidification (pints/hr<sup>2</sup>) 3.7
- 1.2 Compressor Data - 1 cylinder, PSC motor type, 34.0 locked rotor amps, external overload protection, 90.0 power factor, power supply 203/208-1-60 nameplate amps - cooling 7.7/8.0, refriger. type - 22 19.0 ounces full charge.
- 1.3 Evaporator Data - coil width inches 21-1/2, height inches 10, face area sq. ft. 1.49, tube qty. 30, tube O.D. in inches 5/16, 3 rows deep, 2 refrigerant circuits, fins/inch 12, fin depth inches 1-13/16, centrifugal type air handler CFM = high 365, med. 320, low 255 (based on wet evaporator coil) diameter 9-1/2 inches, width 2-1/4 inches.
- 1.4 Condenser Data - coil width inches 15-1/2, height inches 19, face area sq. ft. 2.04, tube qty. 56, tube O.D. in inches 5/16, 3 rows deep, 1 refrigerant circuit, 14 fins/inch, propeller fan type, 14 inch diameter, 6 blades.
- 1.5 Fan Motor - PSC type, 1/5 horsepower RPM at - high -1100, med. - 850, low -700.
- 1.6 Control Data - The control panel has three (3) cooling positions, one (1) heating position and three (3) fan speed positions. Adjusting thermostats control to regulate room temp. thermostat adjustment cycles compressor or heating element. Ventilation control regulates the amount of outdoor air brought into the conditioner space.
- 1.7 Compressor is hermetically sealed and factory/permanently lubricated and externally protected against motor overload.
- 1.8 Fan motor is double-ended and directly connected to both evaporator blower and the condenser fan. It has internal overload protection and permanent lubrication.
- 1.9 Filter type (permanent) cleanable, 24 inches wide, 1-1/2 inches high, 1.58 sq. ft. face area and 1/4 inch thick. Should last life of unit.
- 1.10 BUHC-110-6B unit dimensions 26 inches wide, 20-1/4 high, 17-7/8 deep, approx. weight 111 lbs., shipping 128 lbs.

1.

OVERALL TIME SUMMARY - BY SYSTEM  
ONE (1) TON WINDOW MOUNTED AIR CONDITIONER

<u>YEARS</u>	<u>P.M. - REPAIRS REPLACEMENT HRS.</u>
1	2.26
2	"
3	"
4	"
5	"
6	"
7	"
8	"
9	"
10	7.42
11	2.26
12	"
13	"
14	"
15	"
16	"
17	"
18	"
19	"
20	7.42
21	2.26
22	"
23	"
24	"
25	"
TOTAL	66.82

1.

TIME SUMMARY - BY COMPONENT

ONE (1) TON WINDOW MOUNTED AIR CONDITIONER

Life Cycle 10 yrs.

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	2.26		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"	5.16	Replace AC unit
11	"		
12	"		
13	"		
14	"		
15	"		
16	"		
17	"		
18	"		
19	"		
20	"	5.16	Replace AC unit
21	"		
22	"		
23	"		
24	"		
25	"		
	TOTALS	56.5	10.32

TASK SUMMARY - N

CATEGORY: 1

SYSTEM: One (1) Ton Window Mounted Air Conditioner

DESCRIPTION: Clean, lubricate, adjust and inspect one window air conditioning unit.

TASKS

Remove and reinstall screw

Remove and reinstall panel

Pull unit partially inside window and slip back

Clean unit inside cabinet

Grease blower bearing fitting

Lubricate oil cup

Sensory inspect fan

Sensory inspect blower

Remove and reinstall disposable filter

Material handling

Total Task Time: .95 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.95		1		1.22



TASK SUMMARY - N

CATEGORY: 1

SYSTEM: One (1) Ton Window Mounted Air Conditioner

DESCRIPTION: Preventive maintenance inspection - window air conditioning units.

TASKS

Remove and reinstall screw

Remove and reinstall panel

Sensory inspect bearings

Remove and reinstall disposable filter

Total Task Time: .24 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.24		3		.92

TASK SUMMARY - N

CATEGORY: 1

SYSTEM: One (1) Ton Window Mounted Air Conditioner

DESCRIPTION: Fall shut down -- window unit. Seasonal operation.

TASKS

Turn unit off and pull plug

Install cover over unit and tape edges

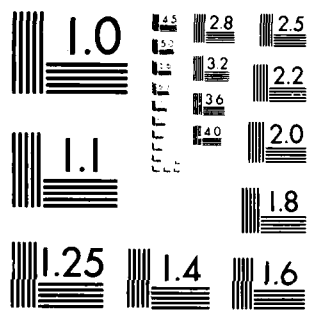
Install climb and remove step ladder

Total Task Time: .09 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time (Hrs/Yr)</u>
1.28		.09		1		.12





MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A

TASK SUMMARY - N

CATEGORY: 1

SYSTEM: One (1) Window Mounted Air Conditioner

DESCRIPTION: Install new window air conditioner (up to 2 tons) in window with raisable sash.

TASKS

- Remove cardboard container
- Remove and reinstall screws
- Remove and reinstall panel
- Remove and reinstall unit in cabinet
- Remove bolt from crate
- Raise and lower window
- Install cabinet in window
- Install leveling arm
- Loosen and tighten leveling screw
- Measure, mark and cut filler panel
- Install filler panel
- Install weatherstripping
- Install caulking
- Install plug
- Check operation of unit
- Material handling

Total Task Time: 1.63 Hour

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>				
<u>TASK TIME</u>	<u>JOB PREPARATION</u>	<u>TRAVEL TIME</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>HOURS/TASK</u>
1.63	0.30	0.85	.19 x 1.63	3.09

TASK SUMMARY - N

CATEGORY: 1

SYSTEM: One (1) Ton Window Mounted Air Conditioner

DESCRIPTION: Remove window air conditioner (up to 2 tons) from raisable window

TASKS

Remove face panel screws

Remove face panel

Remove unit from cabinet

Raise and lower window

Remove weatherstripping

Remove filler panel

Loosen leveling screw

Remove cabinet from window

Reinstall unit in cabinet

Reinstall face panel

Reinstall screws

Material handling

Total Task Time: .77 Hour

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>								
<u>TASK TIME</u>	+	<u>JOB PREPARATION</u>	+	<u>TRAVEL TIME</u>	+	<u>CRAFT ALLOWANCE TIME</u>	=	<u>HOURS/TASK</u>
.77		0.30		0.85		.19 x .77		2.07

15 SYSTEM/25 YEAR LIFE CYCLE STUDY

COOLING SYSTEMS CATEGORIES

CATEGORY 2      (1) System      Four ton pad A/C package system

CATEGORY 2:

- 2.1 Four (4) Ton Pad Mounted Central Air Conditioning Type Unit. Carrier Model 50 YL-042 Self-Contained, cooling capacity (total) at 50,000 BTUH at 95°F temp. air entering outdoor coil. 5.5 kw, SHC-sensible heat capacity 21, indoor air cfm = 1400, bypass factor at .09 entering wet bulb rated used = 72°F E.E.R. at 7.96; for 3-phase add 1000 BTUH and 100 watts.
- 2.2 Compressor Data - 2 cylinder, 3500 rpm (60 Hz) hermetically sealed, 230 volt - 3-phase oper., voltage max. = 253, min. = 207, LRA = 67, RLA = 13.1, BCSC = 14.3, IFM/FLA = 3.5, OFM/FLA = 2.0, max. fuse amp 30 (based on wire size 75C copper conductor) min. circuit amps = 23.4, refrigerant type - 22 operating charge 5.9 lbs./capillary tube, operating weight 370 lbs.
- 2.3 Evaporator Data - plate fin - copper tube type, rows = 3, fins per inch = 11.5, total face area sq. ft. = 7.38, coil system evaporator fan data - air discharge, centrifugal - direct drive - horizontal, 1575 ARI CFM, range CFM 1225 - 1750, motor Hp 1/2, motor rpm, low - 850, med. - 950, high - 1050.
- 2.4 Condenser Coil Data - Plate fine - aluminum tubes, 2 rows fins at 17.5 inches fin capacity, total face area; inner coil 10.4 sq. ft., outer coil 10.8 sq. ft., condenser fan/air discharge = propeller and direct drive/vertical, motor hp 1/4, motor rpm = 1050.
- 2.5 Control Data - One factory assembled package, pre-wired, pre-piped, and pre-charged. No separate coil or interconnecting piping or wiring. Time guard circuit (3-phase) prevents compressor short cycling. High pressure switch (3-phase unit) and low pressure switch (3-phase unit), motor-master head pressure control (solid state) 24 volt thermostat with sub-base. Time guard system component that protects unit compressor by preventing short cycling (for accessory single phase units) crackcase heater - prevents refrigerant dilution, promotes proper lubrication (accessory for single phase units only).
- All controls shall be factory wired and located in a readily accessible location. Compressor and fan motors shall have both thermal and current sensitive overload devices. Control circuit transformer (24V) shall be factory installed. A factory installed receptacle shall be provided for plug-in connection of accessory electric heater control wiring.
- 2.6 General Characteristics -
- weather armor cabinet
  - quiet condenser fan
  - large capacity coils
  - factory wired controls
  - rugged hermetic compressor
  - multi-speed evaporator blower
- 2.7 Filter type - disposable 25 x 25 inch media, 1 inch thick or permanent type filter 20 x 20 inches at 1 inch thickness.

-continued next page-



2.8 Dimension Data for 50YH-042 Type

A - Horizontal length - 4 ft. 7/16 inch

B - Horizontal Width - 3 ft. 6-1/4 inches

C - Vertical Height - 2 ft. 3-5/8 inches (includes 1 inch built-in  
base support channels)

2.

OVERALL TIME SUMMARY - BY SYSTEM  
FOUR (4) TON PAD MOUNTED PACKAGE COOLING UNIT

<u>YEARS</u>	<u>P.M. - REPAIRS REPLACEMENT HRS.</u>
1	6.45
2	"
3	"
4	"
5	"
6	"
7	"
8	"
9	"
10	11.24
11	6.45
12	"
13	"
14	"
15	12.95
16	6.45
17	"
18	"
19	"
20	"
21	"
22	"
23	"
24	"
25	"
TOTAL	172.54

2.

TIME SUMMARY - BY COMPONENT

FOUR (4) TON PAD MOUNTED PACKAGE COOLING UNIT

Life Cycle 15 Years

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	6.45		Replace filters three (3) times per year
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"	4.79	Replace Condenser
11	"		
12	"		
13	"		
14	"		
15	"	6.50	Replace A.C. Unit
16	"		
17	"		
18	"		
19	"		
20	"		
21	"		
22	"		
23	"		
24	"		
25	"		
TOTALS	161.25	11.29	

TASK SUMMARY - N

CATEGORY: 2

SYSTEM: Four (4) Ton Pad Mounted Central Air Conditioning Type Unit

DESCRIPTION: Clean, lubricate, adjust and inspect 3-49 ton package system.  
Does not include tower or evaporative condenser.

TASKS

Remove and reinstall screw  
Remove and reinstall panel  
Lubricate blower bearings  
Lubricate oil cup  
Sensory inspect pump  
Sensory inspect blower  
Clean squirrel cage fan  
Wipe motor and compressor  
Brush cooling coils  
Inspect sight glass  
Inspect for leaks  
Remove and reinstall disposable filter  
Remove and reinstall belt  
Adjust pulley  
Recharge system  
Pump down compressor  
Add oil to crankcase  
Clean interior cabinet by scraping and wiping

Total Task Time: 2.73 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		2.73		1		3.49

TASK SUMMARY - N

CATEGORY: 2

SYSTEM: Four (4) Ton Pad Mounted Central Air Conditioning Type Unit

DESCRIPTION: Preventive maintenance inspection 3-9 ton, package type, air conditioning system

TASKS

Remove and reinstall screw

Remove and reinstall panel

Grease blower bearing fitting

Lubricate oil cup

Sensory inspect fan

Sensory inspect blower

Wipe motor and condenser

Inspect sight glass

Inspect for leaks

Remove and reinstall disposable filter

Fill out inspection report

Total Task Time: .74 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.74		3		2.84

TASK SUMMARY - N

CATEGORY: 2

SYSTEM: Four (4) Ton Pad Mounted Central Air Conditioning Type Unit

DESCRIPTION: Fall Shut-Down

TASKS

Turn unit off at disconnect switch

Install cover over unit

Total Task Time: .09 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.09		1		.12

TASK SUMMARY - S-E-A

CATEGORY: 2

SYSTEM: Four (4) Ton Pad Mounted Central Air Conditioning Type Unit

DESCRIPTION: Replace four (4) ton pad mounted single package cooling unit.

TASKS

Disconnect and reinstall power supply

Disconnect and reinstall ductwork

Remove and reinstall anchor bolts

Remove and reinstall A.C. unit

Total Task Time: 4.5 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TASK TIME</u>	<u>JOB PREPARATION</u>	<u>TRAVEL TIME</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>HOURS/TASK</u>
4.5	0.30	0.85	.19 x 4.5	6.5

TASK SUMMARY - N

CATEGORY: 2

SYSTEM: Four (4) Ton Pad Mounted Central Air Conditioning Type Unit

DESCRIPTION: Remove and reinstall air cooled condenser or evaporator in a 3-10 ton package air conditioning unit.

TASKS

- Remove and reinstall screw
- Remove and reinstall panel
- Pump system down into separate cylinder
- Remove and reinstall fitting
- Plug and unplug port opening
- Prepare to remove air cooled condenser
- Remove and reinstall bolt
- Remove and reinstall condenser
- Put air cooled condenser into operation
- Recharge system
- Material handling
- Check operation of system

Total Task Time: 3.06 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>								
<u>TASK TIME</u>	+	<u>JOB PREPARATION</u>	+	<u>TRAVEL TIME</u>	+	<u>CRAFT ALLOWANCE TIME</u>	=	<u>HOURS/TASK</u>
3.06		0.30		0.85		.19 x 3.06		4.79



15 SYSTEM/25 YEAR LIFE CYCLE STUDY

COOLING SYSTEMS CATEGORIES

CATEGORY 3

(5) Systems / A thru E

- (A) 100 ton (Trane) open reciprocating compressor
- (B) 98.8 ton (York) hermetic reciprocating compressor
- (C) 94 ton air cooled condenser (York)
- (D) 100 ton evaporative condenser (B.A.C.)
- (E) 100 ton cooling tower (Marley)

CATEGORY 3 - A

- 3.1 Compressor Data - Trane Open Reciprocating Type - Model E - 100 Ton, 8 Cylinder, Refrig. 22, Compressor Chiller Model H-3E5H8<sup>7</sup>, RMP 1750, bore 3.66 inches, stroke 2.75 inches, force lubrication, crankcase capacity 33.0 pints, unloading steps 100-50 or 100-75-50-37.5 R-22 capacity 192 lbs., operating wt. compressor 2549 lbs., standard motor size 125 hp.
- 3.2 Motor Data - 125 hp, voltage 200, 230, 460, 575, LRA = XL 930, 744, PW = 1390, 1209, 605, 484, FLA = 359, 312, 156, 125, max. fuse 1200, 1200, 600, 500.
- 3.3 Evaporator Data - chiller tube bundle type, 35.0 gal. storage capacity, min. flow rate 120 GPM, max. flow rate 350 GPM, seamless integrally finned copper tubes expanded into tube sheet.
- 3.4 Condenser Data - Model CDS-289 water cooled - shell and tube design with seamless integrally finned copper tubes expanded into the tube sheet. Operating weight condenser unit 3319 lbs.
- 3.5 Valve Data - Unit equipped with oil check valve, permits oil to be returned to the crankcase and prevent loss of oil during start-up.
- Crankcase Check Valve - Internal relief bypass equipped with a spring loaded relief valve for the purpose of relieving excessive head pressure into the suction chamber.
- Oil Charging Valves - All compressors are provided with a seal capped valve in the crankcase for charging or draining oil.
- Liquid Refrigerant Valves - Back seating, cap seal liquid valves furnished on all water cooled condensing units.
- Pressure Relief Valves - All condensing units have spring loaded PRV installed on condensers.
- 3.6 Pump Data - Positive feed, self-reversing oil pump supplies oil to main and connecting rod bearings through drilled crankshaft. Oil pressure failure control is standard on every machine thereby eliminating the possibility of operation without adequate lubrication.
- 3.7 Control Data - Panel (control) is mounted and wired on all units.
- Cylinder Capacity Control - Multi-step capacity controller is provided on all units. Capacity control is suction electric as standard.
- Under Pressure Cutout - (Low pressure and high pressure safety cutout.)
- Oil Pressure Control - Automatic oil pressure safety control activated by differential between crankcase pressure and discharge pressure at the oil pump.
- Control Power Transformer - 115 volt C.P.T. provided.

3-A

OVERALL TIME SUMMARY - BY SYSTEM  
OPEN RECIPROCATING COMPRESSOR CHILLER - 100 TONS

<u>YEARS</u>	<u>P.M. - REPAIRS REPLACEMENT HRS.</u>
1	29.56
2	"
3	32.50
4	29.56
5	"
6	32.50
7	29.56
8	"
9	32.50
10	34.12
11	29.56
12	32.50
13	29.56
14	"
15	32.50
16.	29.56
17	"
18	32.50
19	29.56
20	"
21	"
22	"
23	32.50
24	29.56
25	"
TOTAL	764.14

3-A

TIME SUMMARY - BY COMPONENT  
OPEN RECIPROCATING COMPRESSOR - CHILLER - 100 TONS

Compressor  
Life Cycle 20 Years

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	9.01		
2	"		
3	"	2.94	Replace crankcase heater
4	"		
5	"		
6	"	2.94	Replace crankcase heater
7	"		
8	"		
9	"	2.94	Replace crankcase heater
10	"	4.56	Replace expansion valve
11	"		
12	"	2.94	Replace crankcase heater
13	"		
14	"		
15	"	2.94	Replace crankcase heater
16	"		
17	"		
18	"	2.94	Replace crankcase heater
19	"		
20	"	* Contract	Replace compressor
21	"		
22	"		
23	"	2.94	Replace crankcase heater
24	"		
25	"		
	TOTALS	225.25	25.14

\* 45% approximate cost factor of system total cost

3-A

TIME SUMMARY - BY COMPONENT

OPEN RECIPROCATING COMPRESSOR - CHILLER - 100 TONS

Life Cycle 24 years

\*Evaporator/Condenser

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	6.69		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"		
17	"		
18	"		
19	"		
20	"		
21	"		
22	"		
23	"		
24	"	* * Contract	Replace evaporator/ condenser
25	"		

TOTALS 167.25

\*Use for evaporator and condenser - 167.25 hrs./unit

\*\*25% approximate cost factor of system total cost

3-A

TIME SUMMARY - BY COMPONENT

OPEN RECIPROCATING COMPRESSOR - CHILLER - 100 TONS

Life Cycle 18 years

Motor 125 hp (includes motor starter)

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	4.61		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"		
17	"		
18	"	* Contract	Replace motor
19	"		
20	"		
21	"		
22	"		
23	"		
24	"		
25	"		
TOTALS	115.25		

\* 25% approximate cost factor of system cost

3-A

TIME SUMMARY - BY COMPONENT  
OPEN RECIPROCATING COMPRESSOR - CHILLER - 100 TONS  
CONTROLS/CONTROL PANEL

Life Cycle 16 Years

<u>YEARS</u>	<u>P.M.</u> <u>HOURS</u>	<u>REPAIRS/</u> <u>REPLACEMENT</u>	<u>MATERIAL</u>
1	2.56		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"	* Contract	Replace controls/control panel
17	"		
18	"		
19	"		
20	"		
21	"		
22	"		
23	"		
24	"		
25	"		
TOTALS	64.0		

\* 5% approximate cost factor of system cost

TASK SUMMARY - N

CATEGORY: 3-A

SYSTEM: 100 Ton (Trane) Open Reciprocating Compressor

DESCRIPTION: Clean, lubricate, adjust and inspect over 100 ton, open  
(central compression) air conditioning compressor.

TASKS

Wipe compressor and motor

Check and adjust motor alignment coupling

Lubricate motor and coupling

Drain oil from crankcase - .0717 + N3 (.0165)  
N3 = No. gallons

Fill crankcase with oil - .0213 + N3 (.0185)  
N3 = No. gallons

Prepare and run to pump down

Inspect sight glass

Recharge system

Check for leaks

Check safety devices

Drain water from air tank

Lubricate air compressor

Remove and reinstall drier

Total Task Time: 3.71 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		3.71		1		4.75



TASK SUMMARY - N

CATEGORY: 3-A

SYSTEM: 100 Ton (Trane) Open Reciprocating Compressor

DESCRIPTION: Preventive maintenance inspection over 25 ton open (central compression) air conditioning compressor

TASKS

Wipe compressor and motor

Check motor alignment and adjust

Inspect sight glass and gages

Lubricate bearings

Add oil - .0213 + N3 (.0185)  
N3 = No. gallons

Drain air tank

Inspect for leaks

Check for proper operation

Fill out inspector report

Total Task Time: .94 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time (Hrs/Yr)</u>
1.28		.94		3		3.61

TASK SUMMARY - N

CATEGORY: 3-A

SYSTEM: 100 Ton (Trane) Open Reciprocating Compressor

DESCRIPTION: Fall shut down all compressors. Seasonal operation.

TASKS

Prepare and pump down system into receiver

Check system for leaks and note

Turn switch off

Fill out inspectors report

Total Task Time: .51 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.51		1		.65

TASK SUMMARY - S-E-A

CATEGORY: 3-A

SYSTEM: 100 Ton (Trane) Open Reciprocating Compressor

DESCRIPTION: Remove and reinstall compressor crankcase heater.

TASKS

- Pump down compressor
- Remove and reinstall drain plug
- Drain and refill crankcase
- Remove and reinstall inspection plate
- Remove and reinstall heater
- Connect, operate and disconnect vacuum pump
- Recharge system
- Check for leaks

Total Task Time: 1.5 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>								
<u>TASK TIME</u>	<u>+</u>	<u>JOB PREPARATION</u>	<u>+</u>	<u>TRAVEL TIME</u>	<u>+</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>=</u>	<u>HOURS/TASK</u>
1.5		0.30		0.85		.19 x 1.5		2.94

TASK SUMMARY - N

CATEGORY: 3-A

SYSTEM: 100 Ton (Trane) Open Reciprocating Compressor

DESCRIPTION: Remove and reinstall expansion valve on 25-99 ton open  
compression air conditioning system

TASKS

Pump down system into receiver  
Remove and install fitting  
Plug and unplug port openings  
Prepare to remove expansion valve  
Remove and reinstall expansion valve  
Put expansion valve into operation  
Recharge system  
Check operation of system  
Material handling

Total Task Time: 2.87 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>				
<u>TASK TIME</u>	<u>JOB PREPARATION</u>	<u>TRAVEL TIME</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>HOURS/TASK</u>
2.87	0.30	0.95	.19 x 2.87	4.56

TASK SUMMARY - N

CATEGORY: 3-A

SYSTEM: Condenser

DESCRIPTION: Drain, remove and reinstall end plates, punch clean tubes and refill a 100-200 ton shell and tube condenser or chilled water evaporator

TASKS

Remove and reinstall filling pipe

Drain and fill tubes, per gallon

Remove and reinstall nut

Remove and reinstall plate cover

Punch clean tube up to 14' long, up to 1" O.D. -  $.0240 + N (.0088)$   
N = No. of tubes

Dry tube with rag -  $.0240 + N (.0088)$   
N = No. of tubes

Cut gasket up to 2 sq. ft. -  $.0156 + N (.1180)$   
N = No. of gaskets cut

Mark and punch holes in gasket -  $.0021 + N1 (.0074)$   
N1 = No. of holes punched

Install gaskets

Material handling

Total Task Time: 5.23 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		5.23		1		6.69

TASK SUMMARY - S-E-A

CATEGORY: 3-A

SYSTEM: Compressor Motor

DESCRIPTION: Planned maintenance

TASKS

Check ventilation ports for soil accumulation, clean if necessary

Clean exterior of motor surfaces of soil accumulation

Lubricate bearings according to horsepower ratings:

<u>HP RANGE</u>	<u>FREQUENCY</u>
1 - 7.5	Every 4 years
10 - 50	Yearly
Over 50 hp	Two times/year

- a. Remove filler and drain plugs (use zerk fittings if installed)
- b. Free drain hole of any hard grease (use piece of wire if necessary)
- c. Add grease; use good grade lithium base grease unless otherwise noted.

Check motor windings for accumulation of soil. Blow out with air if required.

Remove tags and return to service

1 - 7.5 hp  
10 - 50 hp  
Over 50 hp

Total Task Time: .60 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.60		1		.77

TASK SUMMARY - GSA

CATEGORY: 3-A

SYSTEM: Motor Starters

DESCRIPTION: Annual Maintenance or Spring Start-up

TASKS

- Tighten all connections to main bus.
- Inspect breakers and fuses connected to the main bus for tightness.
- Inspect starter coils. Clean contacts, replace as required.
- Use vacuum or dry compressed air to remove dust or other material which may cause shorts or arcing.
- Inspect all interlocks and controls. Clean and lightly lubricate friction points. Remove excess lubricant. (Refer to manufacturers instructions.)
- Test starter heaters for correct design amperage and size.
- Operate breakers to insure proper making.
- Visually inspect for broken parts, contact arcing or any evidence of overheating.
- Check motor nameplate for current rating and controller manufacturer's recommended heater size. (Heater size shall not be changed without the regional design engineer's approval.)
- Check line and load connections and heater mounting screws for tightness.
- Perform time/current characteristics test at the appropriate multiple of heater rating.
- Record test results on GSA Form 2543, Circuit Breaker Test Record. Show both as found and as left.
- Check contact resistance in micro-ohms and dielectric strength in meg-ohms.
- Check starter connection by applying a thin film of black contact grease to the line and load stabs, then rack the breaker in and out of the cubicle and measure the wipe marks on the stab.
- Remove tags and lock and return circuit to service.

Total Task Time: 3.0 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		3.0		1		3.84

TASK SUMMARY - GSA

CATEGORY: 3-A

SYSTEM: Controls, Central Air Conditioning

DESCRIPTION: Annual maintenance or spring start-up

TASKS

Check set point of controls (temperature, pressure, or safety).

Compare control point with an external measuring device, note deviations, and adjust/calibrate.

Check the unit over its range of control. If possible, improve simulated conditions to activate controls and check operation.

Check for control point cycling.

Check closeness of differential gap on two position controllers (on-off-open-closed).

Check condition and action of primary elements in the controllers (bi-metallic strips, sealed bellows with capillary tubes) for remote sensing, etc.

Note the action of the controlling device (thermostats and pressurestats) which changes the controlled devices.

On electronic controls check the source of the signal and its amplification.

Check air systems for leaks, check for correct maintenance of pressure in all control devices. Check units for proper closing and loose connections.

Check resulting action of pressure sensing primary control elements such as diaphragms, bellows, inverted bells, and similar devices when activated by air, water, or similar pressure. Check operation of all relays, pilot valves, and pressure regulators.

Use test kits and manufacturer's instructions whenever possible. Replace rather than rebuild a control installed in the system. Take control to shop for repair.

Total Task Time: 2.00 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		2.0		1		2.56



CATEGORY 3 - B

- 3.2.1 Compressor Data - York Hermetic Reciprocating Chiller (Packaged Liquid)  
Rated 98.8 Tons - LCH100W-Water Cooled Type. 8 cylinders; 1750 RPM; %  
reduction from full load capacity (75,50,25). W-Model operating  
weight 4400 lbs., shipping weight 4260 lbs. Operating charge R-22 at  
130 lbs.; oil = 3.5 gals. Unit power 460-3.60, voltage limitations:  
Min. = 414, max. = 506; full load amp. = 137; locked rotor amps = 685;  
minimum circuit ampacity = 172; kw 93.3, GPM cooler 237.2, GPM  
condenser 301.0.
- 3.2.2 Evaporator Data - High efficiency, cross baffled cooler. Direct expansion  
LCH type has roll-expanded into the tube sheets providing a leak tight  
circuit. Working pressure of 225 psi (refrigerant); water side shell  
has a design working pressure of 150 psi.
- 3.2.3 Condenser Data - 3-pass water cooled type (shell and tube) with relief  
and purge valve. Refrigerant (shell) side has a design working pressure  
of 300 psi; the water (tube) side has a design working pressure of 150 psi.
- 3.2.4 Motor Data - 1750 RPM, refrigerant gas cooled, with three (3) phase  
inherent overload protection; voltages available include 200, 230, 460, 575.
- 3.2.5 Control Data - Equipped with convenient 3-position switch, quick-reading  
safety signals, total system pressure gages, solid state operating  
control, programmed starting timer, oil pressure cutout protection,  
automatic low and high pressure cutout, automatic freeze protection,  
crankcase heater and liquid line solenoid, interlocks for inherent motor  
protectors, 4-stage solid state operating thermostat.
- 3.2.6 Valve Data - Suction and discharge stop valves are seal cap with pressure  
taps and sweat type flanged adapters. Tight seating stop valves to  
isolate compressor.
- 3.2.7 Pump Data - Lubrication is force fed by self-priming, reversible, gear  
type oil pump to all crankshaft bearing surfaces through a fine mesh  
monel oil strainer.

3-B

OVERALL TIME SUMMARY - BY SYSTEM

HERMETIC RECIPROCATING COMPRESSOR - CHILLER - 100 TONS

<u>YEARS</u>	<u>P.M. - REPAIRS REPLACEMENT HRS.</u>
1	27.78
2	"
3	30.72
4	27.78
5	"
6	30.72
7	27.78
8	"
9	30.72
10	32.34
11	27.78
12	30.72
13	33.69
14	27.78
15	30.72
16	27.78
17	"
18	"
19	"
20	"
21	30.72
22	27.78
23	"
24	30.72
25	27.78
TOTAL	725.55

3-B

TIME SUMMARY - BY COMPONENT  
HERMETIC RECIPROCATING COMPRESSOR - CHILLER - 100 TONS

COMPRESSOR/MOTOR

Life Cycle 18 Years

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	8.0		
2	"		
3	"	2.94	Replace crankcase heater
4	"		
5	"		
6	"	2.94	Replace crankcase heater
7	"		
8	"		
9	"	2.94	Replace crankcase heater
10	"	4.56	Replace expansion valve
11	"		
12	"	2.94	Replace oil sump heater
13	"	5.91	Replace purge unit
14	"		
15	"	2.94	Replace crankcase heater
16	"		
17	"		
18	"	* Contract	Replace compressor/motor
19	"		
20	"		
21	"	2.94	Replace crankcase heater
22	"		
23	"		
24	"	2.94	Replace crankcase heater
25	"		
TOTALS		200.0	31.05

\* 45% approximate cost factor of system cost

3-B

TIME SUMMARY - BY COMPONENT

HERMETIC RECIPROCATING COMPRESSOR - CHILLER - 100 TONS

CONDENSER/COOLER \*

Life Cycle 24 Years

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	6.69		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"		
17	"		
18	"		
19	"		
20	"		
21	"		
22	"		
23	"		
24	"	** Contract	Replace condenser/cooler
25	"		
	TOTALS	167.25	

\*Use for condenser and cooler 167.25 hrs./unit

\*\*25% approx. cost factor of system cost

3-B

TIME SUMMARY - BY COMPONENT  
HERMETIC RECIPROCATING COMPRESSOR - CHILLER - 100 TONS  
MOTOR STARTER

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	3.84		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"		
17	"		
18	"	* Contract	Replace starter
19	"		
20	"		
21	"		
22	"		
23	"		
24	"		
25	"		
	TOTALS		
	96.0		

\* 10% approx. cost factor of system cost

3-B

TIME SUMMARY - BY COMPONENT

HERMETIC RECIPROCATING COMPRESSOR - CHILLER - 100 TONS

CONTROLS/CONTROL PANEL

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	2.56		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"	* Contract	Replace controls/ control panel
17	"		
18	"		
19	"		
20	"		
21	"		
22	"		
23	"		
24	"		
25	"		
TOTALS	64.0		

\* 5% approx. cost factor of system cost

TASK SUMMARY - N

CATEGORY: 3-B

SYSTEM: York Hermetic Reciprocating Compressor - 98.8 Ton

DESCRIPTION: Clean, lubricate, adjust and inspect over 100 ton, hermetic air conditioning compressor

TASKS

Wipe compressor and motor

Drain oil from crankcase - .0717 + N3 (.0165)  
N3 = No. gallons

Fill crankcase with oil - .0213 + N3 (.0185)  
N3 = No. gallons

Prepare and run to pump down

Inspect sight glass

Recharge system

Check for leaks

Check safety devices

Drain water from air tank

Lubricate air compressor

Remove and reinstall drier

Total Task Time: 3.00 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		3.0		1		3.84

TASK SUMMARY - N

CATEGORY: 3-B

SYSTEM: York Hermetic Reciprocating Compressor - 98.8 Ton

DESCRIPTION: Preventive maintenance inspection over 25 ton hermetic air conditioning compressor.

TASKS

Wipe compressor and motor

Inspect sight glass and gages

Add oil - .0213 + N3 (.0185)  
N3 = No. gallons

Drain air tank

Inspect for leaks

Check for proper operation

Fill out inspector report

Total Task Time: .94 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.94		3		3.61



TASK SUMMARY - N

CATEGORY: 3-B

SYSTEM: York Hermetic Reciprocating Compressor - 98.8 Tons

DESCRIPTION: Fall shut down all compressors. Seasonal operation.

TASKS

Prepare and pump down system into receiver

Check system for leaks and note

Turn switch off

Fill out inspectors report

Total Task Time: .51 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.51		1		.65

TASK SUMMARY - N

CATEGORY: 3-B

SYSTEM: York Hermetic Reciprocating Compressor - 98.8 Tons

DESCRIPTION: Remove and reinstall expansion valve on 100 ton hermetic air conditioning system.

TASKS

- Pump down system into receiver
- Remove and install fitting
- Plug and unplug port openings
- Prepare to remove expansion valve
- Remove and reinstall expansion valve
- Put expansion valve into operation
- Recharge system
- Check operation of system
- Material handling

Total Task Time: 2.87 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>								
<u>TASK TIME</u>	<u>+</u>	<u>JOB PREPARATION</u>	<u>+</u>	<u>TRAVEL TIME</u>	<u>+</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>=</u>	<u>HOURS/TASK</u>
2.87		0.30		0.85		.19 x 2.87		4.56

TASK SUMMARY - S-E-A

CATEGORY: 3-B

SYSTEM: York Hermetic Reciprocating Compressor - 98.8 Tons

DESCRIPTION: Remove and reinstall compressor crankcase heater.

TASKS

Pump down compressor

Remove and reinstall drain plug

Drain and refill crankcase

Remove and reinstall inspection plate

Remove and reinstall heater

Connect, operate, and disconnect vacuum pump

Recharge system

Check for leaks

Total Task Time: 1.5 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>				
<u>TASK TIME</u>	<u>JOB PREPARATION</u>	<u>TRAVEL TIME</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>HOURS/TASK</u>
1.5	0.30	0.85	.19 x 1.5	2.94

TASK SUMMARY - N

CATEGORY: 3-B

SYSTEM: York Hermetic Reciprocating Compressor - 98.8 Tons

DESCRIPTION: Remove and reinstall purge unit

TASKS

Close and open shut-off valve on refrigerant to line running to purge unit

Disconnect and connect purge unit

Remove and reinstall purge unit

Put purge unit into operation

Check operation of system

Total Task Time: 4.0 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TASK TIME</u>	+	<u>JOB PREPARATION</u>	+	<u>TIME CALCULATION HOURS/TASK</u>	+	<u>TRAVEL TIME</u>	+	<u>CRAFT ALLOWANCE TIME</u>	=	<u>HOURS/TASK</u>
4.0		0.30		0.35		.19 x 4.0				5.91

TASK SUMMARY - N

CATEGORY: 3-B

SYSTEM: York Hermetic Reciprocating Compressor - 98.8 Tons  
Condenser/Cooler

DESCRIPTION: Drain, remove and reinstall end plates, punch clean tubes and  
refill a 100-200 ton shell and tube condenser or chilled water  
evaporator

TASKS

Remove and reinstall filling pipe

Drain and fill tubes, per gallon

Remove and reinstall nut

Remove and reinstall plate cover

Punch clean tube up to 14' long, up to 1" O.D. -  $.0240 + N (.0088)$   
N = No. of tubes

Dry tube with rag -  $.0240 + N (.0088)$   
N = No. of tubes

Cut gasket up to 2 sq. ft. -  $.0156 + N (.1180)$   
N = No. of gaskets cut

Mark and punch holes in gasket -  $.0021 + N1 (.0074)$   
N = No. of holes punched

Install gaskets

Material handling

Total Task Time: 5.23 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		5.23		1		6.69

TASK SUMMARY - GSA

CATEGORY: 3-B

SYSTEM: Motor Starters

DESCRIPTION: Annual maintenance or spring start-up

TASKS

Tighten all connections to main bus.

Inspect breakers and fuses connected to the main bus for tightness.

Inspect starter coils. Clean contacts; replace as required.

Use vacuum or dry compressed air to remove dust or other material which may cause shorts or arcing.

Inspect all interlocks and controls. Clean and lightly lubricate friction points. Remove excess lubricant. (Refer to manufacturer's instructions.)

Test starter heaters for correct design amperage and size.

Operate breakers to insure proper making.

Visually inspect for broken parts, contact arcing or any evidence of overheating.

Check motor nameplate for current rating and controller manufacturer's recommended heater size (heater size shall not be changed without the regional design engineer's approval).

Check line and load connections and heater mounting screws for tightness.

Perform time/current characteristics test at the appropriate multiple of heater rating.

Record test results on GSA Form 2543, Circuit Breaker Test Record. Show both as found and as left.

Check contact resistance in micro-ohms and dielectric strength in meg-ohms.

Check starter connection by applying a thin film of black contact grease to the line and load stabs; then rack the breaker in and out of the cubicle and measure the wipe marks on the stab.

Remove tags and lock and return circuit to service.

Total Task Time: 3.00 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		3.00		1		3.84

TASK SUMMARY - GSA

CATEGORY: 3-B

SYSTEM: Controls, Central Air Conditioning

DESCRIPTION: Annual maintenance or start-up

TASKS

- Check set point of controls (temperature, pressure, and safety).
- Compare control point with an external measuring device, note deviations, and adjust/calibrate.
- Check the unit over its range of control. If possible, impose simulated conditions to activate controls and check operation.
- Check for control point cycling.
- Check closeness of differential gap on two position controllers (on-off-open-closed).
- Check condition and action of primary elements in the controllers (bi-metallic strips, sealed bellows with capillary tubes) for remote sensing, etc.
- Note the action of the controlling device (thermostats and pressurestats) which changes the controlled devices.
- On electronic controls check the source of the signal and its amplification.
- Check air systems for leaks; check for correct maintenance of pressure in all control devices. Check units for proper closing and loose connections.
- Check resulting action of pressure sensing primary control elements such as diaphragms, bellows, inverted bells, and similar devices when activated by air, water, or similar pressure. Check operation of all relays, pilot valves, and pressure regulators.
- Use test kits and manufacturer's instructions whenever possible. Replace rather than rebuild a control installed in the system. Take control to shop for repair.

Total Task Time: 2.0 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		2.0		1		2.56

CATEGORY 3-C

- 3.3.1 Air Cooled Condenser, Rated 94 Tons - York RC-10, 104 kw at 85°F condenser air entering temperature (based on leaving temp. of 44°F (supply water). NOTE: System matched with York LCH-100A, GPM rating at 226.
- 3.3.2 Fan/Motor Data - Quantity 10, diameter 30 inches, (4) four blades per fan, fan pitch 20°, H.P. 1-1/2 (10), RPM 1130, frame size 56, kw input per fan at 1.3, bearing type = ball. F.L.A. at 230/460 V = 4.6/2.3, motor is permanent. Split-capacitor type with permanently lubricated ball bearings.
- 3.3.3 Coil Data - Ext. surface 15,405 sq. ft., face area 166.7 sq. ft., tube type 3/8 inch O.D. x .0165 wall copper, fins at 14 per inch x .006 inch thick aluminum, 3 rows deep coil height 30", length 80" with vertical air flow.
- 3.3.4 Voltage Data - Power supply 200/230-3-60, 460-3-60, 575-3-60, disconnect switch size amp 100, 30, 30, volt 250, 600, 600. Minimum circuit ampacity (RC10) 62,27,24. Maximum dual element fuse size amp. 70,30,25, volt 250, 600, 600.
- 3.3.5 Control Data - Low ambient control of the RC type condensers is suitable for ambient temperatures down to 40°F. This control is accomplished by cycling one of the two banks of fan motors with ambient temperature. The control is set to open at 65°F,  $\pm 2^\circ\text{F}$ , and close at 70°F,  $\pm 1^\circ\text{F}$ , which is suitable for most applications. Cold cut-out limit is 57°F,  $\pm 2^\circ\text{F}$ , and warm cut-in is 78°F,  $\pm 2^\circ\text{F}$ . Note the thermostat is located in a control box at the front of the unit.



3-C

OVERALL TIME SUMMARY - BY SYSTEM

AIR COOLED CONDENSER - 94 TONS

<u>YEARS</u>	<u>P.M. - REPAIRS REPLACEMENT HRS.</u>
1	5.77
2	"
3	"
4	"
5	"
6	"
7	"
8	"
9	"
10	"
11	"
12	"
13	"
14	"
15	12.87
16	5.77
17	"
18	"
19	"
20	"
21	"
22	"
23	"
24	"
25	"
TOTAL	151.35

TIME SUMMARY - BY COMPONENT

3-C

AIR COOLED CONDENSER - 94 TONS

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	5.77		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"	7.1	Replace motors
16	"		
17	"		
18	"		
19	"		
20	"	* Contract	Replace condenser
21	"		
22	"		
23	"		
24	"		
25	"		
TOTALS	144.25	7.1	

\* 80% approx. cost factor of system cost

TASK SUMMARY - N

CATEGORY: 3-C

SYSTEM: Air Cooled Condenser York 94 Tons

DESCRIPTION: Clean, lubricate, adjust and inspect 100 ton air cooled condenser

TASKS

Remove and reinstall screw

Remove and reinstall panel

Clean inside of cabinet with water hose -  $.1862 + N (.0006)$   
N = No. of sq. ft.

Clean inside cabinet by scraping, brushing, and wiping -  $.0231 + N (.0103)$   
N = No. of sq. ft.

Clean fan

Lubricate fan

Clean, lubricate and adjust motor

Material handling

Total Task Time: 2.32 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		2.32		1		2.97

TASK SUMMARY - N

CATEGORY: 3-C

SYSTEM: Air Cooled Condenser York 94 Tons

DESCRIPTION: Preventive maintenance inspection all sizes air cooler condensers. Per fan assembly.

TASKS

Remove and reinstall screw

Remove and reinstall panel

Lubricate bearings

Adjust belt tension

Sensory inspect fan and motor

Fill out inspector report

Total Task Time: .62 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.62		3		2.38

TASK SUMMARY - N

CATEGORY: 3-C

SYSTEM: Air Cooled Condenser York 94 Tons

DESCRIPTION: Fall shut-down -- all air cooled condensers. Seasonal operation -- per fan assembly.

TASKS

Remove and reinstall screw

Remove and reinstall panel

Sensory inspect bearings

Fill out inspector report

Turn off switch

Total Task Time: .33 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time (Hrs/Yr)</u>
1.28		.33		1		.42

TASK SUMMARY - S-E-A

CATEGORY: 3-C

SYSTEM: Air Cooled Condenser York 94 Tons

DESCRIPTION: Remove and reinstall condenser fan motor

TASKS

Remove and reinstall access panels

Disconnect and connect wiring to motor

Remove and install motor

Start fan

Total Task Time: .5 Hour

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>				
<u>TASK TIME</u>	JOB <u>PREPARATION</u>	<u>TRAVEL TIME</u>	CRAFT <u>ALLOWANCE TIME</u>	<u>HOURS/TASK</u>
0.5 x 10	0.30	0.85	.19 x 0.5	6.2
147				

CATEGORY 3-D

- 3.4.1 B.A.C. Evaporative Condenser VCX Type 90 Rated at 1,323.0 MBH (Heat Rejection) Tonnage Equivalent of Approx. 100 Tons.  
Base heat rejection for open compressors - T.H.R. = compressor evaporator capacity (BTUH) + compressor GHP x 2545; hermetic compressors - T.H.R. = compressor evaporator capacity (BTUH) + compressor KW x 3415.  
Single coil section unit.
- 3.4.2 System Data - V X C - 90  
Approx. shipping weight - 4000 lbs.  
Approx. operating weight - 4750 lbs.  
Coil section weight - 2850 lbs.  
CFM - 14,000  
Fan motor h.p. (0" ESP) 7-1/2 h.p.  
GPM - 115  
Pump motor h.p. - 3/4  
System size O.D. sump (remove) 10-1/2 inches x 8 ft. 11-3/4 inches, bottom drain size = 4", F at 48-1/4, H at 112-1/2.
- 3.4.3 Fan Data - A forwardly curved centrifugal fan that is statically and dynamically balanced. Fan housing shall have curved inlet rings for efficient air entry, and rectangular discharge cowls shall extend into the pan to increase fan efficiency and prevent water from entering the fans.
- 3.4.4 Motor Data - drip-proof ball bearing fan motor with a 1.15 service factor. V-belt fan drive to be designed for not less than 150% of motor nameplate h.p.
- 3.4.5 Pump Data - water pump is a close coupled, bronze fitted centrifugal pump with a mechanical seal.
- 3.4.6 Bearing Data - All bearings and drive-end bearings are heavy-duty grease packed self-aligning ball bearings with cast iron bodies, electrical locking collars and accessible lubrication fittings.
- 3.4.7 Capacity Control - Modulating fan discharge dampers, which match evaporative condenser capacity to system heat rejection, while maintaining constant condensing temperatures. Fan h.p. is reduced as the dampers modulate from the full open position. Fan cycling and two-speed fan motor systems are available.
- 3.4.8 Optional accessory equipment -
- sub-cooling coils
  - multiple circuit coils
  - capacity control dampers
  - de-superheaters (for systems with R-717)
  - sound attenuation
  - pan water heaters
  - electric water level control
  - bottom panels and screens

3-D

OVERALL TIME SUMMARY - BY SYSTEM

EVAPORATIVE CONDENSER - 100 TONS

<u>YEARS</u>	<u>P.M. - REPAIRS REPLACEMENT HRS.</u>
1	17.66
2	"
3	"
4	"
5	"
6	"
7	"
8	"
9	"
10	"
11	21.19
12	"
13	17.66
14	"
15	"
16	"
17	"
18	"
19	"
20	"
21	"
22	"
23	"
24	"
25	"
TOTAL	448.56



3-D

TIME SUMMARY - BY COMPONENT

EVAPORATIVE CONDENSER - 100 TONS

Life Cycle 20 Years

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	17.66		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"	3.53	Replace fan motor
12	"	3.53	Replace fan shaft bearings
13	"		
14	"		
15	"		
16	"		
17	"		
18	"		
19	"		
20	"	* Contract	Replace condenser
21	"		
22	"		
23	"		
24	"		
25	"		
	TOTALS	441.50	7.06

\* 95% approx. cost factor of system cost

TASK SUMMARY - N

CATEGORY: 3-D

SYSTEM: 100 ton evaporative condenser (B.A.C.)

DESCRIPTION: Clean, lubricate, adjust and inspect 100-199 ton evaporative condenser or metal cooling tower. Includes draining and filling. Does not include acid clean.

TASKS

Remove and reinstall screw  
Remove and reinstall panel  
Clean inside cabinet with water hose  
Clean inside cabinet by scraping, brushing, wiping  
Clean blower fan  
Lubricate fan  
Clean, lubricate, adjust motor  
Remove and reinstall belt  
Clean water pump  
Lubricate water pump  
Remove and reinstall nozzle  
Clean nozzle  
Remove and reinstall float  
Clean float  
Adjust float  
Remove and reinstall baffle  
Fill and drain condenser

TOTAL TASK TIME: 8.99 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		8.99		1		11.51

TASK SUMMARY - N

CATEGORY: 3-D

SYSTEM: 100 ton evaporative condenser (B.A.C.)

DESCRIPTION: Preventive maintenance inspection 25 ton and over evaporative condenser or metal cooling tower.

TASKS

- Remove and reinstall screw
- Remove and reinstall panel
- Lubricate bearings, fan, motor, pump
- Adjust belt tension
- Adjust float
- Sensory inspect bearings
- Fill out inspector report

TOTAL TASK TIME: 1.09 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		1.09		3		4.18

TASK SUMMARY - N

CATEGORY: 3-D

SYSTEM: 100 ton evaporative condenser (B.A.C.)

DESCRIPTION: Fall shut down 10 199 ton evaporative condensers or metal cooling tower. Seasonal operation.

TASKS

Remove and reinstall screw

Remove and reinstall panel

Sensory inspect bearings

Drain water

Turn switch off

Fill out inspector report

TOTAL TASK TIME: 1.24 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		1.24		1		1.59

TASK SUMMARY - S-E-A

CATEGORY: 3-D  
SYSTEM: 100 ton evaporative condenser (B.A.C.)  
Electric Motor

DESCRIPTION: Annual maintenance or spring start-up

TASKS

1. Check ventilation ports for soil accumulation; clean if necessary.
2. Clean exterior of motor surfaces of soil accumulation.
3. Lubricate bearings according to horsepower ratings:

<u>HP RANGE</u>	<u>FREQUENCY</u>
1-7.5	every 4 years
10-50	yearly
over 50 hp	two times/year

- a. Remove filler and drain plugs (use zerk fittings if installed)
  - b. Free drain hole of any hard grease (use piece of wire if necessary).
  - c. Add grease; use good grade lithium base grease unless otherwise noted
4. Check motor windings for accumulation of soil. Blow out with air if required.
  5. Remove tags and return to service.

1-7.5 hp  
10-50 hp  
over 50 hp

TOTAL TASK TIME: .30 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.30		1		.38

TASK SUMMARY - S-E-A

CATEGORY: 3-D

SYSTEM: 100 ton evaporative condenser (B.A.C.)

DESCRIPTION: Remove and reinstall fan motor for 100 ton evaporative condenser

TASKS

Remove and install access panels

Remove and install belts

Disconnect and connect wiring to motor

Remove and install motor

Remove and install motor pulley

Align pulleys

Check operation of motor

TOTAL TASK TIME: 2.0 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>								
<u>TASK TIME</u>	+	<u>JOB PREPARATION</u>	+	<u>TRAVEL TIME</u>	+	<u>CRAFT ALLOWANCE TIME</u>	=	<u>HOURS/TASK</u>
2.0		0.30		0.85		.19 x 2.0		3.53

TASK SUMMARY - S-E-A

CATEGORY: 3-D

SYSTEM: 100 ton evaporative condenser (B.A.C.)

DESCRIPTION: Remove and install fan shaft bearings for 100 ton evaporative condenser

TASKS

Remove and install access panels

Remove and install belts

Remove and install fan shaft pulley

Remove and install bearings

Align pulleys

Check operation of fan

TOTAL TASK TIME: 2.0 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>				
<u>TASK TIME</u>	<u>JOB PREPARATION</u>	<u>TRAVEL TIME</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>HOURS/TASK</u>
2.0	0.30	0.85	.19 x 2.0	3.53

CATEGORY 3 - E

- 3.5.1 Marley 47100 Super Aquatower Nominal Tonnage at 100 based on (95° - 85° - 78° - 3GPM 1 Ton)  
System length - 8' 3 5/8 inches, width - 7' 11 inches, height - 8' 3 5/8 inches, shipping weight 2260 lbs., operating weight 5540 lbs. G.P.M. minimum - 100, G.P.M. maximum 400, number of orifices 65, suction (beveled) 6 inches, overflow (female) 2 inches, drain (female) 2 inches, float valve (male) 1½ inches, inlet size 6 inches, operating water level 5 inches, overflow level 1 ft. 5/8 inches.
- 3.5.2 Motor Data - motor h.p. (one), fan diameter 48, RPM - 647, CFM (approximately) 24,850, bearing housing - Marley type 118. Horizontal motor discharge, motor 3 phase, 60 hertz, 230/460 volt or 200 volt, 1750 r.p.m.
- 3.5.3. Fan Data - eight (8) bladed, V-belt driven fans are mounted on bearing housing with external lubrication lines.
- 3.5.4 Basin Fixtures - Tower is equipped with bronze, automatic make-up water control valves. Note overflow, drain, suction fitting and suction screens are supplied.
- 3.5.5. General Data - All steel utilized in the manufacture of Super Aquatowers is galvanized, providing a finish on both interior and exterior which is recognized for durability and long, maintenance - free service life.
- Splash box - 14 gauge steel
  - Distribution nozzles - Marley type ST - polypropylene
  - Hot water basin - 15 gauge steel
  - Solid back v-belt drive
  - Top sheet - 14 gauge steel
  - Fan sheet - 14 gauge steel
  - Casing sheet - 14 gauge steel
  - Fill type - M106EH PVC with integral
  - Fan guard - 8 gauge rings on 1 inch centers  
3 gauge diameter spokes
  - Louver type - form steel sheets
  - Fan cylinder - 14 gauge type steel
  - Skid - 12 gauge steel



OVERALL TIME SUMMARY - BY SYSTEM

100 ton cooling tower (Marley)

<u>YEARS</u>	<u>P.M. - REPAIRS REPLACEMENT HRS.</u>
1	17.66
2	"
3	"
4	"
5	"
6	"
7	"
8	"
9	"
10	21.19
11	22.98
12	17.66
13	"
14	"
15	"
16	"
17	"
18	"
19	"
20	"
21	"
22	"
23	"
24	"
25	"

TOTAL 450.35

TIME SUMMARY - BY COMPONENT

100 ton cooling tower (Marley)

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	17.66		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"	3.53	Replace fan motor
11	"	5.32	Replace fan shaft bearings
12	"		
13	"		
14	"		
15	"		
16	"		
17	"		
18	"		
19	"		
20	"		* Contract Replace cooling tower
21	"		
22	"		
23	"		
24	"		
25	"		
	TOTALS	441.50	8.85

\* 95% approx. cost factor of system cost

TASK SUMMARY - N

CATEGORY: 3-E

SYSTEM: 100 ton cooling tower (Marley)

DESCRIPTION: Clean, lubricate, adjust and inspect 100-199 ton evaporative condenser or metal cooling tower, including draining and filling. Does not include acid clean.

TASKS

- Remove and reinstall screw
- Remove and reinstall panel
- Clean inside cabinet with water hose
- Clean inside cabinet by scraping, brushing, wiping
- Clean blower fan
- Lubricate fan
- Clean, lubricate, adjust motor
- Remove and reinstall belt
- Clean water pump
- Lubricate water pump
- Remove and reinstall nozzle
- Clean nozzle
- Remove and reinstall float
- Clean float
- Adjust float
- Remove and reinstall baffle
- Fill and drain condenser

TOTAL TASK TIME: 8.99 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		8.99		1		11.51

TASK SUMMARY - N

CATEGORY: 3-E

SYSTEM: 100 ton cooling tower (Marley)

DESCRIPTION: Preventive maintenance inspection 25 ton and over evaporative condenser or metal cooling tower.

TASKS

Remove and reinstall screw

Remove and reinstall panel

Lubricate bearings, fan, motor, pump

Adjust belt tension

Adjust float

Sensory inspect bearings

Fill out inspector report

TOTAL TASK TIME: 1.09 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		1.09		3		4.18

TASK SUMMARY - N

CATEGORY: 3-E

SYSTEM: 100 ton cooling tower (Marley)

DESCRIPTION: Fall shut down 100-199 ton evaporative condensers or metal cooling tower. Seasonal operation.

TASKS

Remove and reinstall screw

Remove and reinstall panel

Sensory inspect bearings

Drain water

Turn switch off

Fill out inspector report

TOTAL TASK TIME: 1.24 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		1.24		1		1.59

TASK SUMMARY - S-E-A

CATEGORY: 3-E

SYSTEM: 100 ton cooling tower (Marley)

DESCRIPTION: Annual Maintenance or Start-Up

TASKS

Check ventilation ports for soil accumulation; clean if necessary.

Clean exterior of motor surfaces of soil accumulation.

Lubricate bearings according to horsepower ratings:

<u>HP RANGE</u>	<u>FREQUENCY</u>
1-7.5	every 4 years
10-50	yearly
over 50 hp	two times/year

- a. Remove filler and drain plugs (use zerk fittings if installed)
- b. Free drain hole of any hard grease (use piece of wire if necessary).
- c. Add grease; use good grade lithium base grease unless otherwise noted.

Check motor windings for accumulation of soil. Blow out with air required.

Remove tags and return to service.

1-7.5 hp  
10-50 hp  
over 50 hp

TOTAL TASK TIME: .30 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.30		1		.38

TASK SUMMARY - S-E-A

CATEGORY: 3-E

SYSTEM: 100 ton cooling tower (Marley)

DESCRIPTION: Remove and install fall shaft bearings for 100 ton metal cooling tower.

TASKS

Remove and install access panels

Remove and install belts

Remove and install fan shaft pulley

Align pulleys

Check operations of fan

TOTAL TASK TIME: 3.5 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>				
<u>TASK TIME</u>	<u>JOB PREPARATION</u>	<u>TRAVEL TIME</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>HOURS/TASK</u>
3.5	0.30	0.85	.19 x 3.5	5.32

TASK SUMMARY - S-E-A

CATEGORY: 3-E

SYSTEM: 100 ton cooling tower (Marley)

DESCRIPTION: Remove and install fan motor for 100 ton metal cooling tower.

TASKS

- Remove and install access panels
- Remove and install belts
- Disconnect and connect wiring to motor
- Remove and install motor
- Remove and install pulley
- Align pulley
- Check operation of motor

TOTAL TASK TIME: 2.0 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>								
<u>TASK TIME</u>	+	<u>JOB PREPARATION</u>	+	<u>TRAVEL TIME</u>	+	<u>CRAFT ALLOWANCE TIME</u>	=	<u>HOURS/TASK</u>
2.0		0.30		0.85		.19 x 2.0		3.53



15 SYSTEM/25 YEAR LIFE CYCLE STUDY

COOLING SYSTEMS CATEGORIES

CATEGORY 4

(5) Systems / A thru E

- (A) 279 ton centrifugal/hermetic compressor (Trane)
- (B) 284 ton screw type compressor (Dunham-Bush)
- (C) 300 ton open drive compressor/centrifugal (York)
- (D) 306 ton evaporative condenser (B.A.C.)
- (E) 300 ton cooling tower (Marley)

CATEGORY 4 - A

- 4.1 Trane - Centraval 2 - Stage Centrifugal Hermetic Liquid Chiller, model CVHA 032 G F2 F2S based on (95°F adjusted leaving condenser) 279 net tons/224 kw, #12 impeller, (adjusted leaving evaporator 44°F) net tons. Refrigerant type R-11, capacity 665 lbs., oil charge 7 gallons; shipping weight 11,100 lbs., operating weight 11,800; shell and water box volume - evaporator 39.6 gallons, condenser 39.6 gallons.
- 4.2 Motor Data - Hermetic motor rated at 224 kw, 460/480 volt rated load amps at 311-301, locked rotor amps at 1715-1800. Motor component combination availability in kw rating: min = 224, STD. = 244, max. = 298. 3600 rpm low speed turn, squirrel cage, two pole, induction motor: 60 cycle, 3 - phase, liquid refrigerant cooled.
- 4.3 Oil Pump Motor Data - 460/480 volt; FLA = 0.55 - 0.5L, LRA = 3.00 - 2.88; Squirrel cage type, 4 - pole induction motor for 60 cycle - 3 - phase system.
- 4.4 Lubrication Data - A direct-drive, positive displacement oil pump driven by a low voltage 1/4 h.p. motor that is submerged in the oil sump to assure positive oil supply to the two (2) compressor bearings. A low watt-density heater maintains the oil temperature at a level which minimizes its affinity for refrigerant.
- 4.5 Purge System Data - System consists of a positive displacement compressor; 1/3 h.p. 115/60/1 motor; electrically heated oil separator, and a baffled purge pump.

(Note: Water removal and noncondensables are discharged via a manual blow-off valve).

- 4.6 Motor Cooling Data - Cooling is accomplished by the transfer of heat from the motor to a liquid coolant (no moving parts). The liquid refrigerant coolant smoothly circulates over the starter windings and between the rotor and starter. Note the windings are specifically insulated for operation with a refrigerant atmosphere.
- 4.7 Compressor Guide Vanes - Fully modulating capacity control guide vanes are located at the inlet to each compressor stage. The guide vanes are controlled by an externally mounted pneumatic vane operator through a ball joint linkage in response to refrigeration load on the evaporator.
- 4.8 Evaporator Data - Component systems to include: shell and water boxes, tube sheets, tubes, eliminators, refrigerant distribution, refrigerant flow control.
- Shell and Water Boxes - The shell is formed of carbon steel plates and incorporates a two (2) inch carbon rupture disc. A refrigerant temperature thermowell is provided for use with a low limit controller. 150 PSIG cast-iron water boxes with flat faced flanged connections are furnished.

CATEGORY 4 - A - Continued

- 4.8 Tube sheets - are of a thick carbon steel tube sheet that is welded to each end of the shell and drilled and reamed to accommodate the tubes.

Tubes - Individually replaceable externally finned 3/4 inch nominal diameter seamless copper tubing that is utilized as the evaporator heat transfer surface.

Eliminators - Multiple layers of metal mesh screen from the eliminators are installed over the tube bundle along the entire length of the evaporator to prevent liquid refrigerant carryover into the compressor.

Refrigerant Distribution - Refrigerant distribution compartment in the base of the evaporator assures uniform wetting of the heat transfer surface over the entire length of the shell and under varying loads. High velocity refrigerant spray impingement on the tubes is prevented through this design.

Refrigerant Flow Control - A multiple orifice flow control system helps to maintain the correct pressure differential between the economizer and evaporator over the entire range of loading.

- 4.9 Condenser Data - Component systems to include: shell and water boxes, tube sheets, tubes, refrigerant distribution.

Shell and Water Boxes - Condenser shell is formed of carbon steel plate. All shells with nominal capacities are furnished with 150 PSIG cast-iron water boxes with flat faced flanged connections.

Tube Sheets - are of a thick carbon steel tube sheet that is welded to each end of the shell and drilled and reamed to accommodate the tubes.

Tubes - Individually replaceable externally finned 3/4 inch nominal diameter seamless copper tubing that is utilized as the condenser heat transfer surface.

Refrigerant Distribution - A baffled compartment between the tube bundle; the condenser shell distributes the hot gas longitudinally throughout the condenser before it is directed uniformly downward over the tube bundle. Special baffles prevent direct impingement of high velocity compressor discharge gas upon the tubes.

- 4.10 Economizer - An interstate pressure chamber which utilizes a multiple orifice system to help maintain the correct differential between condensing and economizer pressures over the entire range of loading.

- 4.11 Control Data -

- Primary central control range which includes: oil pressure, evaporator refrigerant pressure, condenser refrigerant pressure and purge condenser drum pressure.
- Automatic safety shutdown relays.
- On/off control rocker switch.
- Demand limit switch (40% to 100% load design).

CATEGORY 4 - A - Continued

- 4.11 - Anti-recycle timer.
- Timing relay to ensure positive oil supply to compressor bearings.
- Compressor start and elapsed running time meter.
- Safety interlock controls.
- Auxiliary alarm circuits
- Pneumatic temperature control system components.

4-A

OVERALL TIME SUMMARY - BY SYSTEM

279 Ton Centrifugal/Hermetic Compressor (Trane)

<u>YEARS</u>	<u>P.M. - REPAIRS REPLACEMENT HRS.</u>
1	38.22
2	"
3	41.16
4	38.22
5	"
6	41.16
7	38.22
8	"
9	41.16
10	42.79
11	38.22
12	41.16
13	44.13
14	38.22
15	41.16
16	38.22
17	"
18	"
19	"
20	"
21	41.16
22	38.22
23	"
24	41.16
25	38.22
TOTAL	986.55

TIME SUMMARY - BY COMPONENT

279 Ton Centrifugal/Hermetic Compressor (Trane)

Compressor/Motor

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	8.74		
2	"		
3	"	2.94	Replace Crankcase Heater
4	"		
5	"		
6	"	2.94	Replace Crankcase Heater
7	"		
8	"		
9	"	2.94	Replace Crankcase Heater
10	"	4.56	Replace Expansion Valve
11	"		
12	"	2.94	Replace Crankcase Heater
13	"	5.91	Replace Purge Unit
14	"		
15	"	2.94	Replace Crankcase Heater
16	"		
17	"		
18	"	* Contract	Replace Compressor/Motor
19	"		
20	"		
21	"	2.94	Replace Crankcase Heater
22	"		
23	"		
24	"	2.94	Replace Crankcase Heater
25	"		
	TOTALS	218.50	31.05

\* 65% approx. cost factor of system cost

TIME SUMMARY - BY COMPONENT

279 Ton Centrifugal/Hermetic Compressor (Trane)

\*Condenser/Evaporator

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	11.54		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"		
17	"		
18	"		
19	"		
20	"		
21	"		
22	"		
23	"		
24	"	** Contract	Replace Condenser/Evaporator
25	"		
TOTALS		288.50	

\* Use for condenser/evaporator 288.5 Hours/Unit

\*\* 25% approx. cost factor of system cost

TIME SUMMARY - BY COMPONENT

279 Ton Centrifugal/Hermetic Compressor (Trane)

Motor Starter

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	3.84		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"		
17	"		
18	"	* Contract	Replace Starter
19	"		
20	"		
21	"		
22	"		
23	"		
24	"		
25	"		
TOTALS	96.0		

\* 10% approx. cost factor of system cost



4-A

TIME SUMMARY - BY COMPONENT

279 Ton Centrifugal/Hermetic Compressor (Trane)

Controls/Control Panel

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	2.56		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"	* Contract	Replace Controls/Control Panel
17	"		
18	"		
19	"		
20	"		
21	"		
22	"		
23	"		
24	"		
25	"		
TOTALS	64.0		

\* 5% approx. cost factor of system cost

TASK SUMMARY - N

CATEGORY: 4-A

SYSTEM: 279 ton centrifugal/hermetic compressor (Trane)

DESCRIPTION: Annual Maintenance or Start-Up  
Clean, lubricate, adjust and inspect 300 ton hermetic  
air conditioning compressor.

TASKS

Drain oil from crankcase

Fill crankcase with oil

Prepare and run pump down

Inspect sight glass

Recharge system

Check for leaks

Check safety devices

Drain water from air tank

Lubricate air compressor

Remove and reinstall drier

TOTAL TASK TIME: 3.5 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		3.5		1		4.48

TASK SUMMARY - N

CATEGORY: 4-A

SYSTEM: 279 ton centrifugal/hermetic compressor (Trane)

DESCRIPTION: Preventive maintenance inspection over 25 ton hermetic air conditioning compressor.

TASKS

Wipe compressor and motor

Inspect sight glass and gages

Add oil

Drain air tank

Inspect for leaks

Check for proper operation

Fill out inspector report

TOTAL TASK TIME: .94 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.94		3		3.61

TASK SUMMARY - N

CATEGORY: 4-A

SYSTEM: 279 ton centrifugal/hermetic compressor (Trane)

DESCRIPTION: Fall shut down all compressors. Seasonal operation.

TASKS

Prepare and pump down system into receiver

Check system for leaks and note

Turn switch off

Fill out inspector's report

TOTAL TASK TIME: .51 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.51		1		.65

TASK SUMMARY - N

CATEGORY: 4-A  
SYSTEM: 279 ton centrifugal/hermetic compressor (Trane)  
DESCRIPTION: Remove and reinstall expansion valve on 300 ton hermetic air conditioning system.

TASKS

Pump down system into receiver  
Remove and install fitting  
Plug and unplug port openings  
Prepare and remove expansion valve  
Remove and install expansion valve  
Recharge system  
Check operation of system  
Material handling

TOTAL TASK TIME: 2.87 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>					
<u>TASK TIME</u>	<u>JOB PREPARATION</u>	<u>TRAVEL TIME</u>	<u>CRAFT ALLOWANCE TIME</u>	=	<u>HOURS/TASK</u>
2.87	0.30	0.85	.19 x 2.87		4.56

TASK SUMMARY - S-E-A

CATEGORY: 4-A  
SYSTEM: 279 ton centrifugal/hermetic compressor (Trane)  
DESCRIPTION: Remove and reinstall compressor crankcase heater

TASKS

- Pump down compressor
- Remove and reinstall drain plug
- Drain and refill crankcase
- Remove and reinstall inspector plate
- Remove and reinstall heater
- Connect, operate and disconnect vacuum pump
- Recharge system
- Check for leaks

TOTAL TASK TIME: 1.5 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>								
<u>TASK TIME</u>	+	<u>JOB PREPARATION</u>	+	<u>TRAVEL TIME</u>	+	<u>CRAFT ALLOWANCE TIME</u>	=	<u>HOURS/TASK</u>
1.5		0.30		0.85		.19 x 1.5		2.94

TASK SUMMARY - S-E-A

CATEGORY: 4-A  
SYSTEM: 279 ton centrifugal/hermetic compressor (Trane)  
DESCRIPTION: Remove and reinstall purge unit

TASKS

- Close and open shut off valve on refrigerant to line running to purge unit
- Disconnect and connect purge unit
- Remove and reinstall purge unit
- Put purge unit into operation
- Check operation of system

TOTAL TASK TIME: 4.0 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>				
<u>TASK TIME</u>	<u>JOB PREPARATION</u>	<u>TRAVEL TIME</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>HOURS/TASK</u>
4.0	0.30	0.85	.19 x 4.0	5.91

TASK SUMMARY - N

CATEGORY: 4-A

SYSTEM: 279 ton centrifugal/hermetic compressor (Trane)

DESCRIPTION: Condensor/Evaporator - Drain, remove and reinstall end plates, punch and clean tubes and refill a 300-400 ton shell and tube condenser, or chilled water evaporator. Use ladder or scaffolding. TASKS

- Remove and reinstall pipe fitting
- Drain and fill tubes, per gallon
- Remove and reinstall nut
- Remove and reinstall cover plate
- Punch clean tube up to 25' long, up to 1" O.D.
- Dry tube with rag
- Cut gasket over 2 sq. ft.
- Mark and punch holes in gasket
- Install gasket
- Material handling

TOTAL TASK TIME: 9.02 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time (Hrs/Yr)</u>
1.28		9.02		1		11.54



TASK SUMMARY - GSA

CATEGORY: 4-A  
SYSTEM: 279 ton centrifugal/hermetic compressor (Trane)  
DESCRIPTION: Annual Maintenance or Service Start-Up  
Motor Starters

TASKS

Tighten all connections to main bus.

Inspect breakers and fuses connected to the main bus for tightness.

Inspect starter coils. Clean contacts; replace as required.

Use vacuum or dry compressed air to remove dust or other material which may cause shorts or arcing.

Inspect all interlocks and controls. Clean and lightly lubricate friction points. Remove excess lubricant. (Refer to manufacturers instructions.)

Test starter heaters for correct design amperage and size.

Operate breakers to insure proper making.

Visually inspect for broken parts, contact arcing or any evidence of overheating.

Check motor name plate for current rating and controller manufacturer's recommended heater size. (Heater size shall not be changed without the regional design engineer's approval.)

Check line and load connections and heater mounting screws for tightness.

Perform time/current characteristics test at the appropriate multiple of heater rating.

TASK SUMMARY - GSA

CATEGORY: 4-A  
SYSTEM: 279 ton centrifugal/hermetic compressor (Trane)  
DESCRIPTION: Annual Maintenance or Service Start-Up  
Motor Starters

TASKS

Record test results on GSA Form 2543, Circuit Breaker Test Record.  
Show both as found and as left.

Check contact resistance in micro-ohms and dielectric strength in  
meg-ohms.

Check starter connection by applying a thin film of black contact grease  
to the line and load stabs; then rack the breaker in and out of the cubicle  
and measure the wipe marks on the stab.

Remove tags and lock and return circuit to service.

TOTAL TASK TIME: 3.00 Hours

Page 2 of 2

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		3.00		1		3.84

TASK SUMMARY - GSA

CATEGORY: 4-A  
SYSTEM: 279 ton centrifugal/hermetic compressor (Trane)  
DESCRIPTION: Annual Maintenance or Start-Up  
C-6 Controls, Central Air Conditioning

TASKS

Check set point of controls (temperature or pressure safety).

Compare control point with an external measuring device, note deviations, and adjust/calibrate.

Check the unit over its range of control. If possible, impose simulated conditions to activate controls and check operation.

Check for control point cycling.

Check closeness of differential gap on two position controllers (on-off-open-closed).

Check condition and action of primary elements in the controllers (bi-metallic strips, sealed bellows with capillary tubes) for remote sensing, etc.

Note the action of the controlling device (thermostats and pressurestats) which changes the controlled devices.

On electronic controls check the source of the signal and its amplification.

Check air systems for leaks; check for correct maintenance of pressure in all control devices. Check units for proper closing and loose connections.

Check resulting action of pressure sensing primary control elements such as diaphragms, bellows, inverted bells and similar devices when activated by air, water, or similar pressure. Check operation of all relays, pilot valves, and pressure regulators.

TASK SUMMARY - GSA

CATEGORY: 4-A  
SYSTEM: 279 ton centrifugal/hermetic compressor (Trane)  
DESCRIPTION: Annual Maintenance or Start-Up  
C-6 Controls, Central Air Conditioning

TASKS

Use test kits and manufacturer's instructions whenever possible.  
Replace rather than rebuild a control installed in the system. Take control to shop for repair.

TOTAL TASK TIME: 2.0 Hours

Page 2 of 2

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		2.0		1		2.56

CATEGORY 4 - B

4.2.1 Dunham - Bush PCX-H Hermetic Screw Type Packaged Chiller 290 H Series 284 Tons, at 240 KW based on 95° F leaving condenser water at 44° F leaving evaporator. Chiller min. GPM at 350/ max. GPM at 1000; condenser min GPM at 250, max. GPM at 875; 60 hertz capacity, screw type compressor. "Positive Displacement" inherent design flexibility; compressor model #2013, condenser #18, chiller #20; operating charge R-22 at 575 lbs.; oil at 32 gallons; unit weight at: shipping - 12,550, operating 12,800. Overall dimensions: length 166 inches, width 37 inches, height 74 inches. 460/480 volt, 60 - hertz, 3-phase, lock rotor start at 609-636; Delta at 1870-1910. No purge system required - is designed with high pressure refrigerants. 3600 rpm direct drive packaged chiller.

4.2.2 Motor Data - Hermetic, 2 pole 3600 rpm at 60 hertz, windings insulated with woven fiberglass impregnated with varnish with built in solid state protectors. Main rotor sleeve bearings are of a heavy duty babbit bushing type with steel backing. Standard motor wound for star Delta or across the line starting.

4.2.3 Oil Pump and Oil Cooling System - Done by liquid injection which eliminates the need for a water cooled oil cooler. A liquid injection thermostatic expansion valve modulates refrigerant to the compressor injection port. A solenoid valve controls the flow of refrigerant to the liquid injection expansion valve, on the off-cycle and during low load operation. An immersion type electric heater keeps oil at a safe operating temperature, and prevents oil dilution by the refrigerant during an off-cycle.

Oil saturated gas is discharged from the compressor and circulated through and over the motor where a major portion of the oil is separated out. A flow path pattern within the separator itself, with an oversized mechanical demister, results in a near perfect oil separation from the discharge gas. The separate hermetic motor driven gear type oil pump provides positive lubrication in internal systems.

4.2.4 Evaporator Data - A direct expansion shell and tube chiller with a 3/4 inch diameter, non-ferrous inner - fin tubes mechanically expanded into heavy steel tube sheets. Refrigerant passes through the tubes with water in a counter flow direction on the shell side. The water connections are of the grooved type. Chiller tube shell sheets and segmental baffles are constructed of steel. Model #20 - design press. (watersize PSD) 150, design press. (refrig. side PSI) 200. Number of tubes 330; min. water flow (GPM) 350, max. water flow (GPM) 1100.

CATEGORY 4 - B - Continued

4.2.5 Condenser Data - The condenser is a shell and tube type with integral finned water tubes. All tubes are rolled into heavy fixed steel tube sheets with electronic control. Condenser is designed and constructed in accordance with ASME standards. Shell side of condenser is equipped with dual pressure relief valves with venting provisions. Model #18: design press. (water side PSI) 150, design press. (refrig. side PSI) 300; number of tubes at 228; min. water flow (GPM) 250, max. water flow (GPM) 875.

4.2.6 Control and Valve Data:

- Control panel provides protection against:
  - Low chilled water flow rate
  - Chiller freeze up protection
  - Low suction pressure
  - High discharge pressure
  - High oil temperature
  - High motor temperature
  - Low oil pressure
  - Low water temperature
  - Rapid restart of compressor motor
- Gauges for various pressures, operating time of system and status of unit:
  - Suction pressure gauge
  - Discharge pressure gauge
  - Oil and discharge pressure gauge
  - Elapse time meter (6TR)
  - Power on
  - Unit off
  - Oil pressure below min. limits
  - Anti-recycle timer
  - Start up delay
- Safety controls:
  - High/low pressure switch
  - High oil temperature thermostat
  - Oil pump motor winding temperature protector
  - Chilled water thermostat
  - Chilled water flow switch
  - Chilled water pump interlock
  - Compressor oil pressure differential switch
  - Oil pressure failure time delay
- Automatic controls:
  - Master control relay
  - Anti-recycle timer
  - Oil pump time delay relay

CATEGORY 4 - B - Continued

- Start-up time delay relay
  - Transfer relay
  - Compressor control relay
  - Lock-in relay
  - Low suction pressure pump - down switch
  - Temperature load controller
  - Holding relay
  - Low discharge temperature switch
  - Reed switches
- Refrigeration controls:
- Temperature load control
  - Load solenoid valve
  - Unload solenoid valve
  - Small expansion valve solenoid
  - Large expansion valve solenoid
  - Fast unload solenoid
  - Liquid injection valve solenoid

4-B

OVERALL TIME SUMMARY -- BY SYSTEM  
284 Ton Screw Type Compressor (Dunham-Bush)

<u>YEARS</u>	<u>P.M. - REPAIRS REPLACEMENT HRS.</u>
1	38.22
2	"
3	41.16
4	38.22
5	"
6	41.16
7	38.22
8	"
9	41.16
10	42.79
11	38.22
12	41.16
13	38.22
14	"
15	41.16
16	38.22
17	"
18	"
19	"
20	"
21	41.16
22	38.22
23	"
24	41.16
25	38.22
TOTAL	980.64



TIME SUMMARY - BY COMPONENT

284 Ton Screw Type Compressor (Dunham-Bush)  
Compressor/Motor

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	8.74		
2	"		
3	"	2.94	Replace crankcase heater
4	"		
5	"		
6	"	2.94	Replace crankcase heater
7	"		
8	"		
9	"	2.94	Replace crankcase heater
10	"	4.56	Replace expansion valve
11	"		
12	"	2.94	Replace crankcase heater
13	"		
14	"		
15	"	2.94	Replace crankcase heater
16	"		
17	"		
18	"	* Contract	Replace compressor/motor
19	"		
20	"		
21	"	2.94	Replace crankcase heater
22	"		
23	"		
24	"	2.94	Replace crankcase heater
25	"		
	TOTALS	218.50	25.14

\* 65% approx. cost factor of system cost

TIME SUMMARY - BY COMPONENT

284 Ton Screw Type Compressor (Dunham-Bush)

\*Condenser/Evaporator

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	11.54		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"		
17	"		
18	"		
19	"		
20	"		
21	"		
22	"		
23	"		
24	"	** Contract	Replace Condenser/Evaporator
25	"		
	TOTALS	288.50	

\* Use for condenser/evaporator 288.5 Hours/Unit

\*\* 25% approx. cost factor of system cost

4-B

TIME SUMMARY - BY COMPONENT

284 Ton Screw Type Compressor (Dunham-Bush)

Controls/Control Panel

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	2.56		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"	* Contract	Replace Controls/Control Panel
17	"		
18	"		
19	"		
20	"		
21	"		
22	"		
23	"		
24	"		
25	"		
TOTALS	64.0		

\* 5% approx. cost factor of system cost

TIME SUMMARY - BY COMPONENT

284 Ton Screw Type Compressor (Dunham-Bush)

Motor Starter

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	3.84		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"		
17	"		
18	"	* Contract	Replace Starter
19	"		
20	"		
21	"		
22	"		
23	"		
24	"		
25	"		
	TOTALS		
		96.0	

\* 10% approx. cost factor of system cost

AD-A126 645

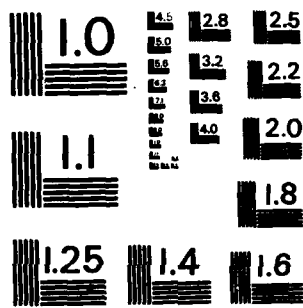
LIFE-CYCLE COST DATABASE VOLUME II APPENDICES E F AND G  
SAMPLE DATA DEVELOPMENT (U) CONSTRUCTION ENGINEERING  
RESEARCH LAB (ARMY) CHAMPAIGN IL R D MEATHAMMER JAN 83  
CERL-TR-P-139-VOL-2

UNCLASSIFIED

F/G 9/2

NL


END  
DATE  
FILMED  
C B R  
01 \*



MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A

TASK SUMMARY - GSA

CATEGORY: 4-B  
SYSTEM: 284 Ton Screw Type Compressor (Dunham-Bush)  
DESCRIPTION: Annual Maintenance or Start-Up  
C-6 Controls, Central Air Conditioning

TASKS

Check set point of controls (temperature or pressure safety).

Compare control point with an external measuring device; note deviations, and adjust/calibrate.

Check the unit over its range of control. If possible, impose simulated conditions to activate controls and check operation.

Check for control point cycling.

Check closeness of differential gap on two position controllers (on-off-open-closed).

Check condition and action of primary elements in the controllers (bimetallic strips, sealed bellows with capillary tubes) for remote sensing, etc.

Note the action of the controlling device (thermostats and pressurestats) which changes the controlled devices.

On electronic controls check the source of the signal and its amplification.

Check air systems for leaks; check for correct maintenance of pressure in all control devices. Check units for proper closing and loose connections.

Check resulting action of pressure-sensing primary control elements such as diaphragms, bellows, inverted bells, and similar devices when activated by air, water, or similar pressure. Check operation of all relays, pilot valves, and pressure regulators.

TASK SUMMARY - GSA

CATEGORY: 4-B  
SYSTEM: 284 Ton Screw Type Compressor (Dunham-Bush)  
DESCRIPTION: Annual Maintenance or Start-Up  
C-6 Controls, Central Air Conditioning

TASKS

Use test kits and manufacturer's instructions whenever possible.  
Replace rather than rebuild a control installed in the system.  
Take control to shop for repair.

TOTAL TASK TIME: 2.00 Hours

Page 2 of 2

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		2.0		1		2.56



TASK SUMMARY - GSA

CATEGORY: 4-B

SYSTEM: 284 Ton Screw Type Compressor (Dunham-Bush)

DESCRIPTION: Annual Maintenance or Spring Start-Up  
Motor Starters

TASKS

Tighten all connections to main bus.

Inspect breakers and fuses connected to the main bus for tightness.

Inspect starter coils. Clean contacts; replace as required.

Use vacuum or dry compressed air to remove dust or other material which may cause shorts or arcing.

Inspect all interlocks and controls. Clean and lightly lubricate *friction* points. Remove excess lubricant. (Refer to manufacturer's instructions.)

Test starter heaters for correct design *amperage* and size.

Operate breakers and insure proper making.

Visually inspect for broken parts, contact arcing or any evidence of overheating.

Visually inspect for broken parts, contact arcing or any evidence of overheating.

Check motor name plate for current rating and controller manufacturer's recommended heater size. (Heater size shall not be changed without the regional design engineer's approval.)

Check line and load connections and heater mounting screws for tightness.

Perform time/current characteristics test at the appropriate multiple of heater rating.

TASK SUMMARY - GSA

CATEGORY: 4-B  
SYSTEM: 284 Ton Screw Type Compressor (Dunham-Bush)  
DESCRIPTION: Annual Maintenance or Spring Start-Up  
Motor Starters

TASKS

Record test results on GSA Form 2543, Circuit Breaker Test Record.  
Show both as found and as left.

Check contact resistance in micro-ohms and dielectric strength in  
meg-ohms.

Check starter connection by applying a thin film of black contact  
grease to the line and load stabs; then rack the breaker in and out  
of the cubicle and measure the wipe marks on the stab.

Remove tags and lock and return circuit to service.

TOTAL TASK TIME: 3.0 Hours

Page 2 of 2

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		3.0		1		3.84

TASK SUMMARY - N

CATEGORY: 4-B

SYSTEM: 284 Ton Screw Type Compressor (Dunham-Bush)

DESCRIPTION: Condenser/Evaporator - Drain, remove and reinstall end plates, punch and clean tubes and refill a 300-400 ton shell and tub condenser or chilled water evaporator. Use ladder or scaffolding.

TASKS

Remove and reinstall pipe fitting  
Drain and rill tubes, per gallon  
Remove and reinstall nut  
Remove and reinstall cover plate  
Punch clean tube up to 25' long, up to 1" O.D.  
Dry tube with rag  
Cut gasket over 2 sq. ft.  
Mark and punch holes in gasket  
Install gasket  
Material handling

TOTAL TASK TIME: 9.02 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		9.02		1		11.54

TASK SUMMARY - S-E-A

CATEGORY: 4-B

SYSTEM: 284 Ton Screw Type Compressor (Dunham-Bush)

DESCRIPTION: Remove and reinstall compressor crankcase heater

TASKS

Pump down compressor

Remove and reinstall drain plug

Drain and refill crankcase

Remove and reinstall inspector plate

Remove and reinstall heater

Connect, operate and disconnect vacuum pump

Recharge system

Check for leaks

TOTAL TASK TIME: 1.5 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>				
<u>TASK TIME</u>	<u>JOB PREPARATION</u>	<u>TRAVEL TIME</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>HOURS/TASK</u>
1.5	0.30	0.85	.19 x 1.5	2.94

TASK SUMMARY - N

CATEGORY: 4-B  
SYSTEM: 284 Ton Screw Type Compressor (Dunham-Bush)  
DESCRIPTION: Remove and reinstall expansion valve on 300 ton hermetic air conditioning system

TASKS

Pump down system into receiver  
Remove and install fitting  
Plug and unplug port openings  
Prepare to remove expansion valve  
Remove and reinstall expansion valve  
Put expansion valve into operation  
Recharge system  
Check operation of system  
Material handling

TOTAL TASK TIME: 2.87 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>				
<u>TASK TIME</u>	<u>JOB PREPARATION</u>	<u>TRAVEL TIME</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>HOURS/TASK</u>
2.87	0.30	0.85	.19 x 2.87	4.56

TASK SUMMARY - N

CATEGORY: 4-B

SYSTEM: 284 Ton Screw Type Compressor (Dunham-Bush)

DESCRIPTION: Fall shut down all compressors. Seasonal operation

TASKS

Prepare and pump down system into receiver

Check system for leaks and note

Turn switch off

Fill out inspector's report

TOTAL TASK TIME: .51 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.51		1		.65

TASK SUMMARY - N

CATEGORY: 4-B

SYSTEM: 284 Ton Screw Type Compressor (Dunham-Bush)

DESCRIPTION: Preventive maintenance inspection over 25 ton hermetic  
air conditioning compressor

TASKS

Wipe compressor and motor

Inspect sight glass and gages

Add oil

Drain air tank

Inspect for leads

Check for proper operation

Fill out inspector report

TOTAL TASK TIME: .94 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.94		3		3.61

TASK SUMMARY - N

CATEGORY: 4-B

SYSTEM: 284 Ton Screw Type Compressor (Dunham-Bush)

DESCRIPTION: Annual Maintenance or Start-Up  
Clean, lubricate, adjust and inspect 300 ton hermetic  
air conditioning compressor.

TASKS

- Wipe compressor and motor
- Drain oil from crankcase
- Fill crankcase with oil
- Prepare and run to pump down
- Inspect sight glass
- Recharge system
- Check for leads
- Check safety devices
- Drain water from air tank
- Lubricate air compressor
- Remove and reinstall dryer

TOTAL TASK TIME: 3.5 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		3.5		1		4.48



CATEGORY 4 - C

- 4.3.1 York Open Turbopak Centrifugal Liquid Chiller Single Stage, 300 Ton  
239 KW rating based on 95° F adjusted leaving condenser water, and 44°  
leaving evaporator temperature: R-11 refrigerant at 650 lbs.; oil  
at 11.5 gallons. Operating weights: 14,165 lbs.; shipping weight  
14,410 lbs. Condenser water volume 51.7 gallons, evaporator/cooler  
49.7 gallons.
- 4.3.2 Motor Data - 3600 rpm motor, open-drip-proof, squirrel cage induction  
type; 460-480 volt, 3-phase; 60 hertz, rated at 239 kw.
- 4.3.3 Cooler/Evaporator Data - Horizontal flooded shell and tube type, liquid  
distribution system consisting of a distributor trough to give uniform  
liquid distribution throughout the shell length, and perforated  
distributor under the entire tube bundle, at 1/2 inch thick; in-  
termediate steel tube supports spaced at intervals less than four (4)  
feet. Highly efficient integral aluminum eliminator are designed with-  
in the system.
- 4.3.4 Condenser Data - Horizontal shell and tube type, distributor gas baffle to  
prevent direct high velocity impingement on tubes and to distribute  
the gas flow properly to utilize all heat transfer surfaces (purge  
collection chamber). Intermediate steel tube supports are spaced at  
intervals less than four (4) feet.
- 4.3.5 Lubrication Data - Forced feed to all bearings; centrifugal oil pumps  
integral with rotor shaft for assured lubrication. External mounted  
auxiliary oil pump driven by a 1/3 h.p. 115-1-60, 1725 r.p.m. inherently  
protected motor.
- Refrigerant cooled cooler and 15 micron external air filter with re-  
placeable type cartridge and service valves for oil system.
- 4.3.6 Shaft Seal - Precision type carbon ring, spring loaded, small face  
area, low rubbing speed-high temperature elastomer "O" ring static seal.
- 4.3.7 Turboguard Purge Unit Data - Completely automatic, self-contained  
compressorless type, utilizing high pressure oil from centrifugal  
compressor as a fluid piston for efficient purging of non-condensable  
gases and eliminating auxiliary motor operating cost and power supply.
- 4.3.8 Control Data - Control center to be in a locked enclosure, factory  
mounted, piped and wired, and to have the capacity of:
- Operating and safety controls
  - Control sequence
  - Fail - safe - automatic operation
  - Oil pump operation
  - Anti-recycling
  - Control variable inlet guide vanes
  - Pneumatic capacity control system or electronic type
  - Interlocking of compressor motor starter

CATEGORY 4 - C

- Chilled water flow switch
- Condenser and chill water pumps
- Cooling tower fan operation
- Chilled water temperature controller
- Compressor start/stop/reset
- Manual reset controls for high oil temperature, high/low refrigerant pressure, low oil pressure, low leaving chilled water temperature, chilled water flow/power failure.
- Dial pressure gauges for refrigerant evaporator, condenser pressure and oil pressure.
- Purge unit excess purge/reset and or refrigerant transfer unit power switch.

OVERALL TIME SUMMARY - BY SYSTEM

300 Ton Open Drive Compressor/Centrifugal (York)

<u>YEARS</u>	<u>P.M. - REPAIRS REPLACEMENT HRS.</u>
1	40.27
2	"
3	43.21
4	40.27
5	"
6	43.21
7	40.27
8	"
9	43.21
10	44.83
11	40.27
12	43.21
13	40.27
14	"
15	43.21
16	40.27
17	"
18	43.21
19	40.27
20	"
21	"
22	"
23	43.21
24	40.27
25	"

TOTAL 1,031.89

4-C

TIME SUMMARY - BY COMPONENT

300 Ton Open Drive Compressor/Centrifugal (York)  
Controls/Control Panel

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	2.56		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"	* Contract	Replace Controls/Control Panel
17	"		
18	"		
19	"		
20	"		
21	"		
22	"		
23	"		
24	"		
25	"		
TOTALS	64.0		

\* 5% approx. cost factor of system cost

4-C

TIME SUMMARY - BY COMPONENT

300 Ton Open Drive Compressor/Centrifugal (York)

Motor 300 h.p. (includes motor starter)

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	4.61		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"		
17	"		
18	"	* Contract	Replace Motor & Motor Starter
19	"		
20	"		
21	"		
22	"		
23	"		
24	"		
25	"		
TOTALS	115.25		

\* 35% approx. cost factor of system cost

TIME SUMMARY - BY COMPONENT

300 Ton Open Drive Compressor/Centrifugal (York)

\*Evaporator/Condenser

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	11.54		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"		
17	"		
18	"		
19	"		
20	"		
21	"		
22	"		
23	"		
24	"	** Contract	Replace Evaporator/Con- denser
25	"		
<b>TOTALS</b>	<b>288.50</b>		

\* Use for evaporator and condenser - 288.50 Hours/Unit

\*\* 25% approx. cost factor of system cost

4-C

TIME SUMMARY - BY COMPONENT

300 Ton Open Drive Compressor/Centrifugal (York)  
Compressor

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	10.02		
2	"		
3	"	2.94	Replace Crankcase Heater
4	"		
5	"		
6	"	2.94	Replace Crankcase Heater
7	"		
8	"		
9	"	2.94	Replace Crankcase Heater
10	"	4.56	Replace Expansion Valve
11	"		
12	"	2.94	Replace Crankcase Heater
13	"		
14	"		
15	"	2.94	Replace Crankcase Heater
16	"		
17	"		
18	"	2.94	Replace Crankcase Heater
19	"		
20	"	* Contract	Replace Compressor
21	"		
22	"		
23	"	2.94	Replace Crankcase Heater
24	"		
25	"		
<b>TOTALS</b>	<b>250.50</b>	<b>25.14</b>	

\* 45% approx. cost factor of system cost

TASK SUMMARY - N

CATEGORY: 4-C

SYSTEM: 300 Ton Open Drive Compressor/Centrifugal (York)

DESCRIPTION: Annual Maintenance or Spring Start-Up  
Compressor - clean, lubricate, adjust and inspect over  
300 ton, open (central compression) air conditioning compressor

TASKS

Wipe compressor and motor

Check and adjust motor alignment coupling

Lubricate motor and coupling

Drain oil from crankcase

Fill crankcase with oil

Prepare and run to pump down

Inspect sight glass

Recharge system

Check for leaks

Check safety devices

Drain water from air tank

Lubricate air compressor

Remove and reinstall drier

TOTAL TASK TIME: 4.5 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		4.5		1		5.76



TASK SUMMARY - N

CATEGORY: 4-C

SYSTEM: 300 Ton Open Drive Compressor/Centrifugal (York)

DESCRIPTION: Preventive maintenance inspection over 25 ton open  
(central compression) air conditioning compressor

TASKS

Wipe compressor and motor

Check motor alignment and adjust

Inspect sight glass and gages

Lubricate bearings

Add oil

Drain air tank

Inspect for leaks

Check for proper operation

Fill out inspector report

TOTAL TASK TIME: .94 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.94		3		3.61

TASK SUMMARY - N

CATEGORY: 4-C

SYSTEM: 300 Ton Open Drive Compressor/Centrifugal (York)

DESCRIPTION: Fall shut down all compressors. Seasonal operation.

TASKS

Prepare and pump down system into receiver

Check system for leaks and note

Turn switch off

Fill out inspector's report

TOTAL TASK TIME: .51 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.51		1		.65

TASK SUMMARY - S-E-A

CATEGORY: 4-C

SYSTEM: 300 Ton Open Drive Compressor/Centrifugal (York)

DESCRIPTION: Remove and reinstall compressor crankcase heater.

TASKS

- Pump down compressor
- Remove and reinstall drain plug
- Drain and refill crankcase
- Remove and reinstall inspection plate
- Remove and reinstall heater
- Connect, operate and disconnect vacuum pump
- Recharge system
- Check for leaks

Total Task Time: 1.5 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>				
<u>TASK TIME</u>	<u>JOB PREPARATION</u>	<u>TRAVEL TIME</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>HOURS/TASK</u>
1.5	0.30	0.85	.19 x 1.5	2.94

TASK SUMMARY - N

CATEGORY: 4-C

SYSTEM: 300 Ton Open Drive Compressor/Centrifugal (York)

DESCRIPTION: Remove and reinstall expansion valve on 300 ton open compression air conditioning system.

TASKS

- Pump down system into receiver
- Remove and install fitting
- Plug and unplug port openings
- Prepare to remove expansion valve
- Remove and reinstall expansion valve
- Put expansion valve into operation
- Recharge system
- Check operation of system
- Material handling

Total Task Time: 2.87 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>					
<u>TASK TIME</u>	<u>JOB PREPARATION</u>	<u>TRAVEL TIME</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>HOURS/TASK</u>	
2.87	0.30	0.85	.19 x 2.87	4.56	

TASK SUMMARY - S-E-A

CATEGORY: 4-C

SYSTEM: 300 Ton Open Drive Compressor/Centrifugal (York)

DESCRIPTION: Remove and reinstall purge unit

TASKS

Close and open shut-off valve on refrigerant to line running to purge unit

Disconnect and connect purge unit

Remove and reinstall purge unit

Put purge unit into operation

Check operation of system

Total Task Time: 4.0 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>					
<u>TASK TIME</u>	<u>JOB PREPARATION</u>	<u>TRAVEL TIME</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>HOURS/TASK</u>	
4.0	0.30	0.85	.19 x 4.0	5.91	

TASK SUMMARY - N

CATEGORY: 4-C

SYSTEM: Condenser/Evaporator

DESCRIPTION: Drain, remove and reinstall end plates, punch and clean tubes and refill a 300-400 ton shell and tube condenser, or chilled water evaporator. Use ladder or scaffolding.

TASKS

Remove and reinstall pipe fitting

Drain and fill tubes, per gallon

Remove and reinstall nut

Remove and reinstall cover plate

Punch clean tube up to 25' long, up to 1" O.D.

Dry tube with rag

Cut gasket over 2 sq. ft.

Mark and punch holes in gasket

Install gasket

Material handling

Total Task Time: 9.02 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		9.02		1		11.54

TASK SUMMARY - S-E-A

CATEGORY: 4-C

SYSTEM: Compressor Motor

DESCRIPTION: Annual maintenance or spring start-up

TASKS

Check ventilation ports for soil accumulation; clean if necessary

Clean exterior of motor surfaces of soil accumulation

Lubricate bearings according to horsepower ratings:

<u>HP RANGE</u>	<u>FREQUENCY</u>
1 - 7.5 HP	Every 4 years
10 - 50	Yearly
over 50 HP	Two Times/Year

- a. Remove filler and drain plugs (use zerk fittings if installed)
- b. Free drain hole of any hard grease (use piece of wire if necessary)
- c. Add grease - use good grade lithium base grease unless otherwise noted

Check motor windings for accumulation of soil. Blow out with air if required.

Remove tags and return to service.

1 - 7.5 HP  
10 - 50 HP  
Over 50 HP

Total Task Time: .60 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.60		1		.77

TASK SUMMARY - GSA

CATEGORY: 4-C

SYSTEM: Motor Starters

DESCRIPTION: Annual maintenance or spring start-up

TASKS

Tighten all connections to main bus.

Inspect breakers and fuses connected to the main bus for tightness.

Inspect starter coils. Clean contacts; replace as required.

Use vacuum or dry compressed air to remove dust or other material which may cause shorts or arcing.

Inspect all interlocks and controls. Clean and lightly lubricate friction points. Remove excess lubricant. (Refer to manufacturer's instructions.)

Test starter heaters for correct design amperage and size.

Operate breakers to insure proper making.

Visually inspect for broken parts, contact arcing or any evidence of overheating.

Check motor nameplate for current rating and controller manufacturer's recommended size. (Heater size shall not be changed without the regional design engineer's approval.)

Check line and load connections and heater mounting screws for tightness.

Perform time/current characteristics test at the appropriate multiple of heater rating.

Record test results on GSA Form 2543, Circuit Breaker Test Record. Show both as found and as left.

Check contact resistance in micro-ohms and dielectric strength in meg-ohms.

Check starter connection by applying a thin film of black contact grease to the line and load stabs; then rack the breaker in and out of the cubicle and measure the wipe marks on the stab.

Remove tags and lock and return circuit to service.

Total Task Time: 3.0 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		3.0		1		3.84



TASK SUMMARY - GSA

CATEGORY: 4-C

SYSTEM: Controls, Central Air Conditioning

DESCRIPTION: Annual maintenance or spring start-up

TASKS

Check set point of controls (temperature, or pressure).

Compare control point with an external measuring device; note deviations, and adjust/calibrate.

Check the unit over its range of control. If possible, impose simulated conditions to activate controls and check operation.

Check for control point cycling.

Check closeness of differential gap on two position controllers (on-off-open-closed).

Check condition and action of primary elements in the controllers (bi-metallic strips, sealed bellows with capillary tubes) for remote sensing, etc.

Note the action of the controlling device (thermostats and pressurestats) which changes the controlled devices.

On electronic controls check the source of the signal and its amplification.

Check air systems for leaks; check for correct maintenance of pressure in all control devices. Check units for proper closing and loose connections.

Check resulting action of pressure sensing primary control elements such as diaphragms, bellows, inverted bells and similar devices when activated by water, or similar pressure. Check operation of all relays, pilot valves, and pressure regulators.

Use test kits and manufacturer's instructions whenever possible. Replace rather than rebuild a control installed in the system. Take control to shop for repair.

Total Task Time: 2.0 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		2.0		1		2.56

CATEGORY 4-D

- 4.4.1 B.A.C. Evaporative condenser VXC Type N250, Rated at 3,675.0 MBH (heat rejection); tonnage equivalent of approximately 306 tons.  
Base heat rejection for open compressor - T.H.R. = compressor evaporator capacity (BTUH) + compressor BHP x 2545. For hermetic compressors = T.H.R. = compressor evaporator capacity (BTUH) + compressor Kw x 3415. Single coil section unit.
- 4.4.2 System Data - VXC-N250  
Approximate shipping weight - 11,550 lbs.  
Approximate operating weight - 15,130 lbs.  
Coil section weight - 7950 lbs.  
CFM = 45,000  
Fan motor h.p. (0" ESP) external static pressure = 20 hp  
GPM = 305  
Pump motor h.p. = 3  
System size - O.D. sump (remote)  
16 inches x 11 ft., 7-3/4 inches  
Bottom drain size at = 4  
F at 48-1/4, H at 149-1/8
- 4.4.3 Fan Data - A forwardly curved centrifugal fan that is statically and dynamically balanced. Fan housing shall have curved inlet rings for efficient air entry, and rectangular discharge cowls shall extend into the pan to increase fan efficiency and prevent water from entering the fans.
- 4.4.4 Motor Data - Drip proof ball bearing fan motor with a 1.15 service, V-belt fan drive to be designed for not less than 150% of motor name-plate h.p.
- 4.4.5 Pump Data - Water pump is a close-coupled bronze fitted, centrifugal pump with a mechanical seal.
- 4.4.6 Bearing Data - All bearings and drive end bearings are heavy-duty grease packed, self-aligning ball bearings with cast iron bodies, eccentric locking collars and accessible lubrication fittings.
- 4.4.7 Capacity Control - Modulating fan discharge damper, which matches evaporative condenser capacity to system heat rejection, while maintaining constant condensing temperatures. Fan h.p. is reduced as the dampers modulate from the full open position. Fan cycling and two-speed fan motor systems are available.
- 4.4.8 Optional accessory equipment -
- sub-cooling coils
  - multiple circuit coils
  - de-superheaters (for systems with R717)
  - sound attenuation
  - pan water heaters
  - electric water level control
  - bottom panels and screens

4-D

OVERALL TIME SUMMARY - BY SYSTEM  
300 TON EVAPORATIVE CONDENSER

<u>YEARS</u>	<u>P.M. - REPAIRS REPLACEMENT HRS.</u>
1	25.16
2	"
3	"
4	"
5	"
6	"
7	"
8	"
9	"
10	"
11	29.88
12	31.07
13	25.16
14	"
15	"
16	"
17	"
18	"
19	"
20	"
21	"
22	"
23	"
24	"
25	"
<b>TOTAL</b>	<b>639.63</b>

4-D

TIME SUMMARY - BY COMPONENT  
300 TON EVAPORATIVE CONDENSER

Life Cycle 20 Years

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	25.16		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"	4.72	Replace fan motor
12	"	5.91	Replace fan shaft bearings
13	"		
14	"		
15	"		
16	"		
17	"		
18	"		
19	"		
20	"	* Contract	Replace condenser
21	"		
22	"		
23	"		
24	"		
25	"		
	<b>TOTALS</b>	629.00	10.63

\* 95% approx. cost factor of system cost

TASK SUMMARY - N

CATEGORY: 4-D

SYSTEM: 306 Ton Evaporative Condenser (B.A.C.)

DESCRIPTION: Clean, lubricate, adjust and inspect 300 ton evaporative condenser or metal cooling tower. Includes draining and filling. Does not include acid clean.

TASKS

Remove and reinstall screw  
Remove and reinstall panel  
Clean inside cabinet with water hose  
Clean inside cabinet by scraping  
Clean blower fan  
Lubricate fan  
Clean, lubricate, adjust motor  
Remove and reinstall belt  
Clean water pump  
Lubricate water pump  
Remove and reinstall nozzle  
Clean nozzle  
Remove and reinstall float  
Clean float  
Adjust float  
Remove and reinstall baffle  
Fill and drain condenser

Total Task Time: 13.89 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		13.89		1		17.78

TASK SUMMARY - N

CATEGORY: 4-D

SYSTEM: 306 Ton Evaporative Condenser (B.A.C.)

DESCRIPTION: Preventive maintenance inspection of 25 ton and over evaporative condenser or metal cooling tower.

TASKS

Remove and reinstall screw

Remove and reinstall panel

Lubricate bearings, fan, motor, pump

Adjust belt tension

Adjust float

Sensory inspect bearings

Fill out inspector's report

Total Task Time: 1.09 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		1.09		3		4.18

TASK SUMMARY - N

CATEGORY: 4-D

SYSTEM: 306 Ton Evaporative Condenser (B.A.C.)

DESCRIPTION: Fall shut down 300 ton evaporative condensers or metal cooling tower. Seasonal operation.

TASKS

Remove and reinstall screw

Remove and reinstall panel

Sensory inspect bearings

Drain water

Turn switch off

Fill out inspector's report

Total Task Time: 2.0 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		2.0		1		2.56

TASK SUMMARY - S-E-A

CATEGORY: 4-D

SYSTEM: Electric Motors

DESCRIPTION: Annual maintenance or spring start-up

TASKS

Check ventilation ports for soil accumulation; clean if necessary

Clean exterior of motor surfaces of soil accumulation

Lubricate bearings according to horsepower ratings:

<u>HP RANGE</u>	<u>FREQUENCY</u>
1 - 7.5 HP	Every 4 years
10 - 50 HP	Yearly
over 50 HP	Two times/year

- a. Remove filler and drain plugs (use zerk fittings if installed)
- b. Free drain hole of any hard grease (use piece of wire if necessary)
- c. Add grease -- use good grade lithium base grease unless otherwise noted

Check motor windings for accumulation of soil. Blow out with air if required.

Remove tags and return to service

1 - 7.5 HP  
10 - 50 HP  
over 50 HP

Total Task Time: .5 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.5		1		.64



TASK SUMMARY - S-E-A

CATEGORY: 4-D

SYSTEM: 306 Ton Evaporative Condenser (B.A.C.)

DESCRIPTION: Remove and reinstall fan motor for 300 ton evaporative condenser

TASKS

Remove and install access panels

Remove and install belts

Disconnect and connect wiring to motor

Remove and install motor

Remove and install motor pulley

Align pulleys

Check operation of motor

Total Task Time: 3.0 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TASK TIME</u>	<u>+</u>	<u>JOB PREPARATION</u>	<u>+</u>	<u>TIME CALCULATION TRAVEL TIME</u>	<u>+</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>=</u>	<u>HOURS/TASK</u>
3.0		0.30		0.85		.19 x 3.0		4.72

TASK SUMMARY - S-E-A

CATEGORY: 4-D

SYSTEM: 306 Ton Evaporative Condenser (B.A.C.)

DESCRIPTION: Remove and install fan shaft bearings for 100 ton evaporative condenser

TASKS

Remove and install access panels

Remove and install belts

Remove and install fan shaft pulley

Remove and install bearings

Align pulleys

Check operation of fan

Total Task Time: 4.0 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>				
<u>TASK TIME</u>	<u>JOB PREPARATION</u>	<u>TRAVEL TIME</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>HOURS/TASK</u>
4.0	0.30	0.85	.19 x 4.0	5.91

CATEGORY 4-E

- 4.5.1 Marley Model 8808 Nominal 300 Ton Cooling Tower, Single Cell Type NC Series. Length at 7 ft. 10-1/2 inches, width at 18 ft. 5-1/16 inches, height 10 ft. 2 inches; shipping wt. 5940 lbs., operating wt. 13,540 lbs.; tonnage based on 95°-85°-78° WB, 3 GPM/Ton.
- 4.5.2 Motor Data - One (1) 15 h.p., fan dia. type 84 H3.8; (60 hertz) at 463 RPM, (50 hertz) at 444 RPM CFM at 68,045. Gear reducer type 20T; ratio - 1(60 hz) : 3.78; ratio 1(50 hz) : 3.27.
- 4.5.3 GPM Data - Minimum at 200, maximum at 1440; number of orifice/TWR at 144.
- 4.5.4 Voltage/Electric Data - Standard voltage at 200 V or 230/460 V when two-speed motors are used; a time delay (20 seconds) must be provided for high/low speed switching.
- 4.5.5 Fill and Eliminator Data - Polyvinyl chloride (PVC) fill in the chevron configuration provide maximum air/water contact for highest thermal efficiency. Molded knob setter assures constant, even spacing. Three pass drift eliminators are integral with the fill pack.
- 4.5.6 Mechanical Data - Marley gear reducer heavy-duty type and right angle motor to the fan assembly (installed outside the corrosive airstream) are provided within the design of the system. Note all fans are gear drive. Motors are mounted on the fan deck and connected to the gear reducer. Tower is of bolted construction and utilizes heavy mill galvanized steel.
- 4.5.7 Fan Data - Series 8800 is designed for smooth, quiet operation and dependability against higher static pressures of high-performance film type fill materials. Adjustable pitch blades permit maximum utilization of rated horsepower. Fan blades are corrosion-resistant solid cast aluminum alloy, and hubs are constructed of aluminum. Cooling tower is a cross-flow axial fan type, induced draft, vertical discharge.

4-E

OVERALL TIME SUMMARY - BY SYSTEM

300 TON COOLING TOWER (MARLEY)

<u>YEARS</u>	<u>P.M. - REPAIRS REPLACEMENT HRS.</u>
1	25.16
2	"
3	"
4	"
5	"
6	"
7	"
8	"
9	"
10	29.88
11	25.16
12	"
13	"
14	"
15	"
16	"
17	"
18	"
19	"
20	"
21	"
22	"
23	"
24	"
25	"

TOTAL : 633.72

4-E

TIME SUMMARY - BY COMPONENT300 TON COOLING TOWER (MARLEY)

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	25.16		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"	4.72	Replace fan motor
11	"		
12	"		
13	"		
14	"		
15	"		
16	"		
17	"		
18	"		
19	"		
20	"	* Contract	Replace cooling tower
21	"		
22	"		
23	"		
24	"		
25	"		
	<b>TOTALS</b>	629.00	4.72

\* 95% approx. cost factor of system cost

TASK SUMMARY - N

CATEGORY: 4-E

SYSTEM: 300 Ton Cooling Tower (Marley)

DESCRIPTION: Clean, lubricate, adjust and inspect 300 ton evaporative condenser or metal cooling tower. Includes draining and filling. Does not include acid clean.

TASKS

- Remove and reinstall screw
- Remove and reinstall panel
- Clean inside cabinet with water hose
- Clean inside cabinet by scraping
- Clean blower fan
- Lubricate fan
- Clean, lubricate, adjust motor
- Add oil to gear box
- Clean water pump
- Lubricate water pump
- Remove and reinstall nozzle
- Clean nozzle
- Remove and reinstall float
- Clean float
- Adjust float
- Remove and reinstall baffle
- Fill and drain condenser

Total Task Time: 13.89 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		13.89		1		17.78

TASK SUMMARY - N

CATEGORY: 4-E

SYSTEM: 300 Ton Cooling Tower (Marley)

DESCRIPTION: Preventive maintenance inspection 25 ton and over evaporative condenser or metal cooling tower.

TASKS

Remove and reinstall screw

Remove and reinstall panel

Lubricate bearings, fan, motor, pump

Add oil to gearbox

Adjust float

Sensory inspect bearings

Fill out inspector's report

Total Task Time: 1.09 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		1.09		3		4.18

TASK SUMMARY - N

CATEGORY: 4-E

SYSTEM: 300 Ton Cooling Tower (Marley)

DESCRIPTION: Fall shut down 300 ton evaporative condensers or metal cooling tower. Seasonal operation.

TASKS

Remove and reinstall screw

Remove and reinstall panel

Sensory inspect bearings

Drain water

Turn switch off

Fill out inspector's report

Total Task Time: 2.0 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		2.0		1		2.56



TASK SUMMARY - S-E-A

CATEGORY: 4-E

SYSTEM: 300 Ton Cooling Tower (Marley)  
Electric Motors

DESCRIPTION: Annual Maintenance or spring start up.

TASKS

Check ventilation ports for soil accumulation; clean if necessary

Clean exterior of motor surfaces of soil accumulation

Lubricate bearings according to horsepower ratings:

<u>HP RANGE</u>	<u>FREQUENCY</u>
1 - 7.5 HP	Every 4 years
10 - 50 HP	Yearly
Over 50 HP	Two Times/Year

- a. Remove filler and drain plugs (use zerk fittings if installed)
- b. Free drain hole of any hard grease (use piece of wire if necessary)
- c. Add grease -- use good grade lithium base grease unless otherwise noted

Check motor windings for accumulation of soil. Blow out with air if required.

Remove tags and return to service

1 - 7.5 HP  
10 - 50 HP  
Over 50 HP

Total Task Time: .5 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.5		1		.64

TASK SUMMARY - S-E-A

CATEGORY: 4-E

SYSTEM: 300 Ton Cooling Tower (Marley)

DESCRIPTION: Remove and reinstall fan motor for 300 ton metal cooling tower.

TASKS

Remove and install access panels

Disconnect and connect wiring to motor

Disconnect and connect coupling

Remove and install motor

Align motor/gearbox coupling

Check operation of motor

Total Task Time: 3.0 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>				
<u>TASK TIME</u>	<u>JOB PREPARATION</u>	<u>TRAVEL TIME</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>HOURS/TASK</u>
3.0	0.30	0.85	.19 x 3.0	4.72

15 SYSTEM/25 YEAR LIFE CYCLE STUDY

COOLING SYSTEMS CATEGORIES

CATEGORY 5

(3) Systems / A thru C

- (A) 977 ton centrifugal/hermetic compressor (Trane)
- (B) 900 ton centrifugal open drive compressor (York)
- (C) 900 ton cooling tower (Marley)

CATEGORY 5-A

- 5.1 TRANE - CENTRAVAC 2-stage centrifugal hermetic liquid chiller, Model CVHB 095 5M1 M15 based on (95°F adjusted leaving condenser) 977 net tons (adjusted leaving evaporator 44°F).  
Kw rated at 703; impeller #09; refrigerant type R-11, capacity 1,800 lbs; oil charge 10 gallons; shipping weight 40,000 lbs., operating weight 44,200 lbs.; shell and water box volume at: evaporator 170 gals., condenser 206 gals.
- 5.2 Motor Data - Hermetic motor rated at 703 kw, 460/480 volt; rated amps at 311-301, locked rotor amps 1715-1800. Motor component combination availability in Kw rating: Std. = 703, Max. = 857. 3600 RPM low speed turn, squirrel cage, two pole, induction motor, 60 cycle, 3-phase, liquid refrigerant cooled.
- 5.3 Oil Pump Motor Data - 460/480 volt; FLA = 0.55 - 0.52; LRA = 3.00 - 2.88; squirrel type, 4-pole induction motor for 60/cycle; 3-phase system.
- 5.4 Lubrication Data - A direct-drive, positive displacement oil pump driven by a low voltage 1/4 h.p. pump motor that is submerged in the oil sump to assure positive oil supply to the two (2) compressor bearings (Journal). A low watt-density heater maintains the oil temperature at a level which minimizes its affinity for refrigerant.
- 5.5 Purge System Data - System consists of a positive displacement compressor, 1/3 h.p., 150/60/1 motor, electrically heated oil separator, and a baffled purge drum. (NOTE: Water removal and noncondensables are discharged via a manual blow-off valve).
- 5.6 Motor Cooling Data - Cooling is accomplished by the transfer of heat from the motor to a liquid coolant (no moving parts). The liquid refrigerant coolant smoothly circulates over the stator windings and between the rotor and stator. Note the windings are specifically insulated for operation within a refrigerant atmosphere.
- 5.7 Compressor Guide Vanes - Fully modulating capacity control guide vanes are located at the inlet to each compressor stage. The guide vanes are controlled by an externally mounted pneumatic vane operator through a ball joint linkage in response to refrigeration load on the evaporator.
- 5.8 Evaporator Data - Component systems to include: shell and water boxes, tube sheets, tubes, eliminators, refrigerant distribution, refrigerant flow control.

Shell and Water Boxes - The shell is formed of carbon steel plates and incorporates a two (2) inch carbon rupture disc. A refrigerant temperature thermowell is provided for use with a low limit controller. 150 PSIG cast-iron water boxes with flat faced flanged connections are furnished.

CATEGORY 5-A (Continued)

Tube Sheets - Are of a thick carbon steel tube sheet that are welded to each end of the shell and drilled and reamed to accommodate the tubes.

Tubes - Individually replaceable externally finned 3/4 inch nominal diameter seamless copper tubing that is utilized as the evaporator heat transfer surface.

Eliminators - Multiple layers of metal mesh screen from the eliminators are installed over the tube bundle along the entire length of the evaporator to prevent liquid refrigerant carry-over into the compressor.

Refrigerant Distribution - Refrigerant distribution compartment in the base of the evaporator assures uniform wetting of the heat transfer surface over the entire length of the shell and under varying loads. High velocity refrigerant spray impingement on the tubes is prevented through this design.

Refrigerant Flow Control - A multiple orifice flow control system helps to maintain the correct pressure differential between the economizer and evaporator over the entire range of loading.

- 5.9 Condenser Data - Component systems to include: shell and water boxes, tube sheets, tubes, refrigerant distribution.

Shell and Water Boxes - Condenser shell is formed of carbon steel plate. All shells with nominal capacities are furnished with 150 psig cast-iron water boxes with flat faced flanged connections.

Tube Sheets - Are of a thick carbon steel tube sheet that is welded to each end of the shell and drilled and reamed to accommodate the tubes.

Tubes - Individually replaceable externally finned 3/4 inch nominal diameter seamless copper tubing that is utilized as the condenser heat transfer surface.

Refrigerant Distribution - A baffled compartment between the tube bundle and the condenser shell distributes the hot gas longitudinally throughout the condenser before it is directed uniformly downward over the tube bundle. Special baffles prevent direct impingement of high velocity compressor discharge gas upon the tubes.

- 5.10 Economizer - An interstage pressure chamber which utilizes a multiple orifice system to help maintain the correct differential between condensing and economizer pressures over the entire range of loading.

-continued next page-

CATEGORY 5-A (Continued)

5.11 Control Data -

- Primary centravac control panel which includes: oil pressure, evaporator refrigerant pressure, condenser refrigerant pressure, and purge condenser drum pressure.
- Automatic safety shutdown relays.
- On/Off control rocker switch.
- Demand limit switch (40% to 100% load design).
- Anti-recycle timer.
- Timing relay to ensure positive oil supply to compressor bearings.
- Compressor start and elapsed running time meter.
- Safety interlock controls.
- Auxiliary alarm circuits.
- Pneumatic temperature control system components.

5A

OVERALL TIME SUMMARY - BY SYSTEM

900 TON CENTRIFUGAL/HERMETIC COMPRESSOR (TRANE)

<u>YEARS</u>	<u>P.M. - REPAIRS REPLACEMENT HRS.</u>
1	63.14
2	"
3	66.08
4	63.14
5	"
6	66.08
7	63.14
8	"
9	66.08
10	67.70
11	63.14
12	66.08
13	69.05
14	63.14
15	66.08
16	63.14
17	"
18	"
19	"
20	"
21	66.08
22	63.14
23	"
24	66.08
25	63.14
<b>TOTAL</b>	<b>1609.55</b>

5A

TIME SUMMARY - BY COMPONENT900 TON CENTRIFUGAL HERMETIC LIQUID CHILLER COMPRESSOR/MOTOR

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	10.66		
2	"		
3	"	2.94	Replace crankcase heater
4	"		
5	"		
6	"	2.94	Replace crankcase heater
7	"		
8	"		
9	"	2.94	Replace crankcase heater
10	"	4.56	Replace expansion valve
11	"		
12	"	2.94	Replace crankcase heater
13	"	5.91	Replace purge unit
14	"		
15	"	2.94	Replace crankcase heater
16	"		
17	"		
18	"	* Contract	Replace compressor/motor
19	"		
20	"		
21	"	2.94	Replace crankcase heater
22	"		
23	"		
24	"	2.94	Replace crankcase heater
25	"		
	<b>TOTALS</b>	<b>266.50</b>	<b>31.05</b>

\* 65% approx. cost factor of system cost



5A

TIME SUMMARY - BY COMPONENT

900 TON CENTRIFUGAL HERMETIC LIQUID CHILLER

\*CONDENSER/EVAPORATOR

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	23.04		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"		
17	"		
18	"		
19	"		
20	"		
21	"		
22	"		
23	"		
24	"	** Contract	Replace Condenser/ Evaporator
25	"		
	<b>TOTALS</b>	<b>576.00</b>	

\*Use for evaporator and condenser 576 hrs./unit

\*\* 25% approx. cost factor of system cost

5A

TIME SUMMARY - BY COMPONENT

900 TONS CENTRIFUGAL HERMETIC LIQUID CHILLER

MOTOR STARTER

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	3.84		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"		
17	"		
18	"	* Contract	Replace starter
19	"		
20	"		
21	"		
22	"		
23	"		
24	"		
25	"		
TOTALS	96.0		

\* 10% approx. cost factor of system cost

5A

TIME SUMMARY - BY COMPONENT

900 TON CENTRIFUGAL HERMETIC LIQUID CHILLER (TRANE)

CONTROLS/CONTROL PANEL

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	2.56		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"	* Contract	Replace controls/ control panel
16	"		
17	"		
18	"		
19	"		
20	"		
21	"		
22	"		
23	"		
24	"		
25	"		
TOTALS	64.0		

\* 5% approx. cost factor of system cost

TASK SUMMARY - N

CATEGORY: 5-A

SYSTEM: 977 Ton Centrifugal/Hermetic Compressor (Trane)

DESCRIPTION: Annual maintenance or start-up. Clean, lubricate, adjust and inspect 900 ton hermetic air conditioning compressor.

TASKS

Wipe compressor and motor.

Drain oil from crankcase.

Fill crankcase with oil.

Prepare and run to pump down.

Inspect sight glass.

Recharge system.

Check for leaks.

Check safety devices.

Drain water from air tank.

Lubricate air compressor.

Remove and reinstall drier.

Total Task Time: 5.0 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		5.0		1		6.4

TASK SUMMARY - N

CATEGORY: 5-A

SYSTEM: 977 Ton Centrifugal/Hermetic Compressor (Trane)

DESCRIPTION: Preventive maintenance inspection over 900 ton hermetic air conditioning compressor.

TASKS

Wipe compressor and motor.

Inspect sight glass and gages.

Add oil.

Drain air tank.

Inspect for leaks.

Check for proper operation.

Fill out inspector's report

Total Task Time: .94 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.94		3		3.61

TASK SUMMARY - N

CATEGORY: 5-A

SYSTEM: 977 Ton Centrifugal/Hermetic Compressor (Trane)

DESCRIPTION: Fall shut down of all compressors. Seasonal operation.

TASKS

Prepare and pump down system into receiver.

Check system for leaks and note.

Turn switch off.

Fill out inspector's report

Total Task Time: .51 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.51		1		.65

TASK SUMMARY - N

CATEGORY: 5-A

SYSTEM: 977 Ton Centrifugal/Hermetic Compressor (Trane)

DESCRIPTION: Remove and reinstall expansion valve on 900 ton hermetic air conditioning system.

TASKS

Pump down system into receiver.

Remove and install fitting.

Plug and unplug port openings.

Prepare to remove expansion valve.

Remove and reinstall expansion valve.

Put expansion valve into operation.

Recharge system.

Check operation of system.

Material handling.

Total Task Time: 2.87 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>								
<u>TASK TIME</u>	<u>+</u>	<u>JOB PREPARATION</u>	<u>+</u>	<u>TRAVEL TIME</u>	<u>+</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>=</u>	<u>HOURS/TASK</u>
2.87		0.30		0.85		.19 x 2.87		4.56

TASK SUMMARY - S-E-A

CATEGORY: 5-A

SYSTEM: 977 Ton Centrifugal/Hermetic Compressor (Trane)

DESCRIPTION: Remove and reinstall compressor crankcase heater.

TASKS

Pump down compressor.

Remove and reinstall drain plug.

Drain and refill crankcase.

Remove and reinstall inspection plate.

Remove and reinstall heater.

Connect, operate, and disconnect vacuum pump.

Recharge system.

Check for leaks.

Total Task Time: 1.5 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

TIME CALCULATION HOURS/TASK

<u>TASK TIME</u>	+	<u>JOB PREPARATION</u>	+	<u>TRAVEL TIME</u>	+	<u>CRAFT ALLOWANCE TIME</u>	=	<u>HOURS/TASK</u>
1.5		0.30		0.85		.19 x 1.5		2.94



TASK SUMMARY - S-E-A

CATEGORY: 5-A

SYSTEM: 977 Ton Centrifugal/Hermetic Compressor (Trane)

DESCRIPTION: Remove and reinstall purge unit

TASKS

Close and open shut-off valve on refrigerant to line running to purge unit.

Disconnect and connect purge unit.

Remove and reinstall purge unit.

Put purge unit into operation.

Check operation of system.

Total Task Time: 4.0 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>				
<u>TASK TIME</u>	<u>JOB PREPARATION</u>	<u>TRAVEL TIME</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>HOURS/TASK</u>
4.0	0.30	0.85	.19 x 4.0	5.91

TASK SUMMARY - N

CATEGORY: 5-A

SYSTEM: 977 Ton Centrifugal/Hermetic Compressor (Trane)

DESCRIPTION: Drain, remove and reinstall end plates, punch and clean tubes and refill a 900 ton shell and tube condenser or chilled water evaporator. Use ladder or scaffolding.

TASKS

Remove and reinstall pipe fitting.

Drain and fill tubes, per gallon.

Remove and reinstall nut.

Remove and reinstall cover plate.

Punch clean tube up to 25' long, up to 1" O.D.

Dry tube with rag.

Cut gasket over 2 sq. ft.

Mark and punch holes in gasket.

Install gasket.

Material handling.

Total Task Time: 18.0 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		18.0		1		23.04

TASK SUMMARY - GSA

CATEGORY: 5-A

SYSTEM: Motor Starters

DESCRIPTION: Planned annual maintenance or spring start-up.

TASKS

Tighten all connections to main bus.

Inspect breakers and fuses connected to the main bus for tightness.

Inspect starter coils. Clean contacts; replace as required.

Use vacuum or dry compressed air to remove dust or other material which may cause shorts or arcing.

Inspect all interlocks and controls. Clean and lightly lubricate friction points. Remove excess lubricant. (Refer to manufacturer's instructions.)

Test starter heaters for correct design amperage and size.

Operate breakers to insure proper making.

Visually inspect for broken parts, contact arcing or any evidence of overheating.

Check motor nameplate for current rating and controller manufacturer's recommended heater size. (Heater size shall not be changed without the regional design engineer's approval.)

Check line and load connections and heater mounting screws for tightness.

Perform time/current characteristics test at the appropriate multiple of heater rating

Record test results on GSA Form 2543, Circuit Breaker Test Record. Show both as found and as left.

Check contact resistance in micro-ohms and dielectric strength in meg-ohms.

-continued next page-

TASK SUMMARY - GSA

CATEGORY: 5-A

SYSTEM: Motor Starters (Continued)

DESCRIPTION: Planned annual maintenance or spring start-up.

TASKS

Check starter connection by applying a thin film of black contact grease to the line and load stabs; then rack the breaker in and out of the cubicle and measure the wipe marks on the stab.

Remove tags and lock and return circuit to service.

Total Task Time: 3.0 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		3.0		1		3.84

TASK SUMMARY - GSA

CATEGORY: 5-A

SYSTEM: Controls, Central Air-Conditioning

DESCRIPTION: Annual maintenance or spring start-up

TASKS

Check set points of controls (temperature or pressure safety).

Compare control point with an external measuring device, note deviations, and adjust/calibrate.

Check the unit over its range of control. If possible, impose simulated conditions to activate controls and check operation.

Check for control point cycling.

Check closeness of differential gap on two position controllers (on-off-open-closed).

Check condition and action of primary elements in the controllers (bi-metallic strips, sealed bellows with capillary tubes) remote sensing, etc.

Note the action of the controlling device (thermostats and pressurestats) which changes the controlled devices.

On electronic controls, check the source of the signal and its amplification.

Check air systems for leaks; check for correct maintenance of pressure in all control devices. Check units for proper closing and loose connections.

Check resulting action of pressure sensing primary control elements such as diaphragms, bellows, inverted bells, and similar devices when activated by air, water, or similar pressure. Check operation of all relays, pilot valves, and pressure regulators.

Use test kits and manufacturer's instructions whenever possible. Replace rather than rebuild a control installed in the system. Take control to shop for repair.

Total Task Time: 2.0 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		2.0		1		2.56

256

CATEGORY 5-B

- 5.2.1 York Open Turbopak Centrifugal Liquid Chiller 900 Ton (Net)  
(adjusted leaving condenser water 95°); 629 Kw rated (adjusted leaving chiller water at 44°); refrigerant type 500, capacity 2,500 lbs.; oil capacity 12 gallons; condenser capacity 194 gallons, cooler capacity 137 gallons; operating weight at 32,900 lbs., shipping weight at 31,500 lbs. Unit Type - 900 OTN4G1.
- 5.2.2 Motor Data - 3600 RPM motor, open - drip-proof, squirrel cage induction type. 460-480 V; 3-phase; 60 hertz; rated at 629 kw.
- 5.2.3 Cooler/Evaporator Data - Horizontal flooded shell and tube type, liquid distribution system consisting of a distribution trough to give uniform liquid distribution throughout the shell length, and a perforated distributor under the entire tube bundle at 1/2 inch thick; intermediate steel tube supports spaced at intervals less than four (4) feet. Highly efficient integral aluminum eliminators are designed within the system.
- 5.2.4 Condenser Data - Horizontal shell and tube type, discharge gas baffle to prevent direct high velocity impingement on tubes, and to distribute the gas flow properly to utilize all heat transfer surfaces (purge collection chamber). Intermediate steel tube supports are spaced at intervals less than four (4) feet.
- 5.2.5 Lubrication Data - Forced feed to all bearings, centrifugal oil pumps integral with rotor shaft for assured lubrication. External mounted auxiliary oil pump driven by a 1/3 h.p., 115/1/60, 1725 RPM inherently protected motor.
- Refrigerant cooled cooler and 15 micron external oil filter with replaceable type cartridge and service valves for oil system.
- 5.2.6 Shaft Seal - Precision type carbon ring, spring loaded, small face area, low rubbing speed - high temperature elastomer "O" ring static seal.
- 5.2.7 Turboguard Purge Unit Data - Completely automatic, self-contained compressorless type, utilizes high pressure oil from centrifugal compressor as a fluid piston for efficient purging of non-condensable gases, and eliminates auxiliary motor operating cost and power supply.
- 5.2.8 Control Data - Control center to be in a locked enclosure, factory mounted, piped and wired, and to have the capacity of:
- Operating and safety controls
  - Control sequence
  - Fail-safe automatic operation
  - Oil pump operation
  - Anti-recycling
  - Control variable inlet guide vanes
  - Pneumatic capacity control system or electronic type
  - Interlocking of compressor motor starter
  - Chilled water flow switch
  - Condenser and chill water pumps

CATEGORY 5-B (Continued)

- Cooling tower fan operation
- Chilled water temperature controller
- Compressor start/stop/reset
- Manual reset controls for high oil temperature, high/low refrigerant pressure, low oil pressure, low leaving chilled water temperature, chilled water flow/power failure
- Dial pressure gauges for refrigerant evaporator, condenser pressure and oil pressure
- Purge unit excess purge/reset and/or refrigerant transfer unit power switch.

5-B

OVERALL TIME SUMMARY - BY SYSTEM

900 TON CENTRIFUGAL OPEN DRIVE COMPRESSOR (YORK)

<u>YEARS</u>	<u>P.M. - REPAIRS REPLACEMENT HRS.</u>
1	65.57
2	"
3	68.51
4	65.57
5	"
6	68.51
7	65.57
8	"
9	68.51
10	70.13
11	65.57
12	68.51
13	71.48
14	65.57
15	68.51
16	65.57
17	"
18	68.51
19	65.57
20	"
21	"
22	"
23	68.51
24	65.57
25	"
<b>TOTAL</b>	<b>1670.30</b>



5-B

TIME SUMMARY - BY COMPONENT  
900 TON OPEN CENTRIFUGAL LIQUID COMPRESSOR (YORK)  
COMPRESSOR

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	12.32		
2	"		
3	"	2.94	Replace crankcase heater
4	"		
5	"		
6	"	2.94	Replace crankcase heater
7	"		
8	"		
9	"	2.94	Replace crankcase heater
10	"	4.56	Replace expansion valve
11	"		
12	"	2.94	Replace crankcase heater
13	"	5.91	Replace purge unit
14	"		
15	"	2.94	Replace crankcase heater
16	"		
17	"		
18	"	2.94	Replace crankcase heater
19	"		
20	"	* Contract	Replace compressor
21	"		
22	"		
23	"	2.94	Replace crankcase heater
24	"		
25	"		
	<b>TOTALS</b>	<b>308.0</b>	<b>31.05</b>

\* 45% approx. cost factor of system cost

5-B

TIME SUMMARY - BY COMPONENT

900 TON OPEN CENTRIFUGAL LIQUID CHILLER (YORK)

\*CONDENSER/EVAPORATOR

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	23.04		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"		
17	"		
18	"		
19	"		
20	"		
21	"		
22	"		
23	"		
24	"	** Contract	Replace condenser/evaporator
25	"		
TOTALS	576.00		

\* Use for evaporator and condenser 576 hrs./unit

\*\* 25% approx. cost factor of system cost

5-B

TIME SUMMARY - BY COMPONENT

900 TON OPEN CENTRIFUGAL LIQUID CHILLER (YORK)

MOTOR 800 H.P. (INCLUDES MOTOR STARTER)

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	4.61		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"		
17	"		
18	"	* Contract	Replace motor
19	"		
20	"		
21	"		
22	"		
23	"		
24	"		
25	"		
TOTALS	115.25		

\* 25% approx. cost factor of system cost

5-B

TIME SUMMARY - BY COMPONENT  
900 TON OPEN CENTRIFUGAL LIQUID CHILLER (YORK)  
CONTROLS/CONTROL PANEL

<u>YEARS</u>	<u>P.M.</u> <u>HOURS</u>	<u>REPAIRS/</u> <u>REPLACEMENT</u>	<u>MATERIAL</u>
1	2.56		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"	* Contract	Replace controls/ control panel
17	"		
18	"		
19	"		
20	"		
21	"		
22	"		
23	"		
24	"		
25	"		
	<b>TOTALS</b>	<b>64.0</b>	

\* 5% approx. cost factor of system cost

TASK SUMMARY - N

CATEGORY: 5-B

SYSTEM: 900 Ton Centrifugal Open Drive Compressor (York)

DESCRIPTION: Clean, lubricate, adjust and inspect over 100 ton, open (central compression) air conditioning compressor.

TASKS

Wipe compressor and motor.

Check and adjust motor alignment coupling.

Lubricate motor and coupling.

Drain oil from crankcase.

Fill crankcase with oil.

Prepare and run to pump down.

Inspect sight glass.

Recharge system.

Check for leaks.

Check safety devices.

Drain water from air tank.

Lubricate air compressor.

Remove and reinstall drier.

Total Task Time: 6.3 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time (Hrs/Yr)</u>
1.28		6.3		1		8.06

TASK SUMMARY - N

CATEGORY: 5-B

SYSTEM: 900 Ton Centrifugal Open Drive Compressor (York)

DESCRIPTION: Preventive maintenance inspection over 25 ton open (central compression) air conditioning compressor.

TASKS

Wipe compressor and motor.

Check motor alignment and adjust.

Inspect sight glass and gages.

Lubricate bearings.

Add oil.

Drain air tank.

Inspect for leaks.

Check for proper operation.

Fill out inspector's report

Total Task Time: .94 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.94		3		3.61

TASK SUMMARY - N

CATEGORY: 5-B

SYSTEM: 900 Ton Centrifugal Open Drive Compressor (York)

DESCRIPTION: Fall shut down all compressors. Seasonal operation.

TASKS

Prepare and pump down system into receiver.

Check system for leaks and note.

Turn switch off.

Fill out inspector's report

Total Task Time: .51 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time (Hrs/Yr)</u>
1.28		.51		1		.65

TASK SUMMARY - S-E-A

CATEGORY: 5-B

SYSTEM: 900 Ton Centrifugal Open Drive Compressor (York)

DESCRIPTION: Remove and reinstall compressor crankcase heater.

TASKS

- Pump down compressor.
- Remove and reinstall drain plug.
- Drain and refill crankcase.
- Remove and reinstall inspection plate.
- Remove and reinstall heater.
- Connect, operate, and disconnect vacuum pump.
- Recharge system.
- Check for leaks.

Total Task Time: 1.5 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>				
<u>TASK TIME</u>	<u>JOB PREPARATION</u>	<u>TRAVEL TIME</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>HOURS/TASK</u>
1.5	0.30	0.85	.19 x 1.5	2.94



TASK SUMMARY - N

CATEGORY: 5-B

SYSTEM: 900 Ton Centrifugal Open Drive Compressor (York)

DESCRIPTION: Remove and reinstall expansion valve on 900 ton open  
compression air conditioning system.

TASKS

Pump down system into receiver.

Remove and install fitting.

Plug and unplug port openings.

Prepare to remove expansion valve.

Remove and reinstall expansion valve.

Put expansion valve into operation.

Recharge system.

Check operation of system.

Material handling.

Total Task Time: 2.87 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>								
<u>TASK TIME</u>	<u>+</u>	<u>JOB PREPARATION</u>	<u>+</u>	<u>TRAVEL TIME</u>	<u>+</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>=</u>	<u>HOURS/TASK</u>
2.87		0.30		0.85		.19 x 2.87		4.56

TASK SUMMARY - S-E-A

CATEGORY: 5-B

SYSTEM: 900 Ton Centrifugal Open Drive Compressor (York)

DESCRIPTION: Remove and reinstall purge unit.

TASKS

Close and open shut-off valve on refrigerant to line running to purge unit.

Disconnect and connect purge unit.

Remove and reinstall purge unit.

Put purge unit into operation.

Check operation of system.

Total Task Time: 4.0 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

<u>TIME CALCULATION HOURS/TASK</u>				
<u>TASK TIME</u>	<u>JOB PREPARATION</u>	<u>TRAVEL TIME</u>	<u>CRAFT ALLOWANCE TIME</u>	<u>HOURS/TASK</u>
4.0	0.30	0.85	.19 x 4.0	5.91

TASK SUMMARY - N

CATEGORY: 5-B

SYSTEM: 900 Ton Centrifugal Open Drive Compressor (York)  
Condenser/Evaporator

DESCRIPTION: Drain, remove and reinstall end plates, punch and clean tubes and refill a 900 ton shell and tube condenser or chilled water evaporator. Use ladder or scaffolding.

TASKS

- Remove and reinstall pipe fitting.
- Drain and fill tubes, per gallon.
- Remove and reinstall nut.
- Remove and reinstall cover plate.
- Punch clean tube up to 25' long, up to 1" O.D.
- Dry tube with rag.
- Cut gasket over 2 sq. ft.
- Mark and punch holes in gasket.
- Install gasket.
- Material handling.

Total Task Time: 18.0 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		18.0		1		23.04

TASK SUMMARY - S-E-A

CATEGORY: 5-B

SYSTEM: Electric Motors

DESCRIPTION: Annual maintenance or spring start-up

TASKS

Check ventilation ports for soil accumulation; clean if necessary.

Clean exterior of motor surfaces of soil accumulation.

Lubricate bearings according to horsepower ratings:

<u>HP RANGE</u>	<u>FREQUENCY</u>
1 - 7.5	Every 4 years
10 - 50	Yearly
over 50 HP	Two times/year

- a. Remove filler and drain plugs (use zerk fittings if installed)
- b. Free drain hole of any hard grease (use piece of wire if necessary)
- c. Add grease -- use a good grade lithium base grease unless otherwise noted.

Check motor windings for accumulation of soil. Blow out with air if required.

Remove tags and return to service.

1 - 7.5 HP  
10 - 50  
over 50 HP

Total Task Time: .60 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.60		1		.77

TASK SUMMARY - GSA

CATEGORY: 5-B

SYSTEM: Motor Starters

DESCRIPTION: Annual maintenance or spring start-up.

TASKS

Tighten all connections to main bus.

Inspect breakers and fuses connected to the main bus for tightness.

Inspect starter coils. Clean contacts; replace as required.

Use vacuum or dry compressed air to remove dust or other material which may cause shorts or arcing.

Inspect all interlocks and controls. Clean and lightly lubricate friction points. Remove excess lubricant. (Refer to manufacturer's instructions.)

Test starter heaters for correct design amperage and size.

Operate breakers to insure proper making.

Visually inspect for broken parts, contact arcing or any evidence of overheating.

Check motor nameplate for current rating and controller manufacturer's recommended heater size. (Heater size shall not be changed without the regional design engineer's approval.)

Check line and load connections and heater mounting screws for tightness.

Perform time/current characteristics test at the appropriate multiple of heater rating.

Record test results on GSA Form 2543, Circuit Breaker Test Record. Show both as found and as left.

Check contact resistance in micro-ohms and dielectric strength in meg-ohms.

-continued next page-

TASK SUMMARY - GSA

CATEGORY: 5-B

SYSTEM: Motor Starters (Continued)

DESCRIPTION:

TASKS

Check starter connection by applying a thin film of black contact grease to the line and load stabs; then rack the breaker in and out of the cubicle and measure the wipe marks on the stab.

Remove tags and lock and return circuit to service.

Total Task Time: 3.0 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		3.0		1		3.84

TASK SUMMARY - GSA

CATEGORY: 5-B

SYSTEM: Controls, Central Air Conditioning

DESCRIPTION: Annual maintenance or spring start-up.

TASKS

Check set point of controls (temperature or pressure).

Compare control point with an external measuring device, note deviations, and adjust/calibrate.

Check the unit over its range of control. If possible, impose simulated conditions to activate controls and check operation.

Check for control point cycling.

Check closeness of differential gap on two position controllers (on-off-open-closed).

Check condition and action of primary elements in the controllers (bi-metallic strips, sealed bellows with capillary tubes) for remote sensing, etc.

Note the action of the controlling device (thermostats and pressurestats) which changes the controlled devices.

On electronic controls check the source of the signal and its amplification.

Check air systems for leaks check for correct maintenance of pressure in all control devices. Check units for proper closing and loose connections.

Check resulting action of pressure sensing primary control elements such as diaphragms, bellows, inverted bells, and similar devices when activated by air, water, or similar pressure. Check operation of all relays, pilot valves, and pressure regulators.

Use test kits and manufacturer's instructions whenever possible. Replace rather than rebuild a control installed in the system. Take control to shop for repair.

Total Task Time: 2.0 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		2.0		1		2.56

CATEGORY 5-C

- 5.3.1 Marley Model 8619 NCM Series Modular Double-Flow Packaged Cooling Tower. Nominal tonnage at 900 tons, based on (95° - 85° - 78° WB) 3 GPM/Ton. Length at 11 ft., 11-1/4 inch, width at 20 ft., 10-3/4 inch, height at 19 ft., 3 inches. Shipping weight - top section at 9600 lbs.; shipping wt. - bottom section at 12,600 lbs.; shipping weight total - 22,200 lbs.; operating weight at 35,800 lbs.
- 5.3.2 Motor Data - One (1) 50 h.p. fan dia. and type 120 H5; RPM (60 cycle) at 427; RPM (50 cycle) at 423; CFM at 117,500; gear reducer type 22.1; drive shaft at 175, ratio = 1 (60 cycle) : 4.10, ratio = 1 (50 cycle) : 3.45; 1800 RPM 3-60.
- 5.3.3 GPM Data - Min. at 900, max. at 3600; number of orifice/tower at 252.
- 5.3.4 Voltage/Electric Data - Standard voltage at 200V, or 230/460 V; two speed motor is one voltage only (200V or 460V).
- 5.3.5 Fill and Eliminator Data - Fill to be lightweight, non-ferrous and non-corrosive. Drift eliminators shall be two-pass non-corrosive, neoprene asbestos honeycomb supported in steel frames.
- 5.3.6 Mechanical Data - Equipment to include Marley gear reducer and motor which is at a right angle to the fan. All fans are gear drive type, large h.p. capacity. High speed reduction ratios are applied with a safety factor that assures long operating service. Note: External oil line and dip stick to be provided.
- 5.3.7 Fan Data - The NCM Series is built for smooth, quiet operation and dependability against higher static pressures of high performance film-type fill materials. Adjustable pitch blades allow maximum utilization of rated h.p. Blades are corrosion-resistant solid-cast aluminum alloy; hubs are also cast aluminum type. Cooling tower is an induced-draft, vertical-discharge, double-flow type.



5-C

OVERALL TIME SUMMARY - BY SYSTEM

900 TON COOLING TOWER (MARLEY)

<u>YEARS</u>	<u>P.M. - REPAIRS REPLACEMENT HRS.</u>
1	30.42
2	"
3	"
4	"
5	"
6	"
7	"
8	"
9	"
10	37.52
11	30.42
12	"
13	"
14	"
15	"
16	"
17	"
18	"
19	"
20	"
21	"
22	"
23	"
24	"
25	"
<b>TOTAL</b>	<b>767.6</b>

5-C

TIME SUMMARY - BY COMPONENT  
900 TON COOLING TOWER (MARLEY)

<u>YEARS</u>	<u>P.M. HOURS</u>	<u>REPAIRS/ REPLACEMENT</u>	<u>MATERIAL</u>
1	30.42		
2	"		
3	"		
4	"		
5	"		
6	"		
7	"		
8	"		
9	"		
10	"	7.1	Replace fan motor
11	"		
12	"		
13	"		
14	"		
15	"		
16	"		
17	"		
18	"		
19	"		
20	"	* Contract	Replace cooling tower
21	"		
22	"		
23	"		
24	"		
25	"		
<b>TOTALS</b>	<b>760.50</b>	<b>7.1</b>	

\* 95% approx. cost factor of system cost

TASK SUMMARY - N

CATEGORY: 5-C

SYSTEM: 900 Ton Cooling Tower (Marley)

DESCRIPTION: Clean, lubricate and inspect 900 ton evaporative condenser or metal cooling tower. Includes draining and filling. Does not include acid clean.

TASKS

Remove and reinstall screw.

Remove and reinstall panel.

Clean inside cabinet with water hose.

Clean inside cabinet by scraping.

Clean blower fan.

Lubricate fan.

Clean, lubricate, adjust motor.

Add oil to gear box.

Clean water pump.

Lubricate water pump.

Remove and reinstall nozzle.

Clean nozzle.

Remove and reinstall float.

Clean float.

Adjust float.

Remove and reinstall baffle.

Fill and drain condenser.

TOTAL TASK TIME: 18.0 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		18.0		1		23.04

TASK SUMMARY - N

CATEGORY: 5-C

SYSTEM: 900 Ton Cooling Tower (Marley)

DESCRIPTION: Preventive maintenance inspection 25 ton and over evaporative condenser or metal cooling tower.

TASKS

Remove and reinstall screw.

Remove and reinstall panel.

Lubricate bearings, fan, motor, pump.

Add oil to gearbox.

Adjust float.

Sensory inspect bearings.

Fill out inspector's report

Total Task Time: 1.09 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		1.09		3		4.18

TASK SUMMARY - N

CATEGORY: 5-C

SYSTEM: 900 Ton Cooling Tower (Marley)

DESCRIPTION: Fall shut down 900 ton evaporative condensers or metal cooling tower. Seasonal operation.

TASKS

Remove and reinstall screw.

Remove and reinstall panel.

Sensory inspect bearings.

Drain water.

Turn switch off.

Fill out inspector's report

Total Task Time: 2.0 Hours

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		2.0		1		2.56

TASK SUMMARY - S-E-A

CATEGORY: 5-C

SYSTEM: Electric Motors

DESCRIPTION: Annual maintenance or spring start-up.

TASKS

Check ventilation ports for soil accumulation; clean if necessary.

Clean exterior of motor surfaces of soil accumulation.

Lubricate bearings according to horsepower ratings:

<u>H.P. RANGE</u>	<u>FREQUENCY</u>
1 - 7.5	Every 4 years
10 - 50	Yearly
over 50 hp	Two times/year

- a. Remove filler and drain plugs (use zerk fittings if installed).
- b. Free drain hole of any hard grease (use piece of wire if necessary).
- c. Add grease -- use good grade lithium base grease unless otherwise noted.

Check motor windings for accumulation of soil. Blow out with air if required.

Remove tags and return to service.

1 - 7.5 hp  
10 - 50 hp  
over 50 hp

Total Task Time: .5 Hour

ANNUAL TIME CALCULATION (HOURS/YEAR)

<u>Allowance</u>	x	<u>Task Time</u>	x	<u>Frequency/Yr.</u>	=	<u>Annual Time(Hrs/Yr)</u>
1.28		.5		1		.64

TASK SUMMARY - S-E-A

CATEGORY: 5-C

SYSTEM: 900 Ton Cooling Tower (Marley)

DESCRIPTION: Remove and reinstall fan motor for 900 ton metal cooling tower.

TASKS

Remove and install access panels.

Disconnect and connect wiring to motor.

Disconnect and connect coupling.

Remove and install motor.

Align motor/gearbox coupling.

Check operation of motor.

Total Task Time: 5.0 Hours

UNSCHEDULED MAINTENANCE (REPAIRS)

TIME CALCULATION HOURS/TASK

<u>TASK TIME</u>	+	<u>JOB PREPARATION</u>	+	<u>TRAVEL TIME</u>	+	<u>CRAFT ALLOWANCE TIME</u>	=	<u>HOURS/TASK</u>
5.0		0.30		0.85		.19 x 5.0		7.10

Chief of Engineers  
ATTN: Tech Monitor  
ATTN: DAEM-AS1-L (2)  
ATTN: DAEM-CCP  
ATTN: DAEM-CV  
ATTN: DAEM-CVE  
ATTN: DAEM-CVM-R  
ATTN: DAEM-CMO  
ATTN: DAEM-CMP  
ATTN: DAEM-EC  
ATTN: DAEM-ECC  
ATTN: DAEM-ECE  
ATTN: DAEM-ZCF  
ATTN: DAEM-ECB  
ATTN: DAEM-RD  
ATTN: DAEM-RDC  
ATTN: DAEM-RDM  
ATTN: DAEM-RM  
ATTN: DAEM-ZCZ  
ATTN: DAEM-ZCE  
ATTN: DAEM-ZCI  
ATTN: DAEM-ZCM

FESA, ATTN: Library 22060

FESA, ATTN: DET III 79906

US Army Engineer Districts

ATTN: Library  
Alaska 99501  
Al Batin 09616  
Albuquerque 87103  
Baltimore 21203  
Buffalo 14207  
Charleston 29402  
Chicago 60604  
Detroit 48231  
Far East 96301  
Fort Worth 76102  
Galveston 77550  
Huntington 25721  
Jacksonville 32232  
Japan 96343  
Kansas City 64106  
Little Rock 72203  
Los Angeles 90053  
Louisville 40201  
Memphis 38103  
Mobile 36628  
Nashville 37202  
New England 02154  
New Orleans 70160  
New York 10007  
Norfolk 23510  
Omaha 68102  
Philadelphia 19106  
Pittsburgh 15222  
Portland 97208  
Riyadh 09638  
Rock Island 61201  
Sacramento 95814  
San Francisco 94105  
Savannah 31402  
Seattle 98124  
St. Louis 63101  
St. Paul 55101  
Tulsa 74102  
Vicksburg 39180  
Walla Walla 99362  
Wilmington 28401

US Army Engineer Divisions

ATTN: Library  
Europe 09757  
Huntsville 35807  
Lower Mississippi Valley 39180  
Middle East 09038  
Middle East (Rear) 22601  
Missouri River 68101  
North Atlantic 10007  
North Central 60605  
North Pacific 97208  
Ohio River 45201  
Pacific Ocean 96858  
South Asian 30303  
South Pacific 94111  
Southwestern 75202

JS Army Europe

HQ, 7th Army Training Command 09114  
ATTN: ACTTG-BEH (5)  
HQ, 7th Army ODCS/Engr. 09403  
ATTN: AEAEN-EN (4)  
V. Corps 09079  
ATTN: ACTYDEN (5)  
VII. Corps 09154  
ATTN: AETSDBH (5)  
21st Support Command 09325  
ATTN: AEREN (5)  
Berlin 09742  
ATTN: AEA-EN (2)  
Southern European Task Force 09168  
ATTN: AESE-ENG (3)  
Installation Support Activity 09403  
ATTN: AEUES-HP

8th USA, Korea  
ATTN: EAFE (8) 96301  
ATTN: EAFE-Y 96308  
ATTN: EAFE-IO 96224  
ATTN: EAFE-AM 96208

8th USA, Korea  
ATTN: EAFE-H 96271  
ATTN: EAFE-P 96259  
ATTN: EAFE-T 96212

ROK/US Combined Forces Command 96301  
ATTN: EUSA-HMC-CFC/Engr

USA Japan (USARJ)  
Ch, FE Div, AJEN-FE 96343  
Fac Engr (Honshu) 96343  
Fac Engr (Okinawa) 96331

Rocky Mt. Area 80903

Area Engineer, AEDC-Area Office  
Arnold Air Force Station, TN 37389

Western Area Office, CE  
Vandenberg AFB, CA 93437

416th Engineer Command 60623  
ATTN: Facilities Engineer

US Military Academy 10996  
ATTN: Facilities Engineer  
ATTN: Dept of Geography &  
Computer Science  
ATTN: DSCPER/MAEN-A

Engr. Studies Center 20315  
ATTN: Library

AMARC, ATTN: DRXMR-ME 02172

USA ARRCOM 61299  
ATTN: DRCS-RI-1  
ATTN: ORSAR-IS

DARCOM - Dir., Inst., & Svcs.

ATTN: Facilities Engineer  
ARRACOM 07801  
Aberdeen Proving Ground 21005  
Army Metls. and Mechanics Res. Ctr.  
Corpus Christi Army Depot 78419  
Harry Diamond Laboratories 20763  
Dugway Proving Ground 84022  
Jefferson Proving Ground 47250  
Fort Monmouth 07703  
Letterkenny Army Depot 17201  
Natick RAD Ctr. 01780  
New Cumberland Army Depot 17070  
Pueblo Army Depot 81001  
Mad River Army Depot 75501  
Redstone Arsenal 35809  
Rock Island Arsenal 61299  
Savanna Army Depot 61074  
Sharpe Army Depot 96331  
Seneca Army Depot 14541  
Toiyah Army Depot 18466  
Tooele Army Depot 84074  
Watervliet Arsenal 12189  
Yuma Proving Ground 85364  
White Sands Missile Range 88002

DLA ATTN: DLA-WI 22314

FORSCOM

FORSCOM Engineer, ATTN: AFEN-FE  
ATTN: Facilities Engineer  
Fort Buchanan 00934  
Fort Bragg 28307  
Fort Campbell 42223  
Fort Carson 80913  
Fort Devens 01433  
Fort Drum 13601  
Fort Hood 76844  
Fort Indiantown Gap 17003  
Fort Irwin 92311  
Fort Sam Houston 78234  
Fort Lewis 98433  
Fort McCoy 54656  
Fort McPherson 30330  
Fort George G. Meade 20755  
Fort Ord 93941  
Fort Polk 71469  
Fort Richardson 99806  
Fort Riley 66442  
Presidio of San Francisco 94129  
Fort Sheridan 60037  
Fort Stewart 31313  
Fort Vainwright 99703  
Vancouver Bks. 98680

HSC

ATTN: HSLD-F 78234  
ATTN: Facilities Engineer  
Fitzsimons AMC 80500  
Walter Reed AMC 20012

INSCOM - Ch, Instl. Div.

ATTN: Facilities Engineer  
Arlington Hall Station (2) 22212  
Vint Hill Farm Station 22186

NSW

ATTN: Facilities Engineer  
Cameron Station 22314  
Fort Lesley J. McHair 20319  
Fort Ryer 22211

MTMC

ATTN: MTMC-SA 20315  
ATTN: Facilities Engineer  
Oakland Army Base 94626  
Bayonne MOT 07002  
Sunny Point MOT 28461

MARADCOM, ATTN: DRDMA-F 071160

TARCOM, Fac. Div. 48090

TRADOC

HQ, TRADOC, ATTN: ATEN-FE  
ATTN: Facilities Engineer  
Fort Belvoir 22060  
Fort Benning 31905  
Fort Bliss 79916  
Carlisle Barracks 17013  
Fort Chaffee 72902  
Fort Dix 08640  
Fort Eastis 23604  
Fort Gordon 30905  
Fort Hamilton 11252  
Fort Benjamin Harrison 46216  
Fort Jackson 29207  
Fort Knox 40121  
Fort Leavenworth 66027  
Fort Lee 23801  
Fort McClellan 36205  
Fort Monroe 23651  
Fort Rucker 36362  
Fort Sill 73503  
Fort Leonard Wood 65473

TSARCOM, ATTN: STSAS-F 63120

USACC

ATTN: Facilities Engineer  
Fort Huachuca 85613  
Fort Ritchie 21719

WESTCOM

ATTN: Facilities Engineer  
Fort Shafter 96858  
ATTN: AFEN-IN

SHAPE 09055

ATTN: Survivability Section, CCB-OPS  
Infrastructure Branch, LAMDA

HQ USEUCOM 09128

ATTN: ECJ 4/7-LOC

Fort Belvoir, VA 22060

ATTN: ATZA-DTE-EM  
ATTN: ATZA-DTE-SM  
ATTN: ATZA-FE  
ATTN: Engr. Library  
ATTN: Canadian Liaison Office (2)  
ATTN: IWR Library

Cold Regions Research Engineering Lab 03755

ATTN: Library

ETL, ATTN: Library 22060

Highways Experiment Station 39180

ATTN: Library

HQ, XVIII Airborne Corps and 28307

Ft. Bragg  
ATTN: AFZA-FE-EE

Chambers AFB, IL 61868

3345 CES/OE, Stop 27

Morton AFB 92409

ATTN: AFNCE-HQ/DEE

Tyndall AFB, FL 32403

AFESC/Engineering & Service Lab

NAFEC

ATTN: NDTME Liaison Office  
Atlantic Division 23511  
Chesapeake Division 20374  
Southern Division 29411  
Pacific Division 96860  
Northern Division 19112  
Western Division 64066  
ATTN: Sr. Tech. FAC-03T 22332  
ATTN: Asst. CLR RAD, FAC-03 22332

NCEL 93041

ATTN: Library (Code LOBA)

Defense Technical Info. Center 22314  
ATTN: DBA (12)

Engineering Societies Library 10017  
New York, NY

National Guard Bureau 20310  
Installation Division

US Government Printing Office 22304  
Receiving Section/Depository Copies (2)



Neathammer, Robert D.

Life-cycle cost database. -- Champaign, Ill : Construction Engineering Research Laboratory ; available from NTIS, 1983.

2v. (Technical report Construction Engineering Research Laboratory ; P-139)

Contents: v.1. Design -- v.2. Appendices E, F, and G, sample data development.

1. Buildings -- life cycles. 2. Building -- estimates. 3. Engineering economy. I. Title. II. Series : Technical report (Construction Engineering Research Laboratory) ; P-139.

DATE

ILME

8