



US Army Corps
of Engineers
Huntsville Division

AD-A153 826

REPORT FOR PREPARATION OF GUIDE SPECIFICATIONS FOR MAINTENANCE MANAGEMENT SYSTEMS

DTIC FILE COPY

This document has been approved
for public release and sale; its
distribution is unlimited.

DTIC
ELECTE
MAY 16 1985
S D A

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER HNDSP84-098-ED-ME	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) REPORT FOR PREPARATION OF GUIDE SPECIFICATIONS FOR MAINTENANCE MANAGEMENT SYSTEMS		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)		8. CONTRACT OR GRANT NUMBER(s) DACA87-84-C-0012 016
9. PERFORMING ORGANIZATION NAME AND ADDRESS VERLE A. WILLIAMS & ASSOCIATES, INC. 7047 Carroll Road, Suite 100 San Diego, California 92121		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer Division, Huntsville P.O. Box 1600 Huntsville, Alabama 35807-4301		12. REPORT DATE OCTOBER 24, 1984
		13. NUMBER OF PAGES 35 PGS
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) DISTRIBUTION STATEMENT A: APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) SPECIFICATIONS, STANDARDS, MAINTENANCE MANAGEMENT SYSTEMS, ARMY CORPS OF ENGINEERS		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) THIS REPORT INCLUDES THE CONSULTANT'S RECOMMENDATIONS FOR INCLUSIONS IN THE MAINTENANCE MANAGEMENT SYSTEM AND THE RECOMMENDED METHOD TO BEST ACCOMPLISH THESE WITHIN THE PROJECTS FOR WHICH THE CORPS OF ENGINEERS GUIDE SPECIFICATION 13880 IS BEING DEVELOPED. THIS REPORT ALSO INCLUDES AN ANALYSIS OF UTILIZING SEPARATE COMPUTERS FOR THE PRIMARY WORK.		

DD FORM 1473

EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT FOR
PREPARATION OF CORPS OF ENGINEERS
GUIDE SPECIFICATION
CEGS 13880
FOR
MAINTENANCE MANAGEMENT SYSTEMS
CONTRACT NO. DACA87-84-C-0012

Prepared For
U.S. Army Engineer Division, Huntsville
P.O. Box 1600
Huntsville, Alabama 35807

By
Verle A. Williams & Associates, Inc.
Williams Engineering Center
7047 Carroll Road, Suite 100
San Diego, California 92121
(619)458-9121

October 24, 1984



Accession No.	
NTIS	☒
DTIC	☐
Unannounced	☐
Justification	
By	
Dist	
Availability Codes	
Dist	
A-1	

TABLE OF CONTENTS

EXECUTIVE SUMMARY	ii
I. AUTHORIZATION	1
II. SCOPE	1
III. ACKNOWLEDGEMENTS	2
IV. REQUIREMENTS OF MAINTENANCE MANAGEMENT SYSTEM	3
V. SYSTEMS AVAILABILITY	9
VI. FUTURE TRENDS IN MAINTENANCE MANAGEMENT SYSTEMS	9
VII. RECOMMENDATIONS	10
VIII. APPENDICES	12
A. Sample Preventive Maintenance Tasks	A-1
B. Sample Tool Kits	B-1
C. Sample Preventive Maintenance Materials	C-1
D. Sample Belt and Filter Requirements and Location	D-1
E. Suggested Maintenance Reports	
1. Maintenance Order Summary	E.1.1
2. Deferred Maintenance Report	E.2.1
3. Maintenance-in-Progress Report	E.3.1
4. Completed Maintenance Report	E.4.1
5. Preventive Maintenance Report	E.5.1
F. Suggested Maintenance Order	F-1
G. Sample Work Schedule Report	G-1
H. Suggested Specification Outline	H-1

operating personnel become more familiar with the overall capabilities and benefits of the system; and (3) keep the two systems' main processors and terminals separate, except for the "hook" desired to retrieve certain status information from the EMCS.

The effectiveness and usefulness of the MMS is directly related to the willingness of the system designer, supplier, installer and commissioner to work closely with the facilities operating personnel to integrate the MMS into the facility's operations program. The users must be involved throughout the program for it to quickly attain its maximum benefit.

→ Keywords: Army Corps of Engineers,
Standards.
→

I. AUTHORIZATION

This report has been prepared under authorization from the U.S. Army Corps of Engineers, Contract #DACA87-84-C-0012, issued by the Huntsville Division.

II. SCOPE OF WORK

The work to be performed consists of developing a new Corps of Engineers Guide Specification (CEGS) 13880 for MMS. The work to be performed consists of developing and writing CEGS 13880 to comply with currently available materials, equipment and installation procedures. The CEGS shall describe the materials, equipment, installation, adjustment, documentation and acceptance testing required to provide a complete and operable MMS. The CEGS will be used by design engineers in preparing project specifications for projects for the Army, Air Force and other Federal agency projects for which the Corps of Engineers is, or may be designated as, the design and/or construction agency. (See Appendix H for suggested specification outline.)

The first document of this task is a report, which includes the consultant's recommendations for inclusions in the MMS and the recommended method to best accomplish these within the projects for which the CEGS is being developed. Since the CEGS' contents will result from items included in the report, this report is to be approved by the Huntsville Division prior to developing the CEGS.

Note: This report also includes an analysis of utilizing separate computers for the primary work required for the MMS and the EMCS.

III. ACKNOWLEDGEMENTS

The preparer wishes to acknowledge many individuals for their input and/or assistance in the preparation of this report. (Listed alphabetically):

COE, HUNTSVILLE DIVISION
Huntsville, Alabama

John Brown	205-895-5480
Frank Carlen	205-895-5480
Bill Stone	205-895-5480

CEDARS-SINAI MEDICAL CENTER
Los Angeles, California

John Colt	213-855-3343
-----------	--------------

FT. EUSTIS, VIRGINIA

Eugene Mahoney	804-878-4357
John McDaniels	804-878-3127
M.D. Richie	804-878-3127

COE, NORFOLK DISTRICT

Jimmie C. Daughety	804-441-3693
--------------------	--------------

HONEYWELL, INC.

Arlington Heights, Illinois

Alan J. Bateman	312-394-4000
Donald M. Joyce	312-394-4000
Donald Spethman	312-394-4000
Harvey Smith	312-394-4000

MCC POWERS

Northbrook, Illinois

John Cecelia	312-272-9555
Paul A. Skukas	312-272-9555
Jim Urbanczyk	312-272-9555

JOHNSON CONTROLS, INC.
Milwaukee, Wisconsin

Christopher A. Kleismet	414-276-9200
Sharon Ingles Kurtz	414-276-9200
Mike McLean	414-276-9200
James L. Geuin	804-857-0191

(Project Superintendent,
Ft. Eustis, Virginia)

MARINE CORPS BASE

Camp Pendleton, California

L.W. Hammett	619-725-4743
Mrs. Bailey	619-725-4813

BURROUGHS CORPORATION

San Diego, California

Edward G. Bohanan	619-451-4965
Tom Gordon	619-451-4968

NCR ELECTRONICS DIVISION

Rancho Bernardo, California

Vince Brogna	619-485-2351
Bill Jones	619-485-2351

In addition to the above personnel, many other individuals contributed by miscellaneous conversations and meetings on the subject.

IV. REQUIREMENTS OF AN EFFECTIVE MAINTENANCE MANAGEMENT SYSTEM

A. GENERAL

An effective MMS will incorporate certain items required by the supervisory and operating personnel.

In addition to maximizing the efficiency of the mechanics by providing reminders and work aids, the system should greatly reduce the clerical, bookkeeping and coordinating efforts previously performed manually by staff personnel. Some examples of these automated efficiency improvements are provided in the Appendix:

1. Sample Preventive Maintenance Task; See Appendix A.
2. Sample Tool Kits Required; See Appendix B.
3. Sample Preventive Maintenance Material Kits; See Appendix C.
4. Sample Belt and Filter Requirements and Location; See Appendix D.

B. REQUIREMENTS FOR AN EFFECTIVE MMS

An effective MMS must have the following features items to be totally effective:

1. Maintenance Order Printout. When setting up the system, the maintenance orders can be designated for printing during a "low traffic" time to permit the operator to organize them for distribution to the designated personnel with minimum lost time by the workers and supervisors. Printing should be able to be automatically initiated by the system or manually initiated by operator request.

2. Flexibility of Input/Output Data Entry and Output Instructions.

There is a constant requirement to change the data base. The basic internal methods may be "system specific" (by the manufacturer); however, the manner of handling and displaying the data should be "site specific" and operator changeable through the keyboard.

3. Password-Controlled Access to Critical Information and Scheduling.

To prevent unauthorized revisions to cost control data, including actual hours vs planned hours, and other critical data, access to these areas should be limited to personnel authorized to be in that specific area of the system. A minimum of two-level access should be incorporated.

4. Graphic Printer. To efficiently and effectively process the maintenance order, both the form and the data should be printed at the same time. This requires a graphic printer with print speed of at least 120 characters per second.

5. Interconnection to EMCS. Interconnection to the EMCS to permit automatic transfer of data regarding equipment run time, or event initiated signals (filter differential pressure alarm, water-low level alarm, etc.) that provide indication of the need for preventive maintenance should be included.

6. Separate Work Scheduling. Separate scheduling for daily, weekly, quarterly, semi-annual, and annual preventive maintenance requirements permits the preventive maintenance personnel to establish priorities of work from shortest to longest period, (to increase personnel effectiveness). (If an emergency arises, requiring work to be delayed, the annual maintenance order printout can be delayed with less immediate impact than the daily or weekly maintenance order printout.)

The system should automatically segregate maintenance order printouts by building and/or area to minimize inter- and intrabuilding travel time. This separation should be assignable using the MMS keyboard.

C. REPORTS

1. Maintenance Order. The most important report of the MMS is the maintenance order, which identifies the maintenance work to be done on a specific item by a designated work crew or skill level. The following items are considered mandatory for a maintenance order. (See Appendix F):

- a. General:

- Facility Number [from existing Integrated Facilities System (IFS)]
- Area and Building Number
- Maintenance Order Number
- Date Generated
- Date Response Required (Reminder to be generated if no response by this date)
- Level of Maintenance Required (Daily, Weekly, Monthly, Quarterly, Semi-annually, Annually, Elapsed Time, etc.)
- Special Instructions (Clearance required to enter the building, special key, escort, etc.)

- b. Equipment Section:

- Description of Equipment
- Location of Equipment
- Manufacturer of Equipment
- Model and Serial Number of Equipment
- Identification Number, Unique for Each (from IFS)

- Property Control Number, Unique for Each (from IFS)
- Technical Description of Equipment & Reference Manual Number
- Work Requirements Summary, or Reference Manual Containing this Information
- Associated Work, if any, that should be accomplished simultaneously, listed by skill-level code
- Area Served (Computer room, critical, non-critical, base commander, etc.).

c. Work Assignment Section:

- Task Code (from IFS)
- Description of Work (Optional at User's Request)
- Priority of Performance
- Shop to which work is assigned
- Craft (Issue separate maintenance order printout for each craft)
- Related Craft Work? (Yes/No, and if yes, what?)
- Special Skill/Worker Requirements (Electronic Control Expert, 2 workers, etc.)
- Tool Requirements, other than standard hand tools
- Replacement Parts Required
- Special Instructions (Call Ext. 3343 before securing unit, etc.)

d. Response Section:

- Estimated Time to Complete
- Date of Response
- Complete/Incomplete
- Worker's Name/Signature
- Time Required, Worker & Supervisor Separate Work Time and Down Time (in transit, etc.)
- Parts Used (Part No., description & quantity)

- Description of Work Completed
- Description of Work Remaining
- Material Required to Complete the Work
- Special Request/Instructions
- Return Response Required? (Notify worker when parts arrive or special request is answered, etc.)

2. Management Reports. The following reports are to be used by management and supervisory personnel in managing the facility and budgeting future expenditures. (See Appendix E.1-1 through E.5-1.)

a. Maintenance Order Summary Report (See Appendix E.1-1):

List numerically by outstanding maintenance order number or by date maintenance order was initially issued, at option of operator requesting report. Include maintenance order number, date issued, date response is required, craft and skill level, equipment description, level of preventive maintenance scheduled and estimated performance time. The summary total should indicate total hours of work in progress, listed by trade. Report may be prescheduled to print automatically, at specific calendar dates, etc., or may be manually requested by operator.

b. Deferred Maintenance Report (See Appendix E.2-1):

A report of all maintenance orders issued but not completed by the required response date. List numerically by outstanding maintenance order number or by date maintenance order was initially issued, at option of operator requesting report. Include maintenance order number, date issued, date response is required, craft and skill level, equipment description, level of preventive maintenance scheduled and estimated performance time. The summary total should indicate total hours of work in progress, listed by trade. Report may be prescheduled to print automatically, at specific calendar dates, etc., or may be manually requested by operator.

c. Maintenance In-Progress Report (See Appendix E.3-1):

A report of all maintenance orders issued less the ones included in the Deferred Maintenance Report. List numerically by maintenance order number or by date maintenance order was initially issued, at option of operator requesting report. Include maintenance order number, date issued, date response is required, craft and skill level, equipment description, level of preventive maintenance scheduled and estimated performance time. The report indicates total hours of maintenance in progress, which is the total scheduled less the total deferred.

d. Completed Maintenance Report (See Appendix E.4-1):

List numerically by maintenance order number. Include maintenance order number, date issued, date response required, date completed, craft and skill level, equipment description, level of preventive maintenance scheduled, estimated hours and actual hours. The report indicates total actual and estimated hours of maintenance completed during the requested report period, which is operator defined by month, quarter or year. The summary of total hours to date will be printed at the bottom of this report indicating total actual hours for month-to-date, quarter-to-date, and year-to-date and total estimated hours for month-to-date, quarter-to-date, and year-to-date.

e. Actual versus Projected Preventive Maintenance Report (See Appendix E.5-1):

Report of total time for all preventive maintenance as projected and as actually consumed, listed by month, quarter, and year to date.

V. SYSTEM AVAILABILITY

Many MMSs are available today. Very few are available from companies associated with EMCS in general and even fewer from those who are associated with the CEGS-EMCS projects.

A. EMCS RELATED COMPANIES

Of the companies interviewed, one had a single CPU totally integrated EMCS/MMS; one had a stand-alone interactive, dual CPU EMCS/MMS; and three had totally stand-alone MMS, with no automatic data link with the EMCS host computer. The fully integrated systems are considered limited in the capacity of MMS data management capability when comparing to the needs of military bases throughout the country.

B. NON-EMCS RELATED COMPANIES

There are many companies marketing totally stand-alone MMSs. These systems range in size from a small microprocessor to a full-sized computer network, with the capacity and capability ranging accordingly.

C. CONCLUSION

No system identified to date meets all the requirements of the system outlined herein as recommended for use in DOD projects.

VI. TRENDS IN MAINTENANCE MANAGEMENT SYSTEMS

More development will occur in the field of fully automated MMSs. Each interviewee indicated many items not yet addressed that should be included in an effective and dependable MMS. Larger system capacities are being implemented as computer hardware/software systems expand.

It appears that the MMS field is in the same relative position, i.e., technique and capability, as the computerized EMCS field was approximately 10 years ago. In terms of integrating the MMS and the EMCS, it is believed that the MMS can move ahead with much greater speed, reliability and useability due to the efforts and education in the EMCS "evolution". The MMS issue is much less complex; therefore, there should be no excessive challenge to the contracting and using personnel.

VII. RECOMMENDATIONS

GENERAL

It is recommended that the MMS be configured and function as follows:

The MMS should be a micro-computer system configured for interactive, stand-alone operation, obtaining event-initiated data and equipment run-time data from the EMCS Central Control Unit (CCU):

- o This will permit the MMS to perform all functions and provide greater flexibility within the MMS without impacting the EMCS operation. Operator interaction with the MMS will not interrupt any of the EMCS functions.
- o This will enable the Government to purchase a stand-alone MMS by competitive bids, as part of a large construction project, with carefully defined interfaces. Many existing EMCS suppliers have not yet developed the first version of MMS; therefore, the cost of integrating the MMS software into the existing EMCS software will expose the purchaser (Government) to a major expense. The MMS suppliers will offer a more complete, more trouble-free system, configured as described, than will result from extending existing EMCS software, which is marginal in many cases, to include all desired MMS features.

- o The hardware and software interface requirement will be defined as part of the MMS CEGS and will be available to any EMCS manufacturer as a requirement for future interface to the MMS.

A P P E N D I C E S

- A. Sample Preventive Maintenance Tasks
- B. Sample Tool Kits
- C. Sample Preventive Maintenance Materials
- D. Sample Belt and Filter Requirements and Location
- E. Suggested Maintenance Reports
 - 1. Maintenance Order Summary
 - 2. Deferred Maintenance Report
 - 3. Maintenance-in-Progress Report
 - 4. Completed Maintenance Report
 - 5. Preventive Maintenance Report
- F. Suggested Maintenance Order
- G. Sample Work Schedule Report
- H. Suggested Specification Outline

APPENDIX A. SAMPLE PREVENTIVE MAINTENANCE TASKS
(Courtesy Ft. Eustis)

CHILLERS (WATER COOLED):

Bi-Monthly Preventive Maintenance (2000 hrs. run time)

A. Compressor

1. Check voltage and amperage on each phase.
2. Check suction, discharge and oil pressure.
3. Check oil and refrigeration level.
4. Check crankcase heater.
5. Check compressor pump cycle.

B. Evaporator

1. Check evaporator chilled water pressure drop and temperature.
2. Check evaporator low temperature control.
3. Check evaporator liquid line solenoid valve.

C. Controls

1. Check sequencer.
2. Check pump out and anti-cycling timer.

Annual Preventive Maintenance

A. Compressor

1. Perform continuity test.
2. Perform ground test (Megohms).
3. Check electrical connections.
4. Check starter and overloads.
5. Calibrate thermometer.
6. Perform refrigeration leak test.

B. Electrical Interlocks and Controls

1. Check condenser and chilled water pumps interlocks.
2. Check flow switches.
3. Check high pressure cut-in and cut-off pressures.
4. Check oil pressure cut-in and cut-out pressures.
5. Check transition timer.

COOLING TOWERS:

Annual Preventive Maintenance

1. Disassemble float valve, clean and reassemble.
2. Drain sump, pans, pumps, pipe lines and flus.
3. Flush interior and tower and check for corrosion.

Appendix A (continued):

4. Inspect fans and motors and repair as necessary.
5. Adjust fan belts.
6. Inspect pump packing.
7. Inspect pump bearings, impeller and casing.
8. Lube motor and pump bearings.
9. Cover system openings.
10. Paint metal welded parts with alkali resistance paint.

CHILLERS (AIR COOLED):

Bi-Monthly Preventive Maintenance (2000 hrs. run time)

A. Compressor

1. Check voltage and amperage on each phase.
2. Check suction, discharge and oil pressure.
3. Check oil and refrigeration level.
4. Check crankcase heater.
5. Check pump-down cycle.
6. Check unusual noise and vibration.

B. Condenser

1. Check condenser ambient temperature.
2. Check amperage on motors.
3. Tighten fan set screws.

C. Evaporators

1. Check chilled water pressure drop and temperature.
2. Check low temperature control.
3. Check heating cable thermostat and amperage.
4. Check liquid line solenoid valve.

D. Controls

1. Check sequencer.

Annual Preventive Maintenance

A. Compressor

1. Perform continuity and ground test.
2. Check electrical connections.
3. Check starter and overloads.

B. Condensers

1. Continuity test fan motors.
2. Ground test.
3. Clean as required.

Appendix A (continued):

C. Electrical interlocks and controls.

1. Check chilled water pump interlocks.
2. Check high pressure cut-in and cut-out pressure.
3. Check low pressure cut-in and cut-out pressure.
4. Check oil pressure cut-in and cut-out pressure.
5. Check ambient thermostat.
6. Check transition timer.

BOILERS:

Monthly Preventive Maintenance

- A. Perform safety valve test per ASME manual.
- B. Inspect operating and limit controls.
- C. Inspect floor drains.
- D. Inspect water treatment system.
- E. Inspect automatic make-up water control.
- F. Inspect steam supply and condensate lines for leaks or corrosion.
Replace insulation as required.

Quarterly Preventive Maintenance

- A. Safety and limit controls.
 1. Check safety valves and test.
 2. Check high limit and operating steam pressure control.
 3. Check oil pressure safety switch.
- B. Visually inspect operating controls.
 1. Check for leaks.
 2. Check operation.
 3. Check all drain lines of monitoring and operating controls.
- C. Remove sludge from mudleg.
- D. Inspect fuel supply system.
 1. Check lines for leaks.
 2. Check fuel level controls.
- E. Inspect fire side heating surfaces; clean as required.

Appendix A (continued):

- F. Inspect exterior of boiler for cracks or corrosion; repair as required.

Annual Preventive Maintenance

- A. Boiler drained and opened for inspection and cleaning.
 - 1. Remove all hand holes and man hole plates and flush boiler thoroughly with high pressure hose to remove loose scale and sludge.
 - 2. Remove soot and dirt from flues and fire chambers.
 - 3. Inspect heating surfaces for signs of corrosion, pitting or scale.
 - 4. Inspect firebrick and refractory; repair as required.
 - 5. Inspect boiler tube and tube sheets for leaks; repair or replace as required.
- B. Dismantle low-water fuel cut-off and inspect for leaks and corrosion; repair as required.
 - 1. Check floats.
 - 2. Check switches.
 - 3. Clean pipes and float chamber.
 - 4. Assemble and test.
- C. Inspect and repair hand valves.
- D. Perform safety valve test per ASME manual.
 - 1. Try lever test.
 - 2. Capacity test.
- E. Dismantle and inspect water column.
 - 1. Clean glass and tubes.
 - 2. Repair or replace as required.
- F. Check all operating controls.
 - 1. Clean as required.
 - 2. Check calibration of all gauges and monitoring equipment.
 - 3. Replace or repair as required.
- G. Check exterior of boiler for cracks and leaks; repair as required.
- H. Paint surfaces as required.
- I. Inspect fuel oil tank and clean.

Appendix A (continued):

- J. Treat fuel oil tank with sludge conditioner.
- K. Check water treatment system.
 - 1. Clean as required.
 - 2. Replace or repair as required.
- L. Inspect boiler room ventilation system.
 - 1. Clean louvers and fans.
 - 2. Inspect controls and test.
- M. Refill boiler, add water treatment and test.
- N. Check steam lines for corrosion and leaks; repair or replace as required.

BOILER COMBUSTION SYSTEM:

Monthly Preventive Maintenance

- A. Test flame detection controls.
- B. Check oil atomization; clean as required.
- C. Check pilot gas system.

Semi-Annual Preventive Maintenance

- A. Test combustion controls.
- B. Test flame detection controls.
- C. Check fuel oil lines for corrosion.
- D. Test pressure control.
- E. Test low gas pressure cut-off.

Annual Preventive Maintenance

- A. Burner
 - 1. Disassemble nozzle assembly and clean; repair or replace as required.
 - 2. Check gas and oil valves; service as required.
 - 3. Clean fuel oil filters at burner.
 - 4. Inspect ignition electrodes; adjust as required or replace.
 - 5. Check wiring of combustion control system.

Appendix A (continued):

6. Test flame detection controls and combustion system controls per ASME manual
 - a. Test pressure control.
 - b. Test low gas pressure cut-off.
5. Forced draft fan.
 1. Check bearing and lube.
 2. Clean blades.
 3. Inspect motor and wiring.
- C. Electric oil heater.
 1. Disassemble and clean.
 2. Check wiring.

AIR COMPRESSORS - BOILERS:

Monthly

- A. Check intake air filter; clean as required.
- B. Change oil and clean crankcase 500 hrs.
- C. Check belts and pulleys for proper tension.
- D. Adjust oil pressure.

Annual Preventive Maintenance

- A. Inspect valve assembly.
- B. Inspect pressure controls.
- C. Inspect motor starter.
- D. Lube motor bearings.

APPENDIX B. SAMPLE TOOL KITS
(Courtesy of Ft. Eustis)

Kit Title	Contents	Tool Kit Code
Boiler Tool Kit #1 (inspect & adjust)	10" adjustable, 10" pipe wrench, allen wrench set, wire brush	0001
Boiler Tool Kit #2 (monthly, quarterly)	Air compressor, 12" adjustable, 14" pipe wrench	0002
Boiler Tool Kit #3 (semi-annual, annual)	Air compressor, 1/2" socket set 14 & 18" pipe wrench open end wrench set, allen wrench set	0003
Combustion Syst. Kit	10" adjustable, 10" pipe wrench, allen wrench set screwdriver (regular & Phillips)	1001
Pump Kit #1	1/2" socket set, open end wrench set	2001
Atomizer Air Compressor Kit	14" pipe wrench, 12" adjustable, 1/2" socket set	1101
Chiller Preventive Maintenance Kit	Voltage tester, amp clamp, screw driver, crescent wrench	5000
Coil Cleaning Kit	Spray pump, screwdriver, water hose, crescent wrench	2101
Pump Kit #2	14 & 18" pipe wrench, crescent wrench, scraper, water hose	2002
Cooling Tower Kit #1	12" pipe wrench, 12" crescent wrench, gauge	1500
Cooling Tower Annual Kit	18" pipe wrench, 12" crescent wrench, hose, screwdriver	1501
705 Fan Kit	Spray pump, water hose, adjustable wrench, 24' ladder, extension cord	2201
Compressor Oil Change Kit	Crescent wrench, oil can, screw- driver	1201

APPENDIX C. SAMPLE PREVENTIVE MAINTENANCE MATERIALS
(Courtesy of Ft. Eustis)

Kit Title	Contents	Material Kit Code
Boiler Kit #1 (monthly)	Solvent, door sealer, rags	5001
Boiler Kit #2 (quarterly, semi-annual)	Same as above plus: (4) hand hole gaskets, 3x4" manhole gaskets, 11x15" & 12x16" gasket material, 3/8" packing	5002
Boiler Kit #3 (annual)	Same as above plus: graphite, refractory	5003
Combustion Kit #1	Cleaning solvent, contact cleaner, electrode wire	6001
Combustion Kit #2 (semi-annual)	Same as above plus: 3/8" tubing	6002
Combustion Kit #3 (annual)	Same as above	6003
Water Treatment Kit	Tannin, caustic soda, phosphate, morpholine	5004
Boiler Plant 801 Kit (A)	8 manhole gaskets, 2 hand hole gaskets, solvent, door sealer gasket material, 3/8" packing	5009
Boiler Plant 801 Kit (B)	Same as above plus: refractory, high temperature compound	5010
Boiler Plant 195 Kit (A)	3 manhole gaskets, solvent, door sealer, rags, gasket material 3/8" packing	5005
Boiler Plant 195 Kit (B)	Same as above plus: refractory, high (graphite) temperature compound	5006
Boiler Plant 2406 Kit (A)	Solvent, door sealer, gasket material, 3/8" packing, rags	5007
Boiler Plant 2406 Kit (B)	Same as above plus: refractory, high (graphite) temperature compound	5008

APPENDIX D. SAMPLE BELT AND FILTER REQUIREMENTS AND LOCATION
(Courtesy of Ft. Eustis)

<u>B E L T S</u>			
Buildings & Units	Quantity	Size	Location
802, 805;	2	B-57	(Fresh Air) Basement (AHU-4)
AHU 4 & 5,	2	B-66	Roof-top Unit (AHU-5)
H & V Units			
803, 808, 810, 813,	2	B-75	(Fresh Air) Basement (AHU-1)
815, 817, 819;	2	5L-87	Roof top, east Bldg. (AHU-2)
AHU 1 & 2			
804, 809, 8112, 812,	2	B-75	(Fresh Air) Basement (AHU-1)
814; AHU 1 & 2	2	5L-82	Roof-top Unit (AHU-2)
H & V Units	2	B-90	H & V for Kitchen

<u>F I L T E R S</u>			
802, 805	6	20x25x2	Basement (AHU-4)
	9	20x20x2	Roof-top Unit (AHU-5)
	3	20x25x2	
	9	20x25x2	Roof for mess area
	6	20x25x2	Heat & A/C (H & V)
	6	20x25x2	
803, 808, 810, 813,	4	16x25x2	(Fresh Air) Basement (AHU-1)
815, 817, 819	2	20x25x2	
	9	20x20x2	Roof top, east Bldg. (AHU-2)
	3	20x25x2	
804, 809, 811	6	16x25x2	(Fresh Air) Basement (AHU-1)
812, 814	15	20x20x2	H & V for Kitchen
	9	20x20x2	Roof top, east Bldg. (AHU-2)
	3	20x25x2	

No: _____
Date: _____

[illegible]

NC: _____
Date: _____

[illegible]

No: _____
Date: _____

[illegible]

No: _____
Date: _____

[illegible]

	Total Actual Hours:	Month-to-Date	Quarter-to-Date	Year-to-Date
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				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				
51				
52				
53				
54				
55				
56				
57				
58				
59				
60				
61				
62				
63				
64				
65				
66				
67				
68				
69				
70				
71				
72				
73				
74				
75				
76				
77				
78				
79				
80				
81				
82				
83				
84				
85				
86				
87				
88				
89				
90				
91				
92				
93				
94				
95				
96				
97				
98				
99				
100				

	Total Estimated Hours:	Month-to-Date	Quarter-to-Date	Year-to-Date
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				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				
51				
52				
53				
54				
55				
56				
57				
58				
59				
60				
61				
62				
63				
64				
65				
66				
67				
68				
69				
70				
71				
72				
73				
74				
75				
76				
77				
78				
79				
80				
81				
82				
83				
84				
85				
86				
87				
88				
89				
90				
91				
92				
93				
94				
95				
96				
97				
98				
99				
100				

No. _____ Date _____ Time Period _____

[illegible]

TOTAL FOR PERIOD

SECTION A

1) Maintenance Order No: _____ 2) Date Generated: _____ 3) Facility No: _____ 4) Req'd. Completion Date: _____
 5) Area and Building No: _____ 6) Maintenance Level Req'd: _____
 7) Special Instructions: _____

SECTION B

1) Equipment Description: _____ 2) Manufacturer: _____
 3) Model No: _____ Serial No: _____ 5) IFS ID No: _____ 6) IFS Property Control No: _____ 7) Reference Manual No: _____
 8) Work Rq. Summary: _____ 9) Technical Equipment Description: _____
 10) Location of Equipment: _____ 11) Area Served: _____
 12) Associated Work: _____
 13) Special Requirements: _____

SECTION C

1) IFS Task Code: _____ 2) Shop: _____ 3) Crafts: _____ 4) Skill Level: _____ 5) Priority: _____
 6) Related Craft Work? _____ If Yes, What Skill Level? _____
 7) Special Worker Skill Req'd? _____ If Yes, What? _____
 8) Description of Work: _____
 9) Replacement Parts: _____ 10) Special Tools Req'd: _____
 11) Special Instructions: _____

SECTION D

1) Response Date: _____ 2) Work Complete? Y N 3) Mechanic's Name: _____ 4) Mechanic's Signature: _____
 4a) Work Time: Workers: _____ Supervision: _____ 4b) Downtime: Workers: _____ Supervision: _____
 5) Parts Used (Part No., Description & Quantity): _____
 6) Description of Work Accomplished: _____

 7) Description of Work Remaining: _____
 8) Material Req'd. to Complete Work: _____
 9) Special Instructions: _____

10) Return Response Req'd? _____ If Yes, What? _____ 11) Estimated Time to Complete: _____

APPENDIX G. SAMPLE WORK SCHEDULE REPORT 1/
(Courtesy of Ft. Eustis)

PH	SP	RDD	QCBC	DESCRIPTION	JUN-SHOP	CUR	FCLTY	PROCDATE	ESTHRS	CPIHRS	STARDATE	CPIDATE	AMENDDATE
	9	1/21/BC	2	RPL FLOORING	GE4709	611	14014		52				
	9	1/21/BC	2	INSULATE CEILING	GE4709--611	611	14014		52				
		5/06/3C	2		GE4744	41	2296		27				
		5/06/3C	2		GE4744--41	41	2296		24				
		5/06/3C	2		GE4744--51	41	2296		3				
		5/06/3C	2	PMT INT 5 Q HUIS	GE4745	43	430102		296				
		5/06/3C	2		GE4745--41	43	430102		16				
		5/06/3C	2		GE4745--43	43	430102		280				
	9	7/01/3C	2	MINIMUM RPHS	GE4754	41	25111		658				12/12/32
	9	7/01/3C	2		GE4754--41	41	25111		560				12/12/32
	9	7/01/3C	2		GE4754--43	41	25111		98				12/12/32
	9	7/01/3C	2		GE4754--50	41	25111		0				12/12/32
		5/24/3C	2	MISC BLDG RPHS	GE4767	44	41350		23				
		5/24/3C	2		GE4767--41	44	41350		8				
		5/24/3C	2		GE4767--43	44	41350		1				
		5/24/3C	2		GE4767--44	44	41350		14				
		5/24/3C	2		GE4767--645	44	41350		0				
		5/06/3C	2	RPR/RPL CEILING	GE4768	43	43298		27				
		5/06/3C	2		GE4768--41	43	43298		9				
		5/06/3C	2		GE4768--43	43	43298		18				
		5/06/3C	2		GE4768--51	43	43298		0				
	9	7/08/3C	2	RPR ROOF	GE4794	41R	53352		394				
	9	7/08/3C	2		GE4794--41	41R	53352		165				
	9	7/08/3C	2		GE4794--41R	41R	53352		155				
	9	7/08/3C	2		GE4794--645	41R	53352		74				
		1/25/3M		MISC RPHS	GE4799	41	51812		106				
		1/25/3M			GE4799--41	41	51812		65				
		1/25/3M			GE4799--43	41	51812		20				
		1/25/3M			GE4799--44	41	51812		13				
		1/25/3M			GE4799--611	41	51812		8				
		5/06/3C	2	RPR SASH	GE4804	41	22154		73				
		5/06/3C	2		GE4804--41	41	22154		50				
		5/06/3C	2		GE4804--43	41	22154		23				
	9	1/18/4C	2	PARTITIONS-CLSRM	GE4812	90	1494		0				10/03/31
	9	1/18/4C	2		GE4812--90	90	1494		0				10/03/31
		5/06/3C	2	MISC RPHS	GE4814	41	1431		38				
		5/06/3C	2		GE4814--41	41	1431		26				
		5/06/3C	2		GE4814--43	41	1431		12				
		6/03/BC	2	PROVIDE SKIRTING	GE4841	41	17114		131				
		6/03/BC	2		GE4841--41	41	17114		105				
		6/03/BC	2		GE4841--43	41	17114		26				

1/

PR	Schedule Priority	Building Number or Unit
SP	Supply Priority	Process Date
RDD	Material Due Date	Estimated Hours
QCBC	Quarter, Back, Comments	Completed Hours
JUN-SHOP	Job Order Number, which shop involved	Date Project Started
CUR	Coordinator	Date Project Completed
		Amended Date, if applicable

APPENDIX II. MAINTENANCE MANAGEMENT SYSTEM SPECIFICATION OUTLINE

PART I - GENERAL:

1. Applicable Publications and Code. This section will contain those publications and codes applicable to a Maintenance Management System.
2. System Description. Provide an overall general description of the operation and functions of the system:
 - a. General
 - b. Abbreviations
 - c. Environmental conditions
 - d. Surge protection
3. Submittals. Description of requirements and procedures for submittals on the system, testing, training, etc.:
 - a. General
 - b. Drawings
 - c. Testing
 - d. Training
 - e. Operation and Maintenance Manuals
 - 1) Functional Design Manual
 - 2) Hardware Manual
 - 3) Software Manual
 - 4) Operator's Manual
 - 5) Maintenance Manual
 - f. Forms
4. Reviews. Description of review period and content of each review:
 - a. General
 - b. First review
 - c. Second review
5. Testing. Description of requirements for factory and field testing:
 - a. Factory
 - 1) Hardware
 - 2) Software
 - b. Field
 - 1) Hardware
 - 2) Software
6. Training. Provide requirements for frequency and content of factory and field training:

- a. General
- b. Phase I
- c. Phase II
- d. Phase III

PART 2 - PRODUCTS

1. Material and Equipment - General. General descriptions and requirements of material and equipment being provided.
2. Field Equipment. Provide reference to CEGS for field hardware requirements:
 - a. General
3. System Central Hardware. Detailed description of the central hardware, peripheral equipment and applicable interfaces:
 - a. General
 - b. Central Computer
 - 1) Central Processor
 - 2) Memory
 - 3) Interfaces
 - c. Peripherals
 - 1) Operator's Console
 - 2) Printer
 - 3) MODEM
 - 4) Disk Storage System
 - 5) Magnetic Tape Storage System
4. Software. Detailed description of the software requirements for the system, including system and application software:
 - a. System software
 - 1) General
 - 2) Bootstrap Program
 - 3) Disk Operating Systems
 - 4) Assembler
 - 5) Relocatable Linking Loader
 - 6) Editor
 - 7) Compiler
 - 8) Debugger
 - 9) Copy Routine
 - 10) Program Development
 - 11) Data Base Management

b. Applications Software

- 1) Operator Commands
- 2) Graphic and Alphanumeric Displays
- 3) Printer Formats
- 4) Point and System Definition Software
- 5) Report Generation
- 6) Algorithmic Control Sequences (flow measurement, efficiency calculation, etc.)
- 7) System Access
- 8) Data Exchange Requirements with EMCS
- 9) Preventive Maintenance Scheduling (time, hours)
- 10) Maintenance Order Generation
- 11) Management Reports
- 12) Scheduled Work Reports
- 13) Maintenance-in-Progress Report
- 14) Finished Work Report
- 15) Labor Forecasting Report
- 16) Material Listing (per job)
- 17) Project Scheduling
- 18) Grouping Similar Work and Work Areas

PART 3 - EXECUTION:

1. Installation. Detailed description of the installation of new central and field hardware, etc.:
 - a. General
 - b. Connection to existing equipment
 - c. Central hardware
 - d. Field hardware
 - e. Software
2. Maintenance and Service. Description of requirements for maintaining the system during first year after acceptance:
 - a. General
 - b. Personnel
 - c. Supervision
 - d. Minor inspection
 - e. Major inspection
 - f. Software update