DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-150829

PROTOTYPE SOLAR HEATING AND COOLING SYSTEMS (Monthly Progress Reports)

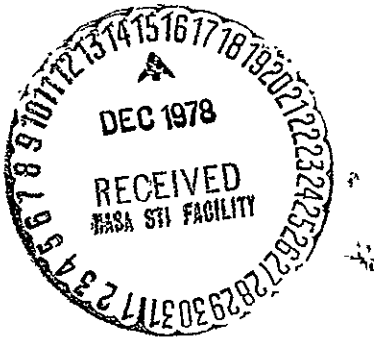
Prepared from documents furnished by

AiResearch Manufacturing Company of California
2525 West 190th Street
Torrance California 90509

Under Contract NAS8-32091 with

National Aeronautics and Space Administration
George C. Marshall Space Flight Center, Alabama 35812

For the U. S. Department of Energy



U.S. Department of Energy

Solar Energy

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15 SUPPLEMENTARY NOTES

This work was done under the technical management of Mr James W Clark, George C Marshall Space Flight Center, Alabama

16. ABSTRACT

This report is a collection of monthly status reports from the AiResearch Manufacturing Company, who is developing eight prototype solar heating and cooling systems under NASA Contract NAS8-32091 This effort calls for the development, manufacture, test, system installation, maintenance, problem resolution, and performance evaluation The systems are 3-, 25-, and 75-ton size units.

Cost information has been removed from these reports.

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PART A

Seventeenth Monthly Status Report
Data Requirement No. 500-11

SOLAR HEATING AND COOLING SYSTEMS DESIGN AND DEVELOPMENT

Contract NAS8-32091

76-13110(17)

May 10, 1978

P A Benson

Prepared for

George C Marshall Space Flight Center
National Aeronautics and Space Administration
Marshall Space Flight Center
Huntsville, Alabama 35812

AIRESEARCH MANUFACTURING COMPANY
OF CALIFORNIA

INTRODUCTION

This is the seventeenth monthly status report prepared by AiResearch Manufacturing Company of California under Contract NAS8-32091 for the National Aeronautics and Space Administration Marshall Space Flight Center (MSFC). The report summarizes activities from April 1 to April 30, 1978.

For simplicity in reporting, activities are reported by subject matter rather than by WBS item number.

MEETINGS, REVIEWS, AND MAJOR EVENTS

Activities during April were as follows

- A program review meeting was held at AiResearch from March 29 through April 4, 1978 (5 work days) with Mr James Clark of NASA in attendance.

PROGRAM PLANNING AND CONTROL

Site Activities

During April, the site and site equipment status charts requested by NASA were generated as completely as possible. It was found that approximately 30 charts are necessary to outline the site and major subsystem status to the requested depth of penetration. After further familiarization with the usage of these charts, the number of charts possibly may be reduced to eliminate redundancy and render the charts more easily assimilated and more readily issued.

Site and Site Equipment Status Charts

The following charts were submitted in preliminary form in mid-April.

Chart 1	Operational Test Site Status
Chart 2	Heat Pump Development and Test Schedule (charts issued for 3 3-ton heat pump sites and 2 75-ton heat pump sites)
Chart 3	Operational Test Site Subsystem Schedule (sample only)
Chart 4	Operational Test Site Installation Schedule (sample only)
Chart 5	GFE Delivery Dates for System Equipment (1)
Chart 6	Daystar Collector Delivery Schedule - 1978 (1)
Chart 7	Site Equipment Disposition and Costs
Chart 8	Travel Budget for Future Site Visits
Chart 9	Heat Pump Delivery Schedule

(1) Blank form to be completed by NASA

Status of Instrumentation System Planning Information (ISPI)

Site	ISPI Revision	Remarks
Allaire Park, N.J.	A	Revision B in progress to revise liquid flowmeter ranges per SDAS remarks (1)
Lawrenceburg, Tenn.	NC	Revision A in progress, to be issued pending receipt of information from SDAS personnel
Harrisonburg, Va.	--	To be started this month
Novato, Ca.	--	No action as yet, site recently reactivated
St. Louis, Mo.	--	No action, site not yet determined
Los Angeles, Ca.	--	No action, site not yet determined
Houston, Tex.	C	Submitted April 25, 1978
Las Vegas, Nev.	C	Revision D in progress to incorporate SDAS remarks (1) and to revise schematic

Program Documentation

The following documents were prepared in accordance with the requirements of Appendix A of the statement of work.

a. Sixteenth Monthly Status Report 76-13110(16), dated April 10, 1978 (DR500-11).

b. Quarterly Contractor Financial Management Report (DR500-27).

Other publications were submitted during April to the parties listed as tabulated below

(1) SDAS comments were from Mr. George Mizell of IBM/Huntsville per telecon on May 1, 1978.

Submittal Date	To	Subject
4-4-78	J. Clark (NASA/MSFC), Mueller Associates and F. Rushing, Lawrenceburg, Tenn.	Lawrenceburg, Tenn. Site ISPI Forms
4-12-78	J. Clark	Site and Solar System Status Charts
4-25-78	J. Clark and E. Samfield, Univ. of Houston	Houston Site ISPI, Rev. C
4-26-78	J. Clark	Solar Energy Usage Table

SYSTEM DEVELOPMENT

The activities reported below involve heat pump component design, fabrication and testing, and heat pump package development.

Component Design, Fabrication and Test

1. Turbomachine

(a) 3-Ton Unit

Cooling tests have been completed on the 3-ton test system. The system was operated in the motor-driven and the turbine-driven modes with performance results as predicted. The plumbing changes underway on the prototype unit at Dunham-Bush will not be incorporated in the test system and all subsequent system testing will be conducted at the Harrisburg, Va. facility. Two turbocompressors have been shipped to support the test effort.

(b) 25-Ton Unit

Testing in the heating mode at speeds from 35,000 to 40,000 rpm resulted in contact between the rotor and motor stator. Analysis indicated that the rotor-stator clearance was marginal and a stator has been reworked to increase the gap to 0.020 inches. This unit will be assembled and tested early in May.

(c) 75-Ton Unit

Testing of the unit continued through the month with various bearing modifications. The final configuration is an assembly which provides an 0.005 in. radial sway space in the journal bearings. (Tests were conducted with 0.003 and 0.007 in. sway spaces.) A unit has been completely assembled and tested to 22,000 rpm. It will be sent to Dunham-Bush the first week in May.

Unit No. 2 is being assembled and will be available for test late in May.

2. Motor Controller

(a) 3-Ton Controller

Tests are being conducted on the heat pump package at Dunham-Bush.

(b) 25-Ton Controller

System testing of this controller is continuing. Investigation of the motor mechanical problems is still in progress.

(c) 75-Ton Controller

Controller No. 1 has been tested at 90 percent speed with an unloaded motor. At that speed, uneven margin times were observed in the inverter devices. This problem will be investigated further when another motor becomes available.

Controller No. 2 is 95 percent complete.

3. System Controller

The interface unit between the system and motor controller has been modified to output the motor speed signal only after the motor controller ready signal is received.

4. R-11 Liquid Pump

(a) 3-Ton Unit

Three pump units were delivered in March. Testing is now at the subsystem level.

(b) 25-Ton Unit

Parts have been received for three pumps. One pump has been assembled and is in test.

Heat Pump Design, Fabrication and Test

1. Design

As a result of continuing 3-ton unit testing, considerable recircuiting is required. These changes will not be incorporated in drawings until tests confirm no additional changes are required.

2. Prototypes

The revisions noted last month have been made on the second of three 3-ton prototypes. This unit was cleaned with tricholoroethylene before revisions.

The motor control panel was reworked as a result of February-March tests. The second 3-ton heat pump was reconfigured to eliminate restrictions at the compressor inlet and discharge. The evaporator inlet manifold was divided into four sections and 12 distributor tubes were incorporated for better flow distribution. Strainers were added at the turbine and compressor inlets.

3. Testing

Testing of the 3-ton system was resumed with the modified motor controller, piping at the turbocompressor with reduced restrictions and a 12-tube evaporator inlet manifold.

Operation with the force-cooled motor controller was normal and the temperature levels were maintained within the expected range. The starting, current limit and speed control functions performed normally. Compressor performance improved to the values obtained during the breadboard test as a result of the plumbing changes. The 12-tube distributor improved refrigerant distribution in the evaporator but not enough to provide the required system cooling capacity. Discussion with the vendor and subsequent analysis has resulted in a distribution system modification which will be incorporated for testing which will resume in May.

Testing for the month was concluded when the turbocompressor could not be restarted after shutdown. Teardown of the unit revealed oil and solid particles which resulted in excessive starting torque. This contamination came from the system heat exchangers which were not properly cleaned upon receipt for test. It was resolved that all components would be thoroughly flushed with trichloroethylene and that strainers would be installed at the turbomachine inlets A secondary problem was uncovered in the motor controller when starts were attempted with the high torque compressor. A new circuit will be installed to disconnect power when motor start does not occur within a time limit to be determined. This circuit will protect the controller in the event of compressor failure.

PART B

Eighteenth Monthly Status Report
Data Requirement No. 500-11

SOLAR HEATING AND COOLING SYSTEMS DESIGN AND DEVELOPMENT

Contract NAS8-32091

76-13110(18)

June 9, 1978

Prepared for

George C. Marshall Space Flight Center
National Aeronautics and Space Administration
Marshall Space Flight Center
Huntsville, Alabama 35812

AIRESEARCH MANUFACTURING COMPANY
OF CALIFORNIA

INTRODUCTION

This is the eighteenth monthly status report prepared by AiResearch Manufacturing Company of California under Contract NAS8-32091 for the National Aeronautics and Space Administration Marshall Space Flight Center (MSFC). The report summarizes activities from May 1 to May 31, 1978, except for site status charts which reflect NASA comments received on June 6 and 7.

For simplicity in reporting, activities are reported by subject matter rather than by WBS item number.

MEETINGS, REVIEWS AND MAJOR ACTIVITIES

A contract review meeting was held on May 11, 1978 at AiResearch (Torrance) with Mssrs. Bill Brooksbank, Larry Marshall, Jim Clark, Byron Crider and Claude Dorning of NASA/MSFC in attendance. Contractual scope, financial status, hardware development status and program schedule were reviewed in detail.

PROGRAM PLANNING AND CONTROL

Site Activities

Deliveries of heat pumps were delayed 3 to 5 weeks (see Chart 9 of Appendix A) due to rotor rub during development tests of the 3-ton unit turbocompressor and the heat exchanger contaminant problem reported last month for the 3-ton heat pump tests at Dunham-Bush. Deliveries of heat exchangers for the 75-ton heat pump are also 2 months tardy, but schedule tightening is expected to recover 1 month of this delay.

Site and Site Equipment Status Charts

The site status charts previously submitted to NASA in mid-April were updated on May 4 and again during a NASA-AiResearch program review meeting on June 6 through 8. The June updated charts are included in Appendix A of this report.

Chart 1 Operational Test Site Status

Chart 2 Heat Pump Development and Test Schedule (8 heat pumps)

Chart 3 Operational Test Site Subsystem Schedule (all sites except Los Angeles)

Chart 4 Operational Test Site Installation Schedule (all sites except Los Angeles)

Chart 9 Heat Pump Delivery Schedule

Charts 5, 6, 7 and 8 presenting GFE delivery dates, collector delivery dates, site equipment costs and future site visit travel budgets were deleted this month since there were no changes from the previously submitted information.

Subsystems Updated

As a result of recent component and subsystem tests, various component arrangement and plumbing changes have been made to improve overall performance. During May the schematic diagrams for the subsystem and system have been revised to reflect these changes. Figures 1 through 5 of this report present these changes.

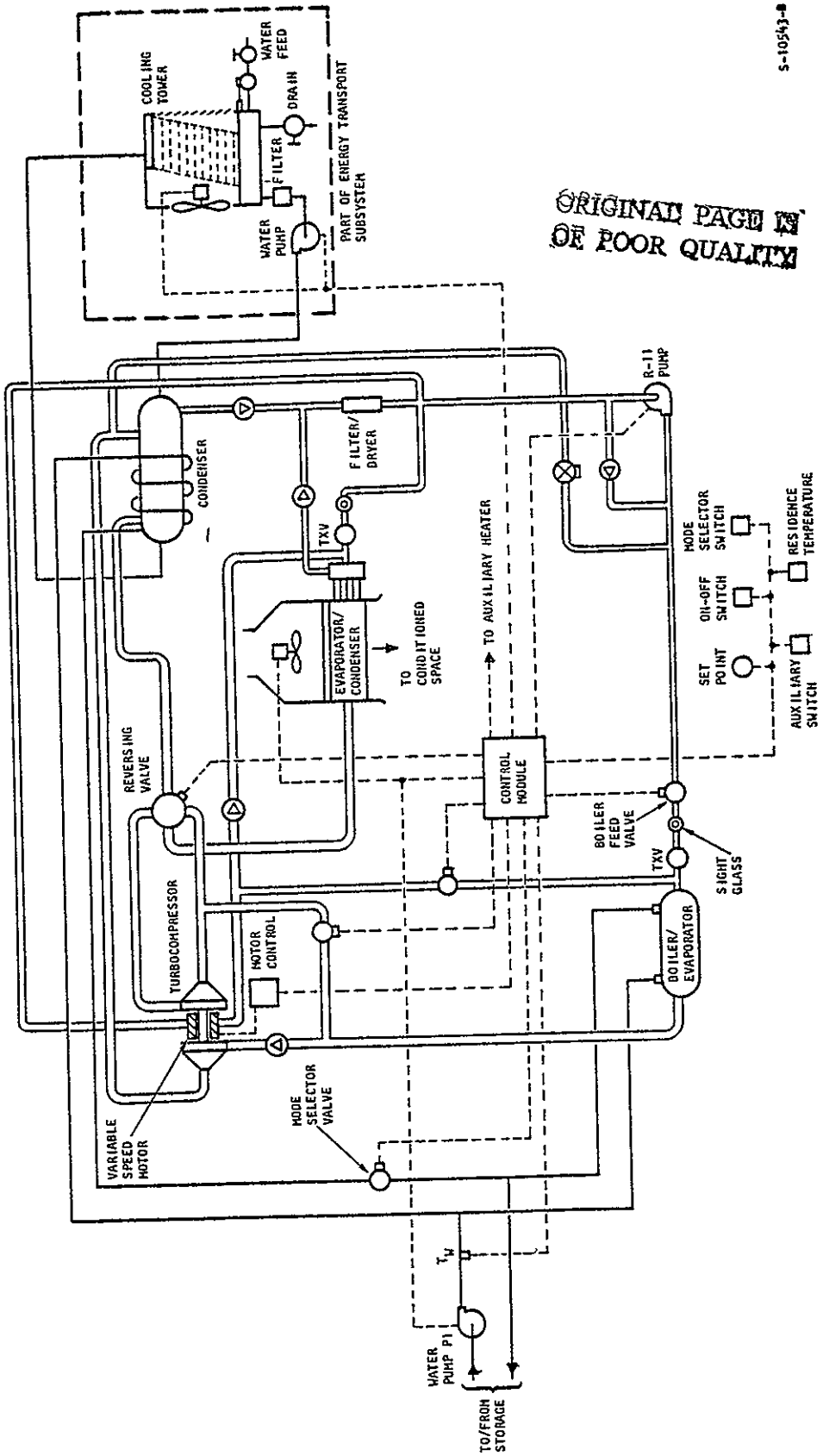

Figure 1. 3-Ton /60 KBTUH Space Heating and Cooling Subsystem

76-13110(18)

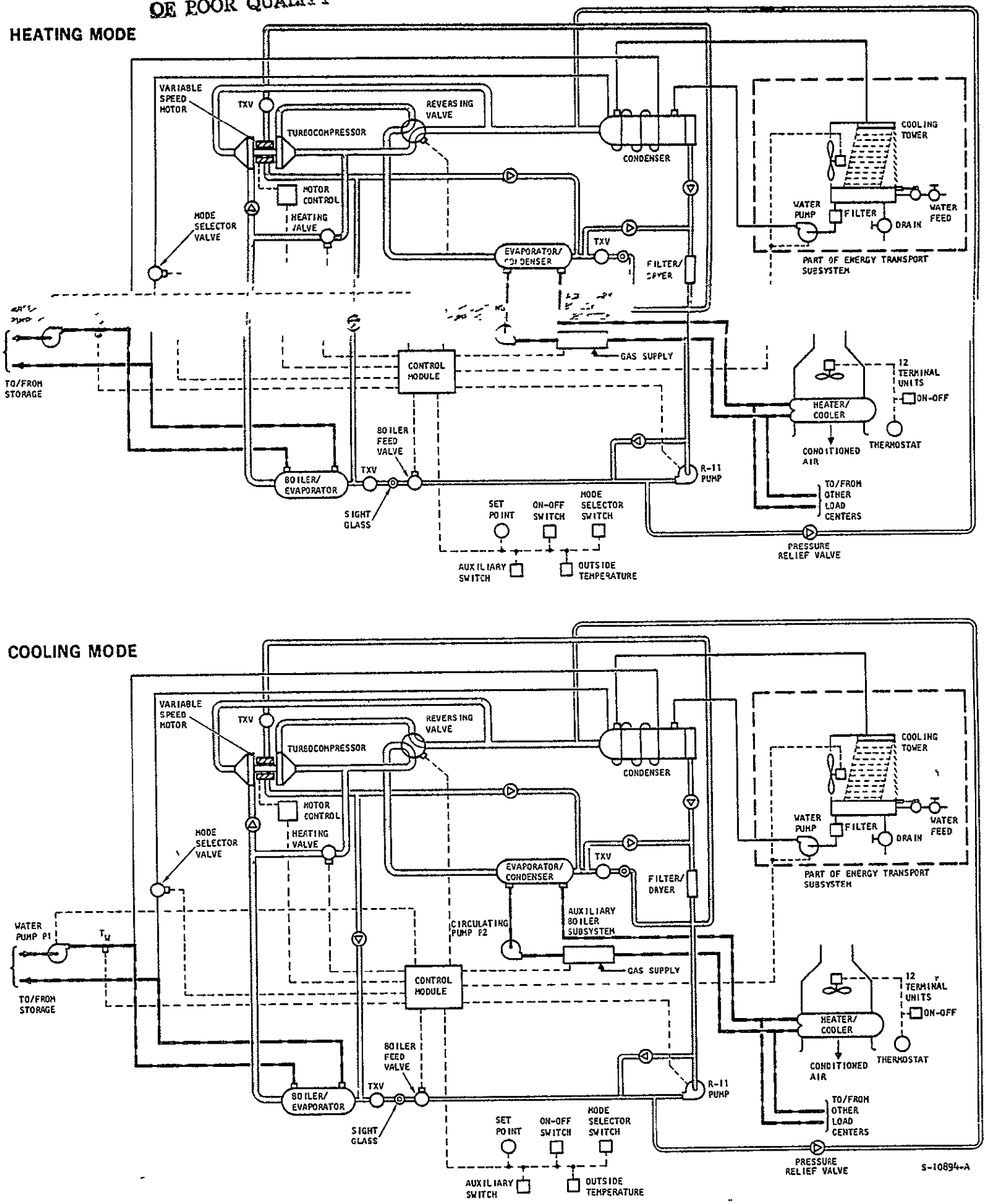

Figure 2. 3-Ton Subsystem Flow Paths in the Heating and Cooling Modes

76-13110(18)

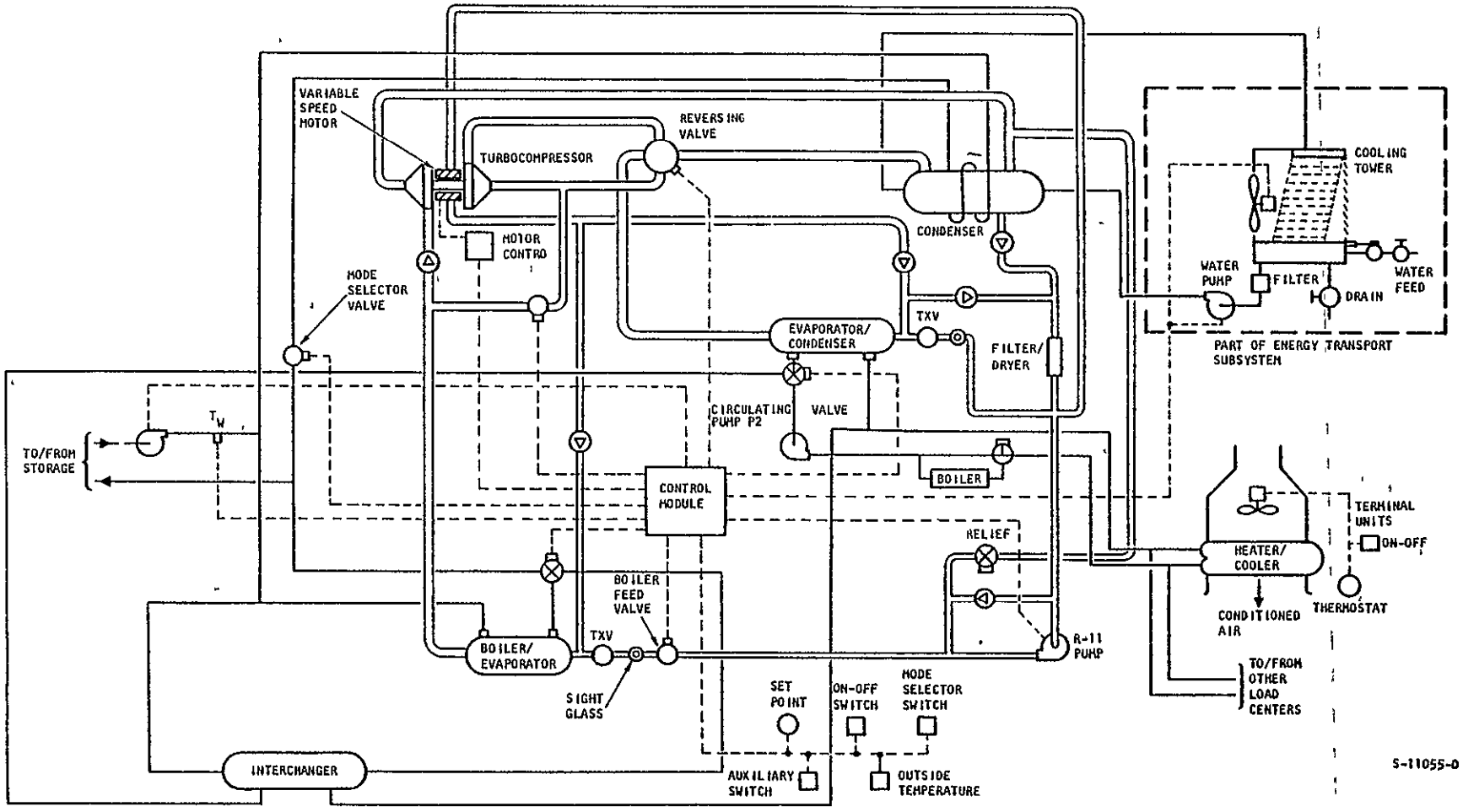

Figure 3. 25-Ton/600 KBTUH Cooling and Heating Subsystems Schematic

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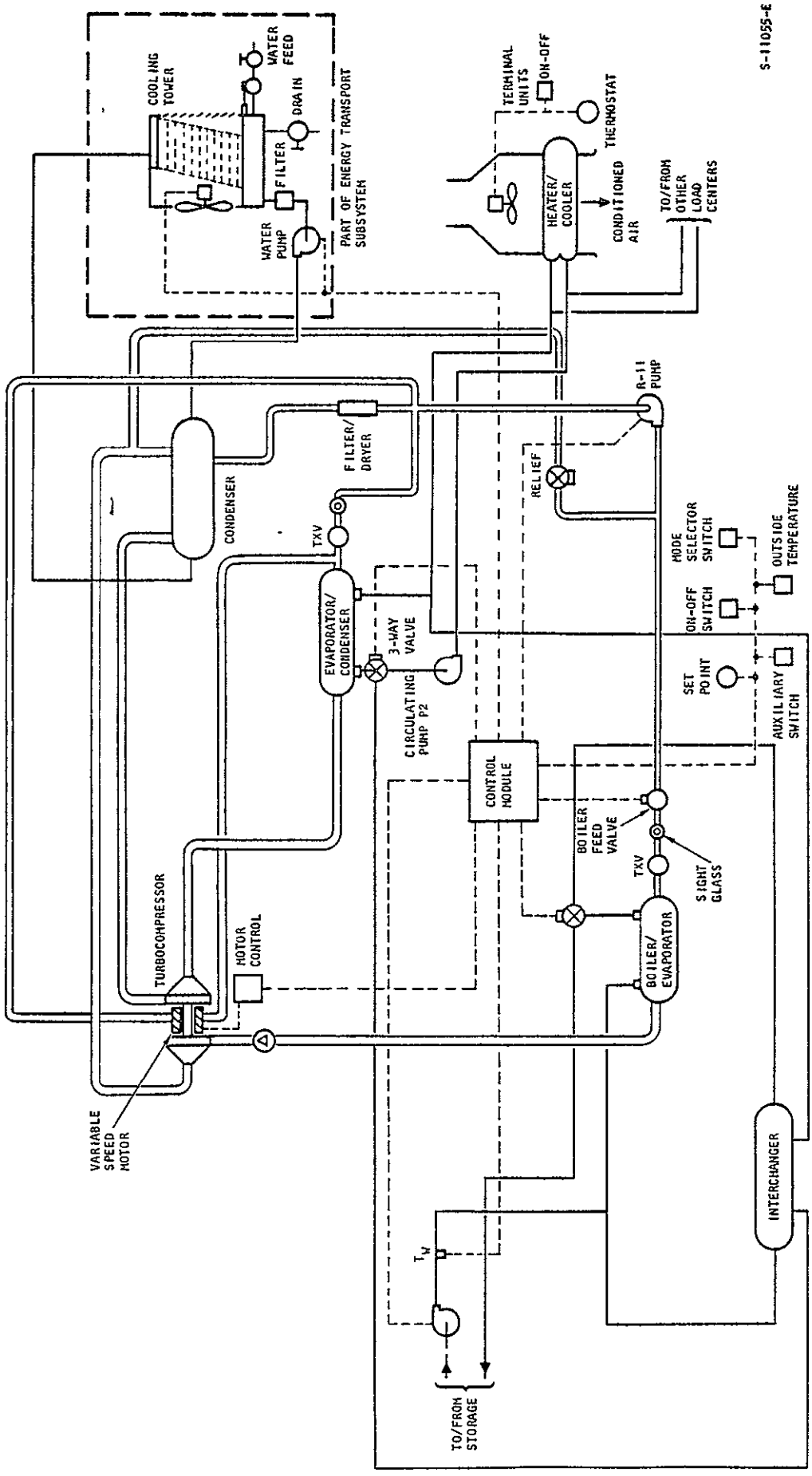


Figure 4.1 75-Ton/1600-KBTUH Cooling and Heating Subsystems Schematic (Houston)

76-13110(18)

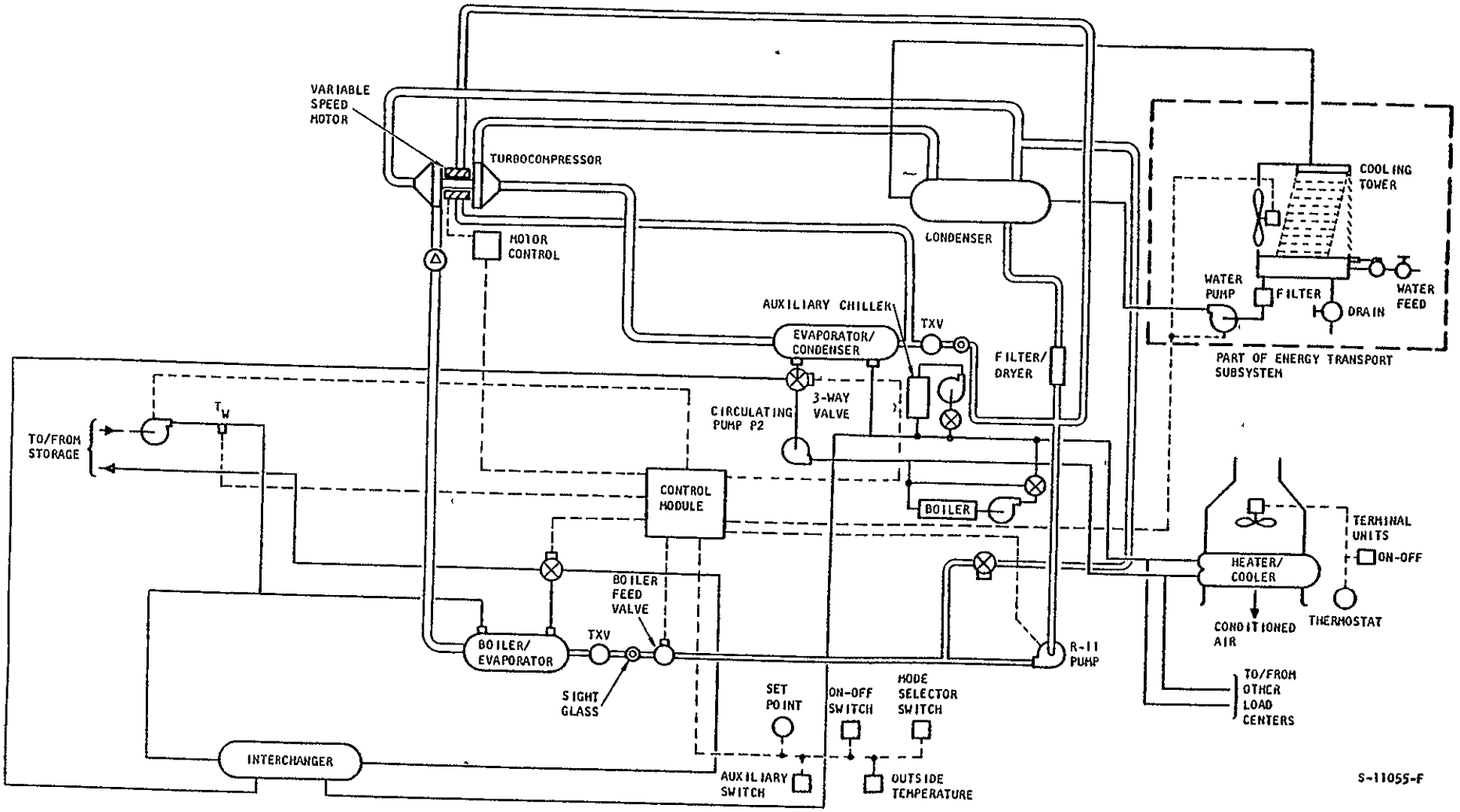


Figure 5. 75-Ton/1600-KBTUH Cooling and Heating Subsystems Schematic (Las Vegas)

Status of Instrumentation System Planning Information (ISPI)

Site	Revision	Remarks
Allaire Park, N.J.	A	Revision B submitted May 23, 1978
Lawrenceburg, Tnn.	NC	Revision A submitted May 19, 1978
Harrisonburg, Va.	--	In process, awaiting air duct details from Dunham-Bush
Novato, Ca.	--	No action as yet, site recently reactivated
St. Louis, Mo.	--	No action, site not yet determined
Los Angeles, Ca.	--	No action, site not yet determined
Houston, Tex.	C	Submitted April 25, 1978, awaiting AIP from IBM/MSFC
Las Vegas, Nev.	C	Revision D submitted May 31, 1978.

Program Documentation

a. Seventeenth Monthly Status Report 76-13110(16), dated May 10, 1978 (DR500-11).

b. Quarterly Contractor Financial Management Report (DR500-27).

Other publications were submitted during May to the parties listed as tabulated below:

Submittal Date	To	Subject
5-1-78	IBM/MSFC	Storage Tank Drawings H-TX-M2-2, H-TX-M2-3
5-1-78	Timmerman Engrg., Inc., Houston, Tex.	Drawing 2101876 (of the 75-ton heat pump turbocompressor motor controller)
5-19-78	J. Clark (NASA/MSFC), Mueller Associates and F. Rushing, Lawrenceburg, Tenn.	Lawrenceburg, Tenn. Site ISPI Forms, Revision A
5-23-78	J. Clark, Mueller Associates	Allaire State Park, N.J. Site ISPI, Revision B
5-31-78	J. Clark, R. Joeckel and L. Borns	Las Vegas, Nev. Site ISPI, Revision D

SYSTEM DEVELOPMENT

The activities reported below involve heat pump component design, fabrication and testing, and heat pump package development.

Component Design, Fabrication and Test

1. Turbomachine

(a) 3-Ton Unit

All activity has been at Dunham-Bush. One unit was returned because it would not start repeatedly. Unit disassembly revealed that one sensor had become detached from its magnet.

Another unit was sent to Dunham-Bush. On the initial startup in the system, an intermittent rubbing noise occurred at 60,000 rpm. This unit was bench tested exactly as returned, to 75,000 rpm several times without noise. A system problem associated with physical distortion is suspected, and a fixture for testing the effects of distortion is being fabricated.

(b) 25-Ton Unit

The month was spent trying to determine the cause of the high speed rubbing. The rubbing was time related. Upon disassembly, rubbing evidence was very slight and not in the same location. Time vs speed is as follows:

35,000 rpm - 1 hr

38,000 rpm - 12 to 15 min.

40,000 rpm - 6 to 8 min.

This speed/time relationship was repeatable with various modifications.

Near the end of the month, a bench test run was made at 38,000 rpm. The rub occurred after 7 min. The unit was disassembled within 5 minutes and it was discovered that the tie bolt and magnetic rotor were extremely hot and that the lock-up torque was essentially zero. (Tie bolt and rotor temperatures were approximately 200°F.) It was concluded that there is self-induced heating in the rotor causing excessive tie bolt temperature and loss of lock-up. Increased lockup was attempted with the identical unit. No rub occurred in 14 minutes. Immediate disassembly produced evidence that this new lock-up torque (600 in. lb) should be sufficient. The unit has been rebuilt and is being installed in the system for tests under load.

(c) 75-Ton Unit

Unit No. 1 has been shipped to Dunham-Bush. Unit No. 2 is assembled and in the electric laboratory for test.

2. Motor Controller

(a) 3-Ton Controller

Tests are being conducted on the heat pump package at Dunham-Bush.

(b) 25-Ton Controller

System testing of this controller is continuing. Investigation of the motor mechanical problems is still in progress.

(c) 75-Ton Controller

Investigation of uneven margin times in the inverter at high motor speed is continuing.

Controller No. 2 is 95 percent complete.

3. System Controller

The interface unit between the system and motor controller has been modified to output the motor speed signal only after the motor controller ready signal is received.

4. R-11 Liquid Pump

(a) 3-Ton Unit

Three pump units were delivered in March. Testing is now at the subsystem level.

(b) 25-Ton Unit

Parts have been received for three pumps. One pump has been tested and shipped to Dunham-Bush. Flow rate for this unit was slightly low because of internal leakage. Rework of this pump (and the remaining two) is being held in abeyance pending system test evaluation.

Heat Pump Design, Fabrication and Test

1. Design

The 3-ton plumbing changes reported last month have not been evaluated due to the compressor starting problems presently under investigation. Drawing changes will be deferred until testing confirms that no additional changes are required.

2. Prototypes

Two 3-ton heat pump packages are assembled and available for the test program. A 25-ton package is partially assembled, ready for installation of the turbocompressor next month. The 75-ton systems are waiting receipt of heat exchangers by Dunham-Bush West Hartford now scheduled for June delivery.

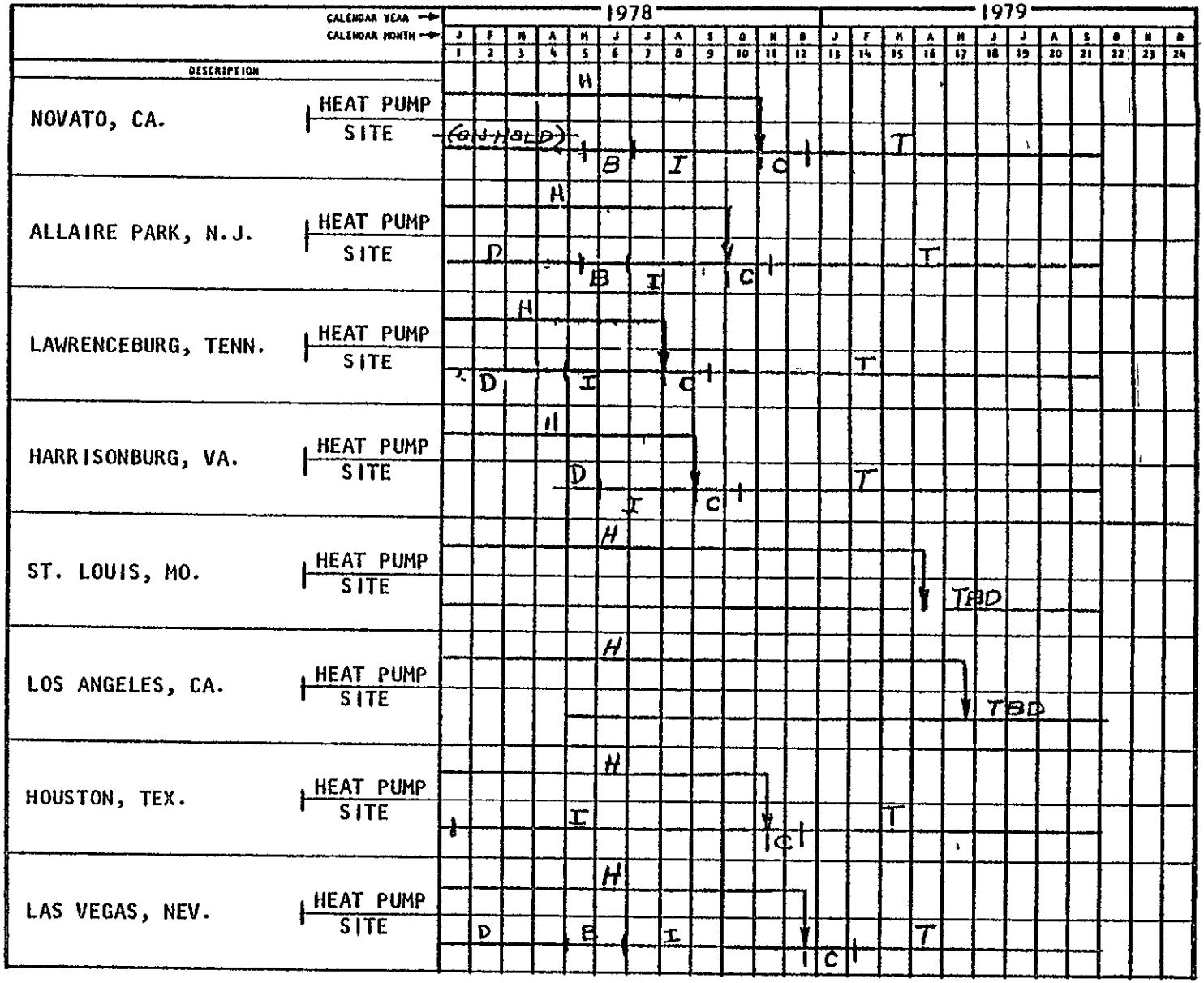
3. Testing

Testing during May is described in the turbomachine tests section.

APPENDIX A

SITE STATUS CHARTS (ATTACHMENTS)

Chart	Title
1	Operational Test Site Status
2	Heat Pump Development and Test Schedule (Lawrenceburg, Tenn.)
2a	Heat Pump Development and Test Schedule (Harrisonburg, Va.)
2b	Heat Pump Development and Test Schedule (Allaire State Park, N.J.)
2c	Heat Pump Development and Test Schedule (Novato, Ca.)
2d	Heat Pump Development and Test Schedule (St. Louis, Mo.)
2e	Heat Pump Development and Test Schedule (Los Angeles, Ca.)
2f	Heat Pump Development and Test Schedule (Houston, Tx.)
2g	Heat Pump Development and Test Schedule (Las Vegas, Nev.)
3	Operational Test Site Subsystem Schedule (Allaire State Park, N.J.)
4	Operational Test Site Installation Schedule (Allaire State Park, N.J.)
3a	Operational Test Site Subsystem Schedule (Lawrenceburg, Tenn.)
4a	Operational Test Site Installation Schedule (Lawrenceburg, Tenn.)
3b	Operational Test Site Subsystem Schedule (Harrisonburg, Va.)
4b	Operational Test Site Installation Schedule (Harrisonburg, Va.)
3c	Operational Test Site Subsystem Schedule (Novato, Ca.)
4c	Operational Test Site Installation Schedule (Novato, Ca.)
3d	Operational Test Site Subsystem Schedule (St. Louis, Mo.)
4d	Operational Test Site Installation Schedule (St. Louis, Mo.)
3f	Operational Test Site Subsystem Schedule (Houston, Tx.)
4f	Operational Test Site Installation Schedule (Houston, Tx.)
3g	Operational Test Site Subsystem Schedule (Las Vegas, Nev.)
4g	Operational Test Site Installation Schedule (Las Vegas, Nev.)
9	Heat Pump Delivery Schedule



H-Heat Pump Assembly, Test and Delivery to Site
D-System Installation Design
B-System Installation Bids
C-System Installation Checkout
T-System Test Operations
I-System Installation

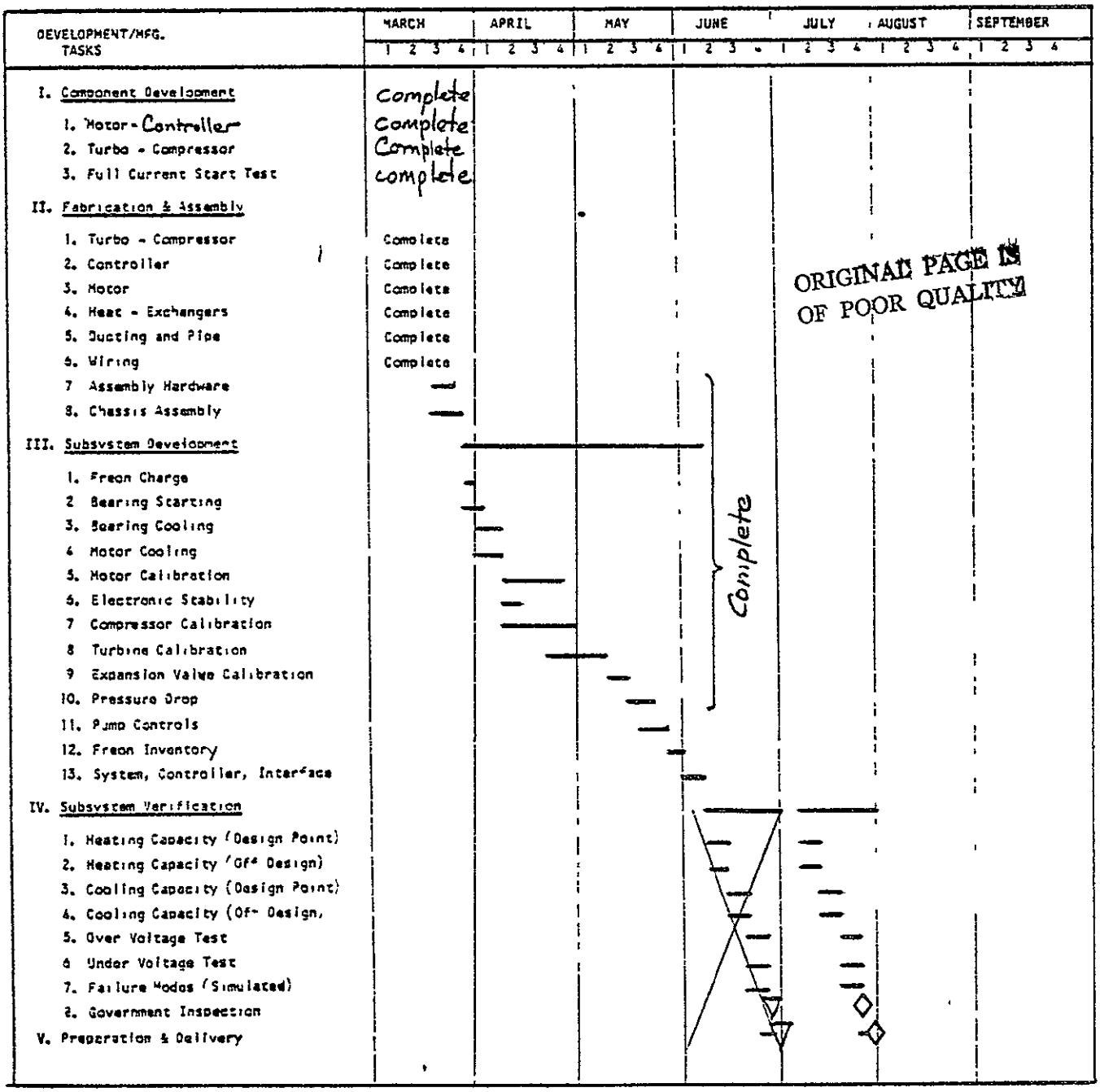
SOLAR HEATING AND COOLING SYSTEMS OPERATIONAL TEST SITE STATUS

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

B-12

CHART 1
Date: 6-12-78

SOLAR HEATING AND COOLING SYSTEM
HEAT PUMP DEVELOPMENT AND TEST SCHEDULE
UNIT: 3-1 (LAWRENCEBURG)

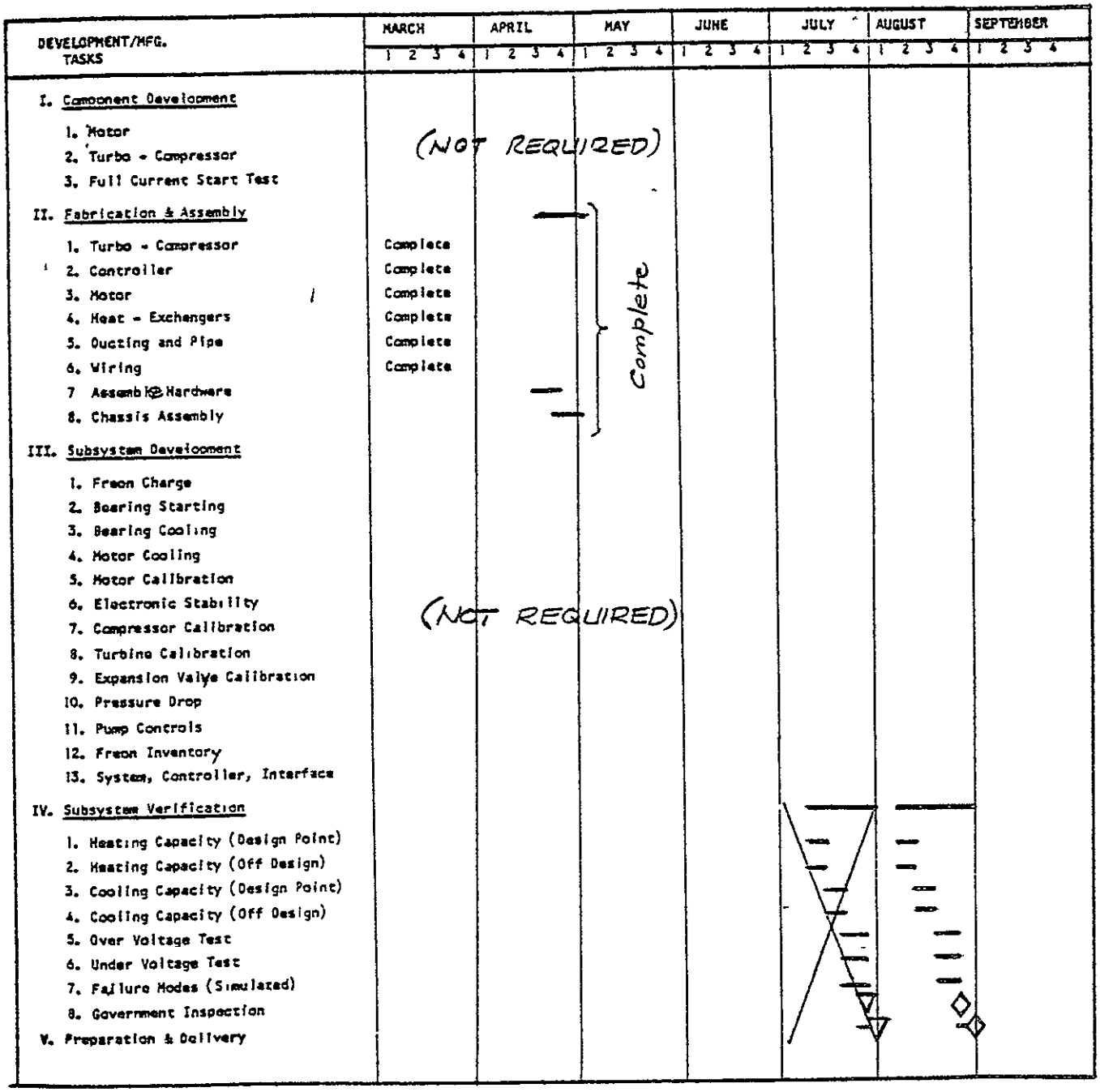


AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

▽ Original milestone
◇ Rescheduled milestone

CHART 2
Date: 6-12-78

-SOLAR HEATING AND COOLING SYSTEM
HEAT PUMP DEVELOPMENT AND TEST SCHEDULE
UNIT: 3-2 (HARRISONBURG)

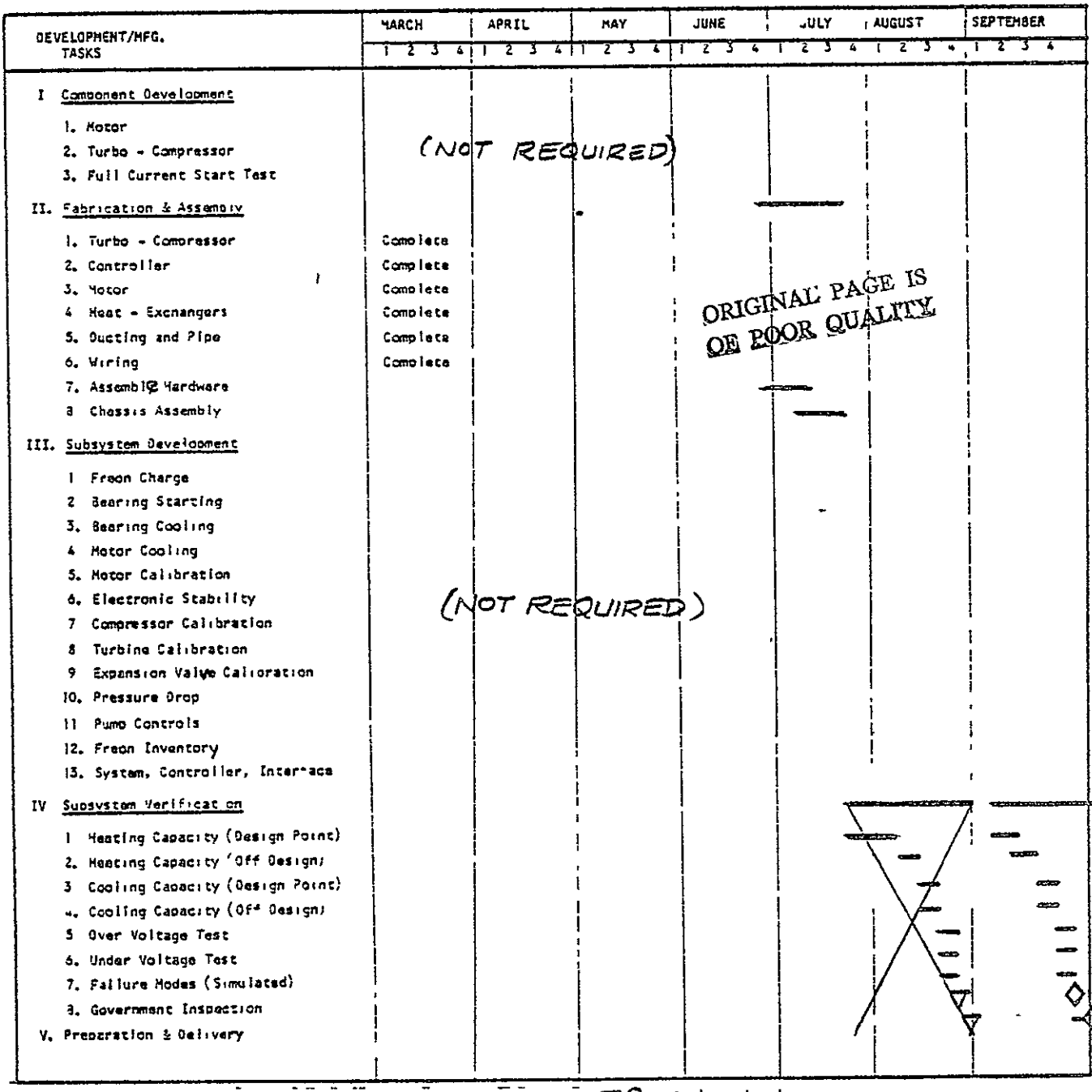


GARRETT AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

▽ Original milestone
◇ Rescheduled milestone

CHART 2a
Date: 6-12-78

SOLAR HEATING AND COOLING SYSTEM
HEAT PUMP DEVELOPMENT AND TEST SCHEDULE
UNIT: 3-3 (ALLAIRE)

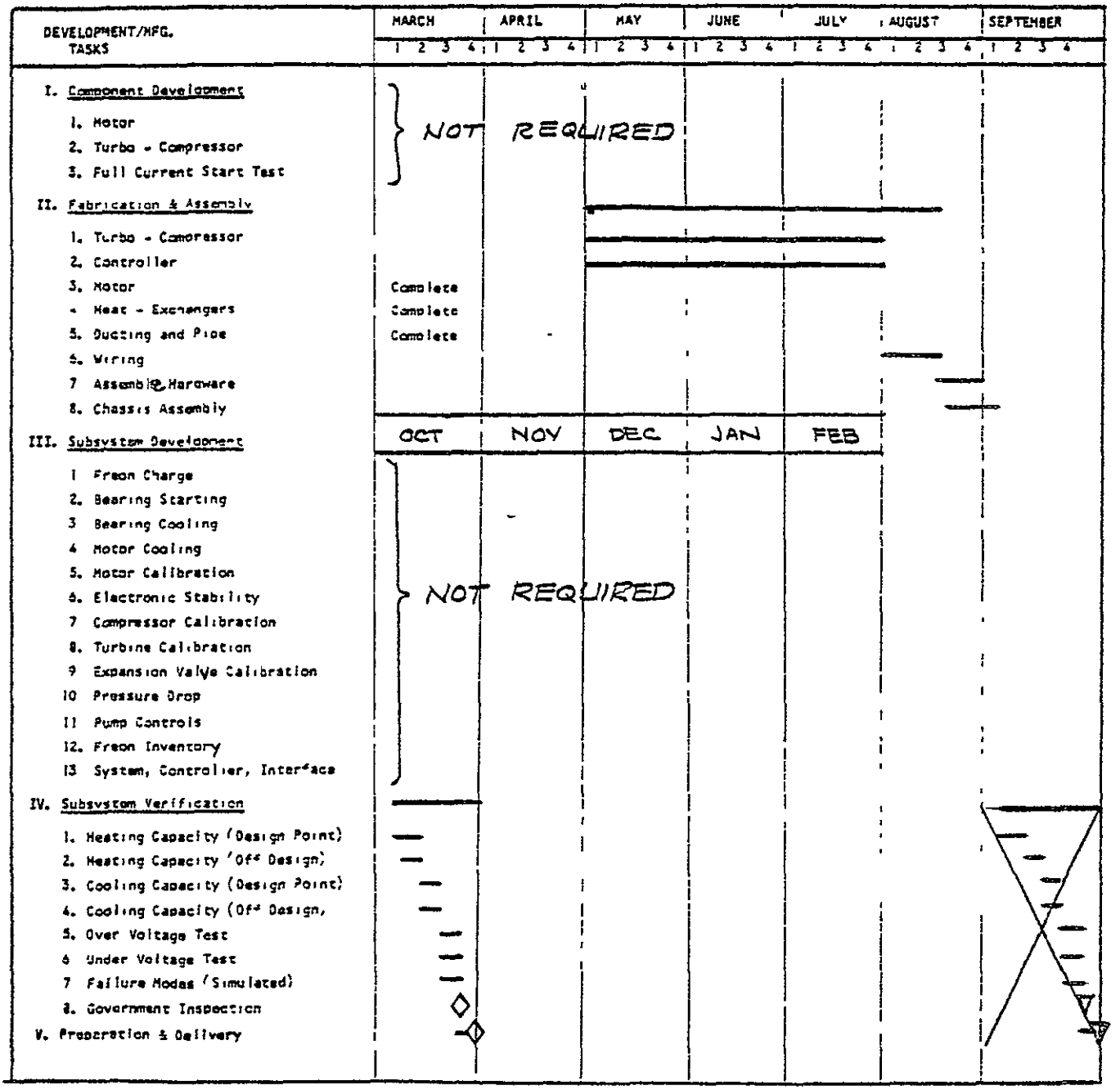


▽ Original milestone
◇ Rescheduled milestone

GARRETT AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

CHART 2b
Date: 6-12-78

SOLAR HEATING AND COOLING SYSTEM
HEAT PUMP DEVELOPMENT AND TEST SCHEDULE
UNIT: 3-4 (NOVATO)

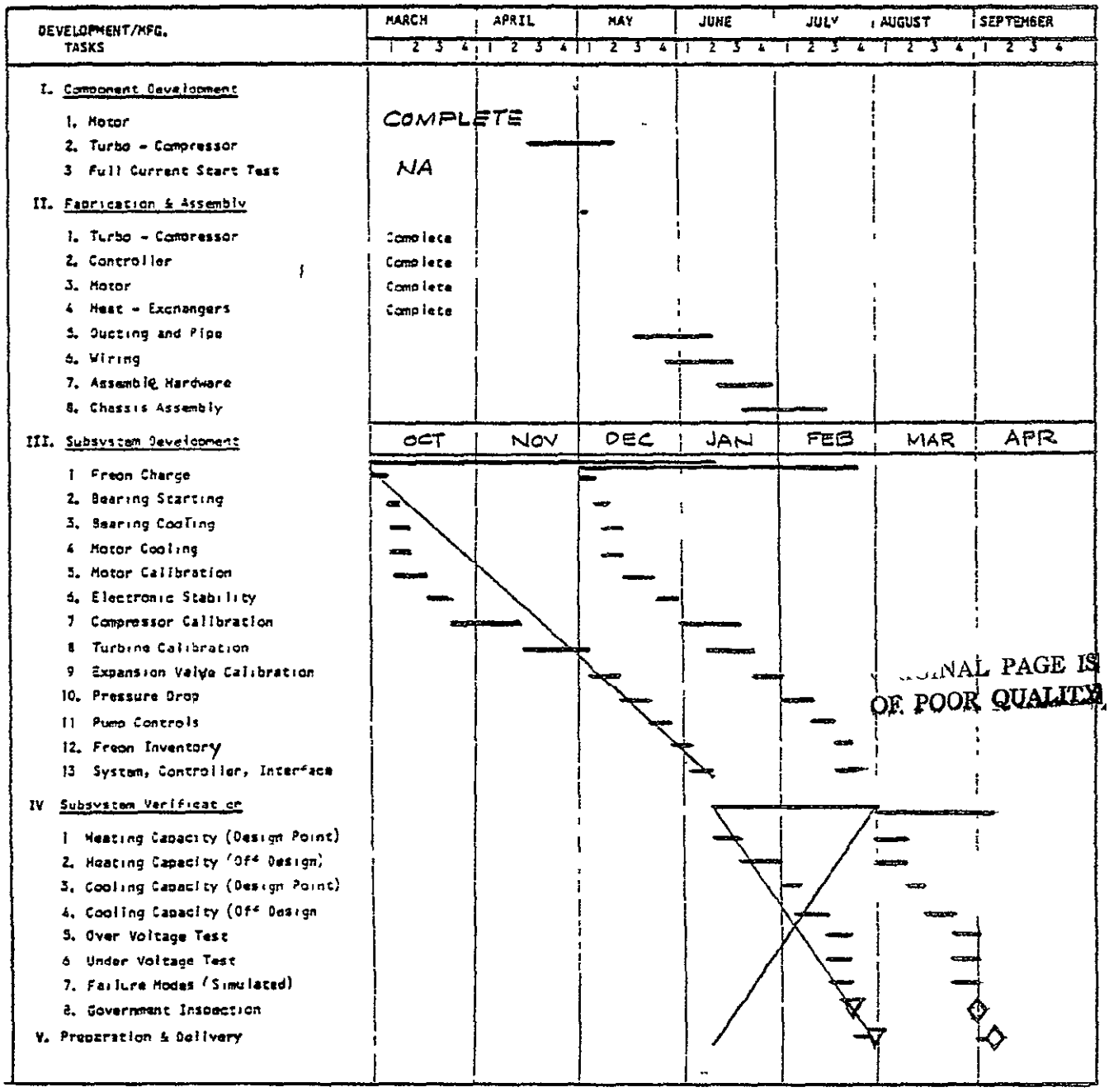


AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

▽ Original milestone
◇ Rescheduled milestone

CHART 2C
Date: 6-12-78

SOLAR HEATING AND COOLING SYSTEM
HEAT PUMP DEVELOPMENT AND TEST SCHEDULE
UNIT 25-1 (ST. LOUIS)

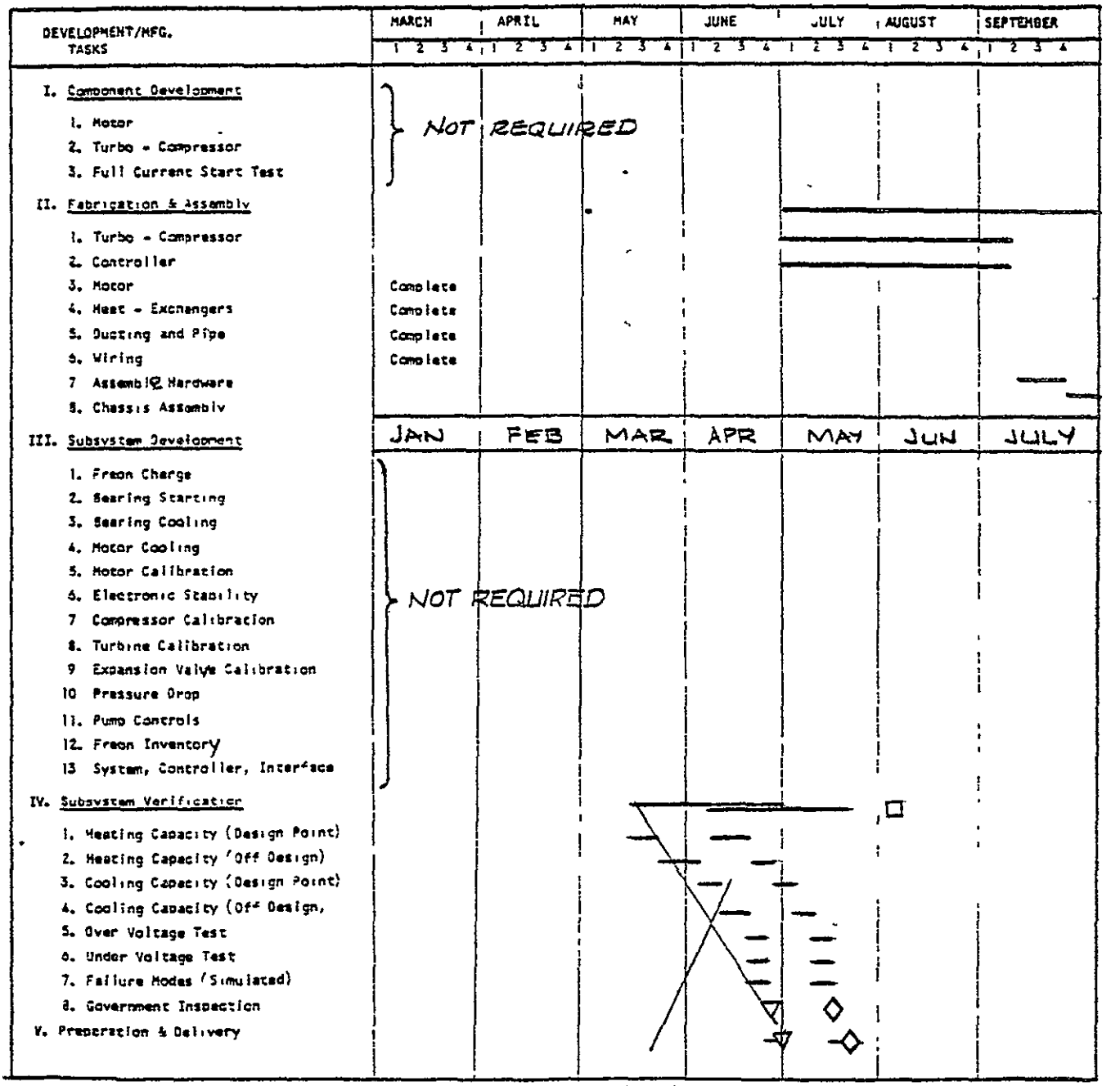


GARRETT AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

▽ Original milestone
◇ Rescheduled milestone

CHART 2d
Date: 6-12-78

SOLAR HEATING AND COOLING SYSTEM
HEAT PUMP DEVELOPMENT AND TEST SCHEDULE
UNIT. 25-2 (LOS ANGELES)

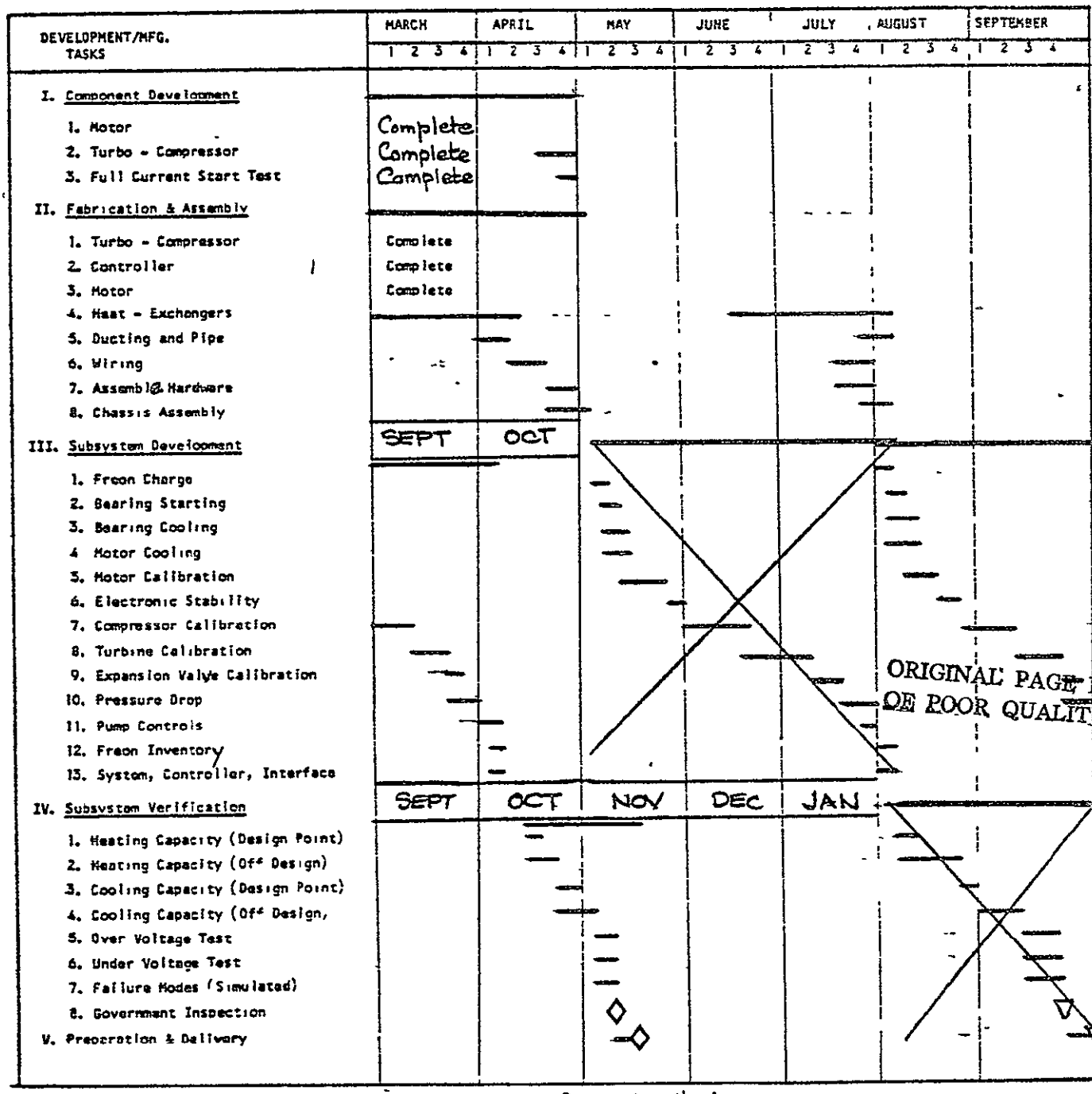


GARRETT AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

▽ Original milestone
◇ Rescheduled milestone
□ This scheduled may be expedited one month should the St. Louis unit delivery be delayed by change of site.

CHART 2e
Date: 6-12-78

SOLAR HEATING AND COOLING SYSTEM
HEAT PUMP DEVELOPMENT AND TEST SCHEDULE
UNIT: 75-1 (HOUSTON)

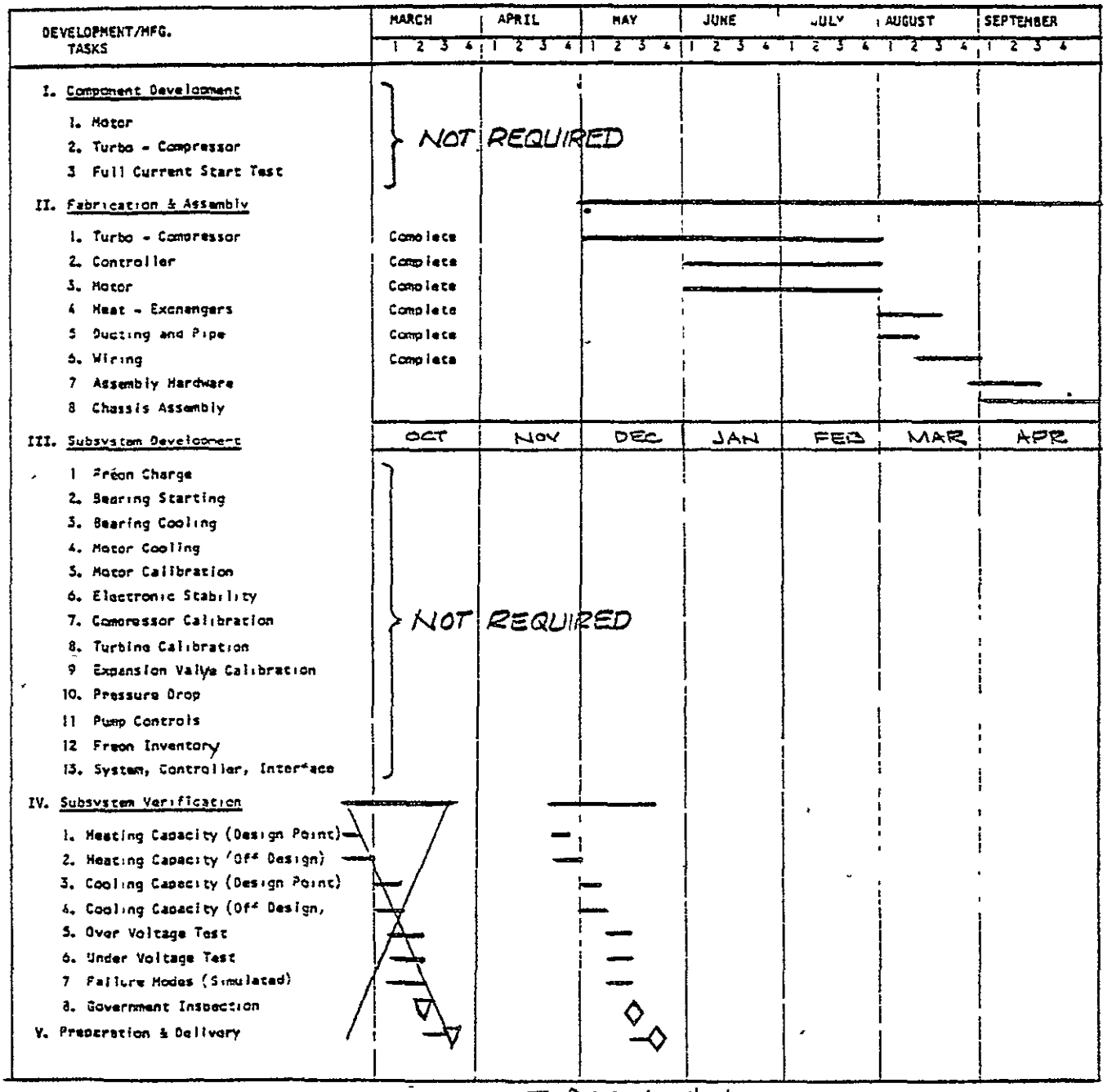


AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

▽ Original milestone
◇ Rescheduled milestone

CHART 2B
Date: 6-12-78

SOLAR HEATING AND COOLING SYSTEM
HEAT PUMP DEVELOPMENT AND TEST SCHEDULE
UNIT: 75-2 (LAS VEGAS)



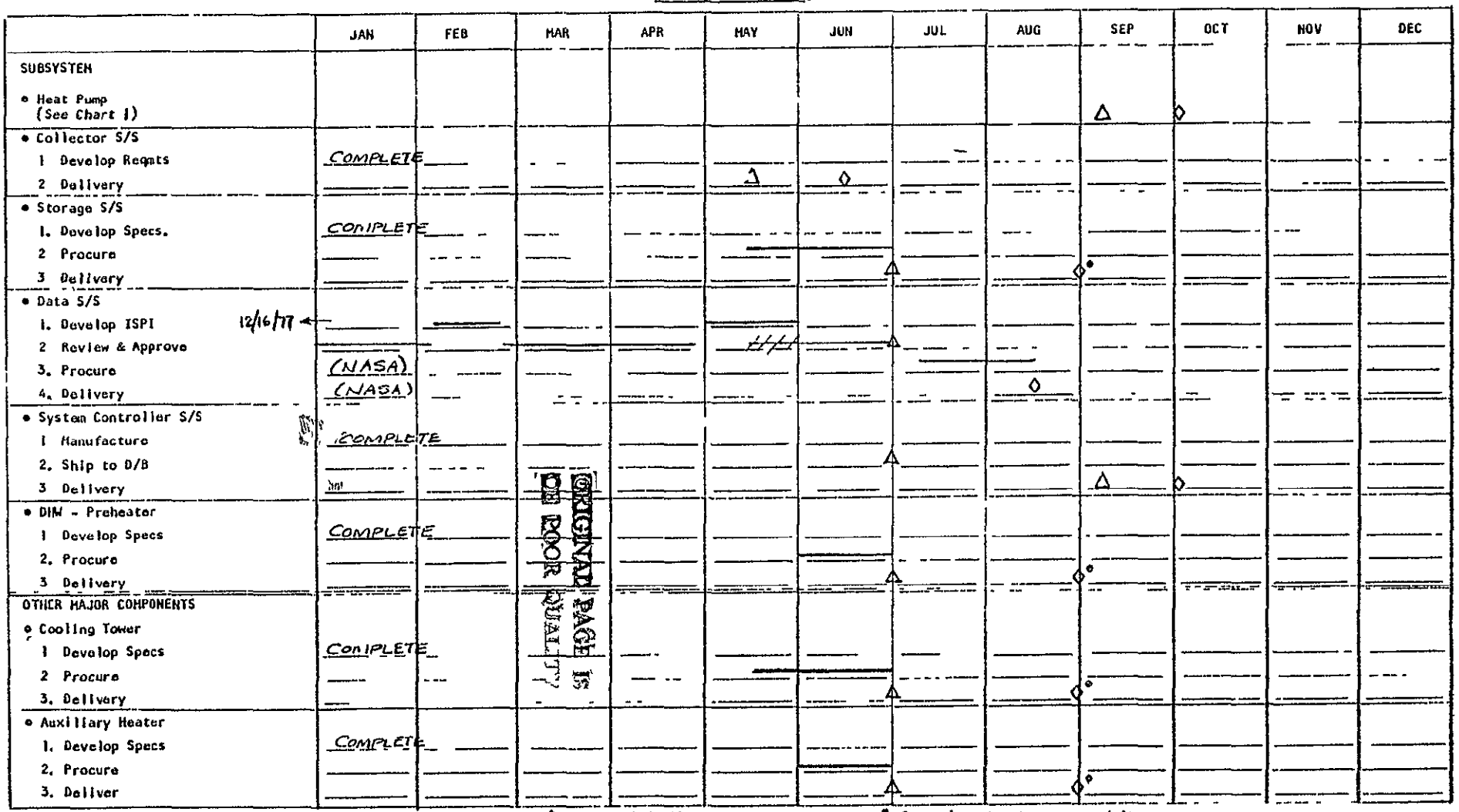
AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

▽ Original milestone
◇ Rescheduled milestone

CHART 29
Date: 6-12-78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE SUBSYSTEM SCHEDULE

SITE *ALLAIRE STATE PARK, NJ*



△ Original milestone ◇ Rescheduled milestone ⊙ General contractor procured item

AiResearch Manufacturing Company of California

Chart 3
Date 6-12-78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE INSTALLATION SCHEDULE

SITE ALLAIRE STATE PARK, N.J

INSTALLATION/OPERATION TASKS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BLDG CONSTRUCTION/MOD												
1. Design	COMPLETE											
a System Req. Inputs	COMPLETE											
b Design Reviews	?											
2. Construction												
a Collector Interface					△							
b. Backup Syst Interface						△						
c. Other Equip Interface						△						
SOLAR SYSTEM INSTALLATION												
1. A&E Selection	COMPLETE											
2 Sys Installation Design	COMPLETE											
3, Select Contractor					△	◇						
4. Install Collector S/S												
5 Install Storage S/S												
6. Install DHW Preheat S/S												
7 Install Data S/S												
8. Install Sys Control S/S												
9 Install Heat Pump S/S												
SYSTEM CHECKOUT												
1. Leakage Test												
2. Balance Collector Field												
3 Wiring C/O and Test												
4. Functional Test All Modes												
5 Instrumentation Verification												
6 System Turn-On										△	◇	
7. System Acceptance Tests												
OPERATIONAL TESTING												
1. Data Acquisition												
2 Schedule Maintenance	TBD											
3 Performance Reports												△

△ Original milestone ◇ Rescheduled milestone

GAMMON AINSLAKLIN MANUFACTURING COMPANY OF CALIFORNIA

Chart 4
Date 6-12-78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE SUBSYSTEM SCHEDULE

SITE LAWRENCEBURG, TENN.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SUBSYSTEM												
• Heat Pump (See Chart 1)							△ ◇					
• Collector S/S												
1 Develop Reqmts	COMPLETE											
2 Delivery			△									
• Storage S/S												
1 Develop Specs.	COMPLETE											
2. Procure							△ •					
3 Delivery												
• Data S/S												
1 Develop ISPI												
2 Review & Approve						△						
3. Procure	(NASA)											
4. Delivery	(NASA)						◇					
• System Controller S/S												
1 Manufacture	COMPLETE											
2 Ship to D/B	N/A											
3. Delivery							△ ◇					
• DHW - Preheater												
1. Develop Specs	COMPLETE											
2 Procure						△ •						
3 Delivery												
OTHER MAJOR COMPONENTS												
• Cooling Tower												
1. Develop Specs	COMPLETE											
2 Procure						△ •						
3 Delivery												
• Auxiliary Heater												
1 Develop Specs	N/A											
2. Procure	N/A											
3 Deliver	N/A											

△ Original Milestone ◇ Rescheduled milestone • General Contractor/procured Item

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 3a
Date 6-12-78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE INSTALLATION SCHEDULE

SITE LAWRENCEBURG, TENN.

INSTALLATION/OPERATION TASKS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BLDG. CONSTRUCTION/MOD												
1. Design	COMPLETE											
a System Req. Inputs	COMPLETE											
b. Design Reviews	?											
2. Construction												
a. Collector Interface			△									
b. Backup Syst Interface				△								
c. Other Equip. Interface				△								
SOLAR SYSTEM INSTALLATION												
1. A&E Selection	COMPLETE											
2. Sys Installation Design	COMPLETE											
3, Select Contractor	N/A											
4. Install Collector S/S						COMPLETE						
5 Install Storage S/S												
6 Install DHW Preheat S/S												
7 Install Data S/S												
8 Install Sys Control S/S												
9 Install Heat Pump S/S												
SYSTEM CHECKOUT												
1. Leakage Test												
2 Balance Collector Field												
3. Wiring C/O and Test												
4 Functional Test All Modes												
5. Instrumentation Verification												
6 System Turn-On								◇				
7 System Acceptance Tests												
OPERATIONAL TESTING												
1. Data Acquisition												
2. Schedule Maintenance	TBD									△	△	△
3 Performance Reports												

△ Original milestone ◇ Rescheduled milestone

GARRETT AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 4a
Date 6-12-78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE SUBSYSTEM SCHEDULE

SITE HARRISONBURG, VA.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SUBSYSTEM												
• Heat Pump (See Chart 1)								△	◇			
• Collector S/S												
1 Develop Reqnts	COMPLETE											
2 Delivery				△								
• Storage S/S												
1. Develop Specs.	COMPLETE											
2 Procure												
3 Delivery						△	◇					
• Data S/S												
1 Develop ISPI												
2. Review & Approve							△					
3. Procure	(NASA)											
4 Delivery	(NASA)						◇					
• System Controller S/S												
1. Manufacture	COMPLETE											
2 Ship to D/B						△						
3 Delivery						◇			◇			
• DHW - Preheater												
1 Develop Specs	COMPLETE						N/A					
2 Procure							N/A					
3 Delivery						△	N/A					
OTHER MAJOR COMPONENTS												
• Cooling Tower												
1 Develop Specs	COMPLETE											
2 Procure												
3. Delivery					△		◇					
• Auxiliary Heater												
1 Develop Specs	N/A											
2. Procure	N/A											
3 Deliver	N/A											

ORIGINAL PAGE IS OF POOR QUALITY

△ Original milestone ◇ Rescheduled milestone

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 3b
Date 5-4-76

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE INSTALLATION SCHEDULE
SITE HARRISONBURG, VA.

INSTALLATION/OPERATION TASKS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BLDG CONSTRUCTION/MOD												
1. Design	COMPLETE											
a. System Req. Inputs	COMPLETE											
b. Design Reviews	?											
2. Construction												
a. Collector Interface				△								
b. Backup Syst Interface						△	◇					
c. Other Equip. Interface						△	◇					
SOLAR SYSTEM INSTALLATION												
1 A&E Selection	COMPLETE											
2. Sys. Installation Design	COMPLETE											
3, Select Contractor	N/A											
4 Install Collector S/S												
5. Install Storage S/S												
6. Install DHW Preheat S/S						N/A						
7. Install Data S/S												
8 Install Sys Control S/S												
9 Install Heat Pump S/S												
SYSTEM CHECKOUT												
1. Leakage Test												
2. Balance Collector Field												
3 Wiring C/O and Test												
4. Functional Test All Modes												
5 Instrumentation Verification												
6. System Turn-On									△	◇		
7 System Acceptance Tests												
OPERATIONAL TESTING												
1. Data Acquisition												
2. Schedule Maintenance	TBD											
3 Performance Reports										X	△	△

△ Original Milestone ◇ Rescheduled Milestone

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 4b
Date 5-4-78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE SUBSYSTEM SCHEDULE

SITE NOVATO, CALIF.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SUBSYSTEM												
• Heat Pump (See Chart 1)												
• Collector S/S												
1. Develop Reqmts	COMPLETE											
2. Delivery												
• Storage S/S												
1 Develop Specs.												
2. Procure												
3 Delivery												
• Data S/S												
1. Develop ISPI												
2 Review & Approve												
3. Procure	(NASA)											
4 Delivery	(NASA)											
• System Controller S/S												
1 Manufacture												
2. Ship to D/B	N/A											
3 Delivery												
• DHW - Preheater												
1 Develop Specs	COMPLETE											
2. Procure												
3 Delivery												
OTHER MAJOR COMPONENTS												
• Cooling Tower												
1. Develop Specs	N/A											
2 Procure	N/A											
3 Delivery	N/A											
• Auxiliary Heater												
1. Develop Specs	(NASA)											
2. Procure	(NASA)											
3 Deliver												

△ Original Milestone ◇ Rescheduled Milestone ◦ General contractor procured item

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 3C
Date 6-18-78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE INSTALLATION SCHEDULE

SITE. NOVATO, CALIF

INSTALLATION/OPERATION TASKS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BLDG. CONSTRUCTION/MOD												
1. Design	~~COMPLETE~~											
a. System Req. Inputs	~~COMPLETE~~					△ ◇						
b. Design Reviews	(NASA)						◇					
2. Construction												
a Collector Interface									◇			
b. Backup Syst. Interface							△		◇			
c. Other Equip. Interface								△	◇			
SOLAR SYSTEM INSTALLATION												
1. A&E Selection					△	◇						
2. Sys Installation Design							△		◇			
3, Select Contractor								△	◇			
4. Install Collector S/S												
5 Install Storage S/S												
6. Install DHW Preheat S/S												
7 Install Data S/S												
8. Install Sys. Control S/S												
9 Install Heat Pump S/S										~~~~		
SYSTEM CHECKOUT												
1 Leakage Test												
2 Balance Collector Field												
3. Wiring C/O and Test												
4 Functional Test All Modes												
5. Instrumentation Verification												
6 System Turn-On											△	◇
7 System Acceptance Tests												
OPERATIONAL TESTING												
1. Data Acquisition												~~~~
2. Schedule Maintenance	TBD											
3. Performance Reports												1/22 →

Chart 4C
Date 6-12-78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE SUBSYSTEM SCHEDULE

SITE St. Louis, Mo.

1979 → | 1978 →

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SUBSYSTEM												
• Heat Pump (See Chart I)			△									
• Collector S/S							COMPLETE					
1 Develop Reqmts.												
2 Delivery							△					
• Storage S/S												
1. Develop Specs.												
2 Procure												
3 Delivery										△		
• Data S/S												
1 Develop ISPI												
2 Review & Approve												
3 Procure							NASA					
4. Delivery							NASA					
• System Controller S/S												
1 Manufacture												
2. Ship to D/B	N/A											
3 Delivery			△									
• DIM - Preheater												
1 Develop Specs												
2 Procure												
3 Delivery								△				
OTHER MAJOR COMPONENTS												
• Cooling Tower												
1 Develop Specs							COMPLETE					
2 Procure												
3. Delivery								△				
• Auxiliary Heater												
1. Develop Specs	N/A											
2 Procure	N/A											
3 Deliver	N/A											

SCHEDULE SHOWN MAY BECOME OBSOLETE IF THIS SITE IS RELOCATED

ORIGINAL PAGE IS OF POOR QUALITY

LOCKHEED AIRCRAFT MANUFACTURING COMPANY OF CALIFORNIA

Chart 3d
Date 6-12-78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE INSTALLATION SCHEDULE

1979 → SITE St. Louis, Mo. 1978 →

INSTALLATION/OPERATION TASKS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BLDG. CONSTRUCTION/MOD												
1. Design							COMPLETE					
a System Req. Inputs							COMPLETE					
b. Design Reviews							(NASA)					
2. Construction												
a Collector Interface												
b Backup Syst Interface							N/A					
c. Other Equip Interface							N/A					
SOLAR SYSTEM INSTALLATION												
1 A&E Selection							N/A					
2 Sys. Installation Design							COMPLETE					
3, Select Contractor												
4 Install Collector S/S												
5 Install Storage S/S												
6. Install DHW Preheat S/S							N/A					
7 Install Data S/S												
8 Install Sys Control S/S												
9. Install Heat Pump S/S												
SYSTEM CHECKOUT												
1 Leakage Test												
2 Balance Collector Field												
3. Wiring C/O and Test												
4 Functional Test All Modes												
5 Instrumentation Verification												
6. System Turn-On												
7. System Acceptance Tests												
OPERATIONAL TESTING												
1. Data Acquisition												
2. Schedule Maintenance	TBD											
3. Performance Reports					Δ	Δ						

SCHEDULE SHOWN MAY BECOME OBSOLETE IF THIS SITE IS RELOCATED

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 4d
Date 6-12-78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE SUBSYSTEM SCHEDULE

SITE HOUSTON, TEX

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SUBSYSTEM												
• Heat Pump (See Chart 1)										△	◇	
• Collector S/S												
1. Develop Reqmts.	COMPLETE											
2 Delivery						△ ◇						
• Storage S/S												
1 Develop Specs.	COMPLETE											
2 Procure												
3. Delivery						△						
• Data S/S												
1 Develop ISPI (11-15-77)						COMPLETE						
2 Review & Approve												
3. Procure	(NASA)											
4. Delivery	(NASA)					◇						
• System Controller S/S												
1 Manufacture	COMPLETE											
2. Ship to D/B	N/A											
3 Delivery										△	◇	
• DHW - Preheater												
1 Develop Specs												
2 Procure												
3. Delivery								△				
OTHER MAJOR COMPONENTS												
• Cooling Tower												
1 Develop Specs	N/A											
2. Procure	N/A											
3. Delivery	N/A											
• Auxiliary Heater												
1. Develop Specs	N/A											
2. Procure	N/A											
3. Deliver	N/A											

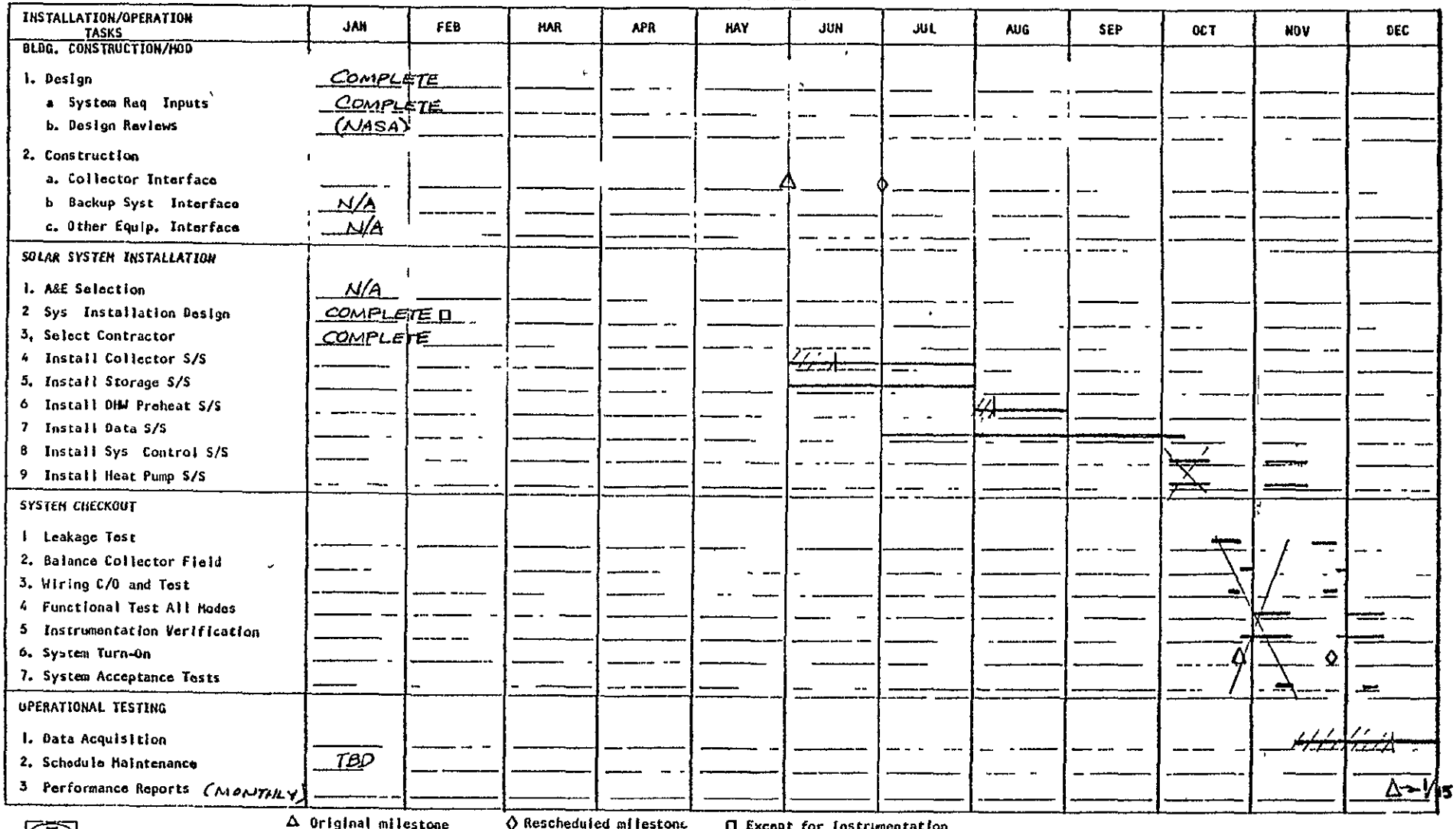
△ Original milestone ◇ Rescheduled milestone

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 3f
Date 6/12/78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE INSTALLATION SCHEDULE

SITE Houston, Tex



Δ Original milestone ◊ Rescheduled milestone □ Except for instrumentation

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 4A
Date 6/12/78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE SUBSYSTEM SCHEDULE

SITE, LAS VEGAS, NEV

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SUBSYSTEM												
• Heat Pump (See Chart 1)											△	◇
• Collector S/S												
1 Develop Reqmts	COMPLETE											
2. Delivery						△		◇				
• Storage S/S												
1 Develop Specs.	COMPLETE											
2 Procure												
3 Delivery						△				◇		
• Data S/S												
1 Develop ISPI (12-12-77)												
2. Review & Approve												
3. Procure	(NASA)											
4 Delivery	(NASA)						◇					
◦ System Controller S/S												
1. Manufacture												
2 Ship to D/B	N/A										△	◇
3 Delivery												
• DHW - Preheater												
1 Develop Specs	COMPLETE											
2 Procure										◇ •		
3. Delivery							△					
OTHER MAJOR COMPONENTS												
◦ Cooling Tower												
1 Develop Specs	COMPLETE											
2. Procure												
3. Delivery							△			◇ •		
◦ Auxiliary Heater												
1 Develop Specs	N/A											
2. Procure	N/A											
3 Deliver	N/A											

△ Original Milestone ◇ Rescheduled Milestone • General contractor procured item

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 39
Date 6/12/78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE INSTALLATION SCHEDULE

SITE LAS VEGAS, NEV.

INSTALLATION/OPERATION TASKS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BLDG CONSTRUCTION/MOD												
1 Design	COMPLETE											
a System Req. Inputs	COMPLETE											
b. Design Reviews	(NASA)											
2 Construction												
a. Collector Interface							△		◇			
b Backup Syst. Interface	N/A											
c. Other Equip Interface	N/A											
SOLAR SYSTEM INSTALLATION												
1 A&E Selection	COMPLETE											
2 Sys Installation Design	COMPLETE											
3, Select Contractor	COMPLETE											
4 Install Collector S/S												
5 Install Storage S/S												
6. Install DHW Preheat S/S												
7 Install Data S/S												
8 Install Sys Control S/S												
9 Install Heat Pump S/S												
SYSTEM CHECKOUT	1979 →											
1 Leakage Test												
2. Balance Collector Field												
3 Wiring C/O and Test												
4. Functional Test All Modes												
5 Instrumentation Verification												
6. System Turn-On	◇											
7 System Acceptance Tests												
OPERATIONAL TESTING	1979 →											
1. Data Acquisition	//////			→								
2. Schedule Maintenance	TBD											
3. Performance Reports		△	△	△ ETC								

△ Original milestone ◇ Rescheduled Milestone

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 49
Date 6/12/78

SIZE	UNIT	TURBOCOM-PRESSOR	MOTOR CONTROL	FREON PUMP	HEAT PUMP COMPLETE	START TEST	TEST TIME, WEEKS	TEST COMPLETE	SHIP DATE	INTENDED SITE
3 TON						3-1 &				
	#1	Shipped	Shipped	Shipped	Comp.	4-10	8	7-25	7-31	Lawrenceburg, TN
	#2	Shipped	Shipped	Shipped	6-1	7-25	4	8-25	8-31	Harrisonburg, VA
	#3	6-23	6-23	6-23	7-23	8-25	4	9-25	10-2	Allaire Park, N.J.
	#4	8-15	8-15	8-15	9-15	9-25	4	10-25	11-1	Novato, CA.
25 TON										
	#1	6-21	6-21	6-21	7-28	12-15	14	3-30	4-7	St. Louis, MO.
	#2	8-1	9-1	8-1	10-1	3-30	6	5-15	5-22	Los Angeles, CA.
75 TON										
	#1	Shipped	5-7	Rec.	8-7	8-7	14	11-6	11-13	Houston, TX.
	#2	*	*	Rec.	*	*	14	12-15	12-22	Las Vegas, NV.

*To be redetermined

Heat Pump Delivery Schedule

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

CHART 9
Date: 6-12-78

PART C

Nineteenth Monthly Status Report
Data Requirement No. 500-11

SOLAR HEATING AND COOLING SYSTEMS DESIGN AND DEVELOPMENT

Contract NAS8-32091

76-13110(19)

July 10, 1978

P. A. Benson

Prepared for

George C. Marshall Space Flight Center
National Aeronautics and Space Administration
Marshall Space Flight Center
Huntsville, Alabama 35812

AIRESEARCH MANUFACTURING COMPANY
OF CALIFORNIA

INTRODUCTION

This is the nineteenth monthly status report prepared by AiResearch Manufacturing Company of California under Contract NAS8-32091 for the National Aeronautics and Space Administration Marshall Space Flight Center (MSFC). The report summarizes activities from June 1 to June 30, 1978, except for site status charts which reflect NASA comments received on June 6 and 7.

For simplicity in reporting, activities are reported by subject matter rather than by WBS item number.

MEETINGS, REVIEWS AND MAJOR ACTIVITIES

Activities during June were as follows:

- A program review meeting was held at AiResearch on June 6 and 7, 1978, with NASA/MSFC representatives James Clark and Robert Gunner in attendance. Site schedules and component delivery dates were the major topic. (Revised site schedules from this meeting were included in the May progress report.)

- A system design presentation was made to representatives of the Bonneville Power Authority, the owner of the Redmond, Oregon, proposed site on June 8, 1978. (Redmond, Oregon, is an alternate for the now-defunct Los Angeles light commercial SHAC site.)

- Job Meeting No. 15 was held at Houston on June 15, 1978 with Mssrs. Clark and Gunner of NASA and Mr. Paul Benson of AiResearch attending. It was found that the storage tank was installed backwards to allow easier access into the tank man-hole. AiResearch agreed with Timmerman Engineers, Inc. to allow tank modification to permit installation of the horizontal temperature probes from the open side. The DHW preheater was too high for this building. It was redesigned to fit within the 19 ft allowable vertical space. Consequently, its capacity was reduced by 25 percent.

- A site owners meeting and heat pump review were held at Harrisonburg, Virginia, on June 20 with Mssrs. Benson and H. Yee of AiResearch and Mr. Clark of NASA present. Major items discussed were delivery schedules, means to expedite component delivery, review of the ISPI and the best way to return Houston site instrumentation erroneously shipped to Dunham-Bush by IBM/Huntsville personnel.

- A bid meeting was held for the Allaire State Park site on June 27, 1978, in preparation for selection of a contractor. All bids were too high.

Activities scheduled for the month of July include:

- A quarterly review meeting at AiResearch on July 10 and 11, 1978.
- A contractor/owner interface meeting with the Bonneville Power Authority regarding a SHAC site at Redmond, Oregon, on July 12, 1978.
- A contractor/owner interface meeting at Novato, Calif., on July 13, 1978.
- A contractor/owner interface meeting at Houston, Texas, on July 20, 1978.

Site and Site Equipment Status Charts

Site Status Charts 1 through 4 were updated on June 4 through June 8 at the monthly program review meeting. At that time, it was decided to delete Charts 5 through 8 since the dates and costs of these charts does not change often. Chart 5 (previously Chart 9) the heat pump delivery schedule, in contrast, is subject to frequent change depending on development test results). This chart was updated on July 14, 1978 to reflect Dunham-Bush heat pump test estimates received early in July. Charts 1 through 4 have not been updated to agree with the latest information because of progress report time restrictions. Charts 1 through 5 are included in Appendix A of this report.

Subsystems Updated

Figures 1 through 4 of this report were presented in last month's report. They have been corrected to delete the cooling tower (which is not part of the heating and cooling freon subsystem) and to denote that the collector, interchanger and storage loops are not shown. In addition, Figure 4 (the Las Vegas subsystem schematic) has been altered slightly at the auxiliary boiler to be consistent with the site equipment A and E drawings.

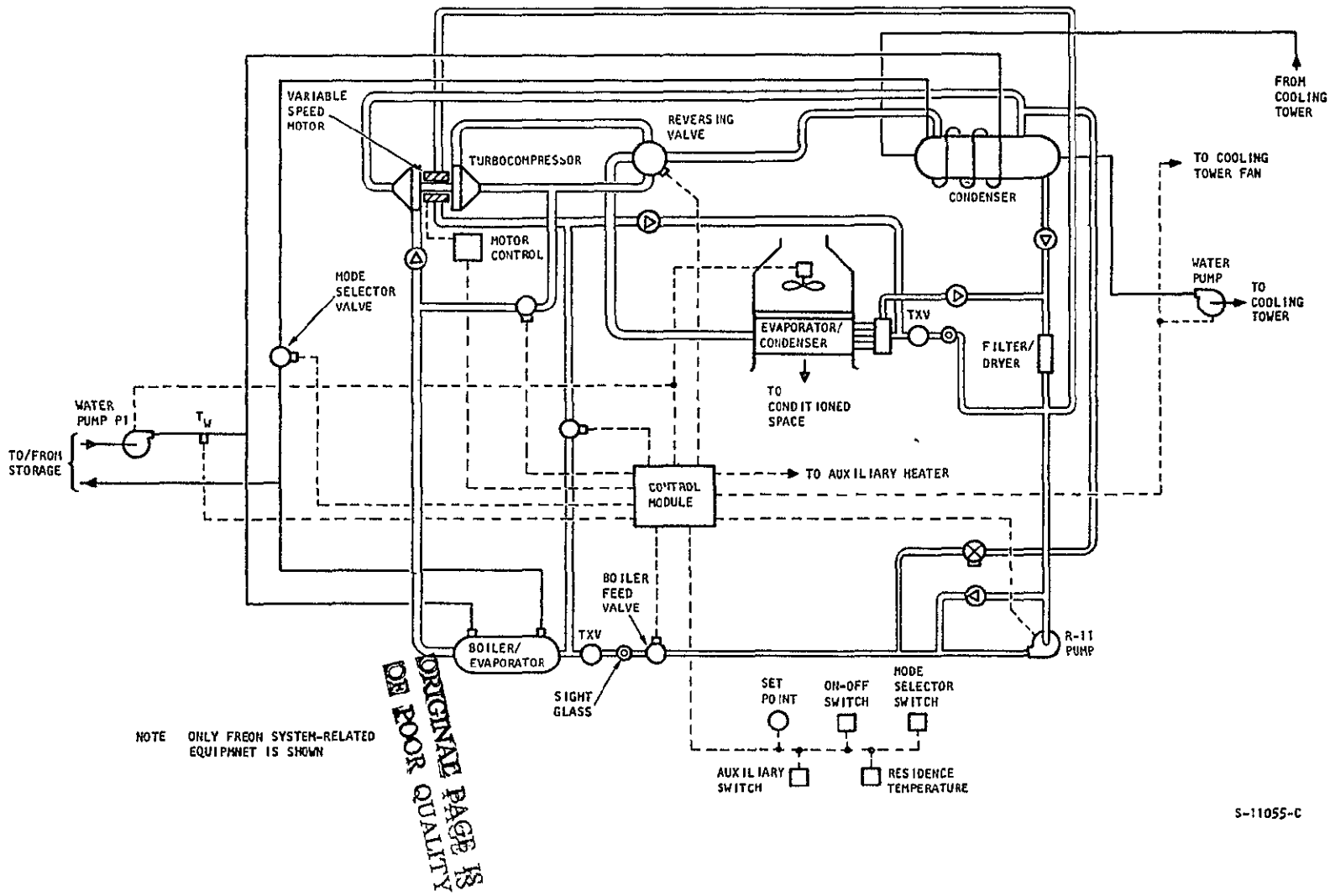


Figure 1. 3-Ton/60 KBTUH Space Heating and Cooling Freon Subsystem Schematic

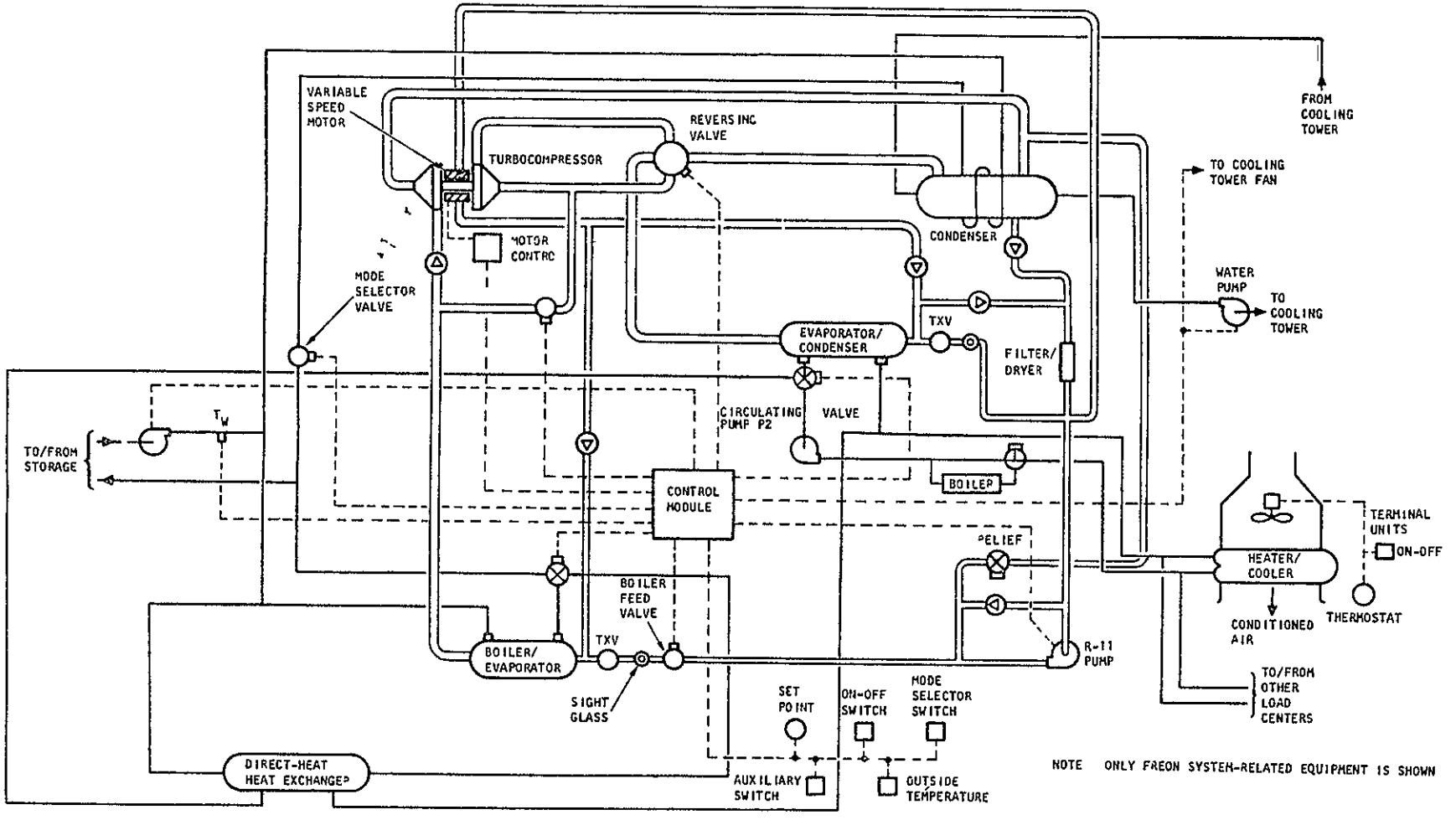


Figure 2. 25-Ton/600 KBTUH Cooling and Heating Freon Subsystem Schematic

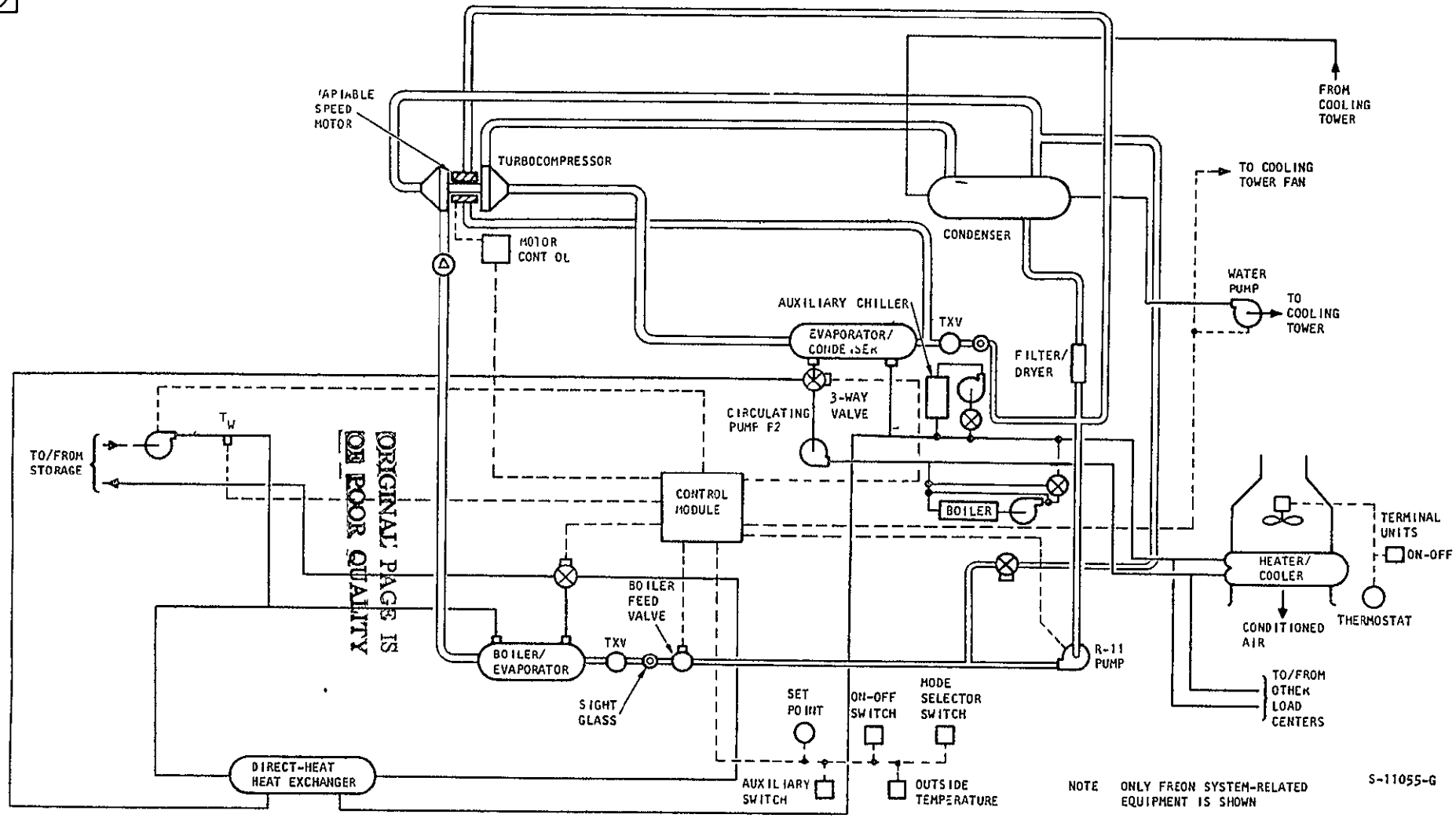


Figure 3.75-Ton/1600-KBTUH Cooling and Heating Freon Subsystem Schematic (Las Vegas)

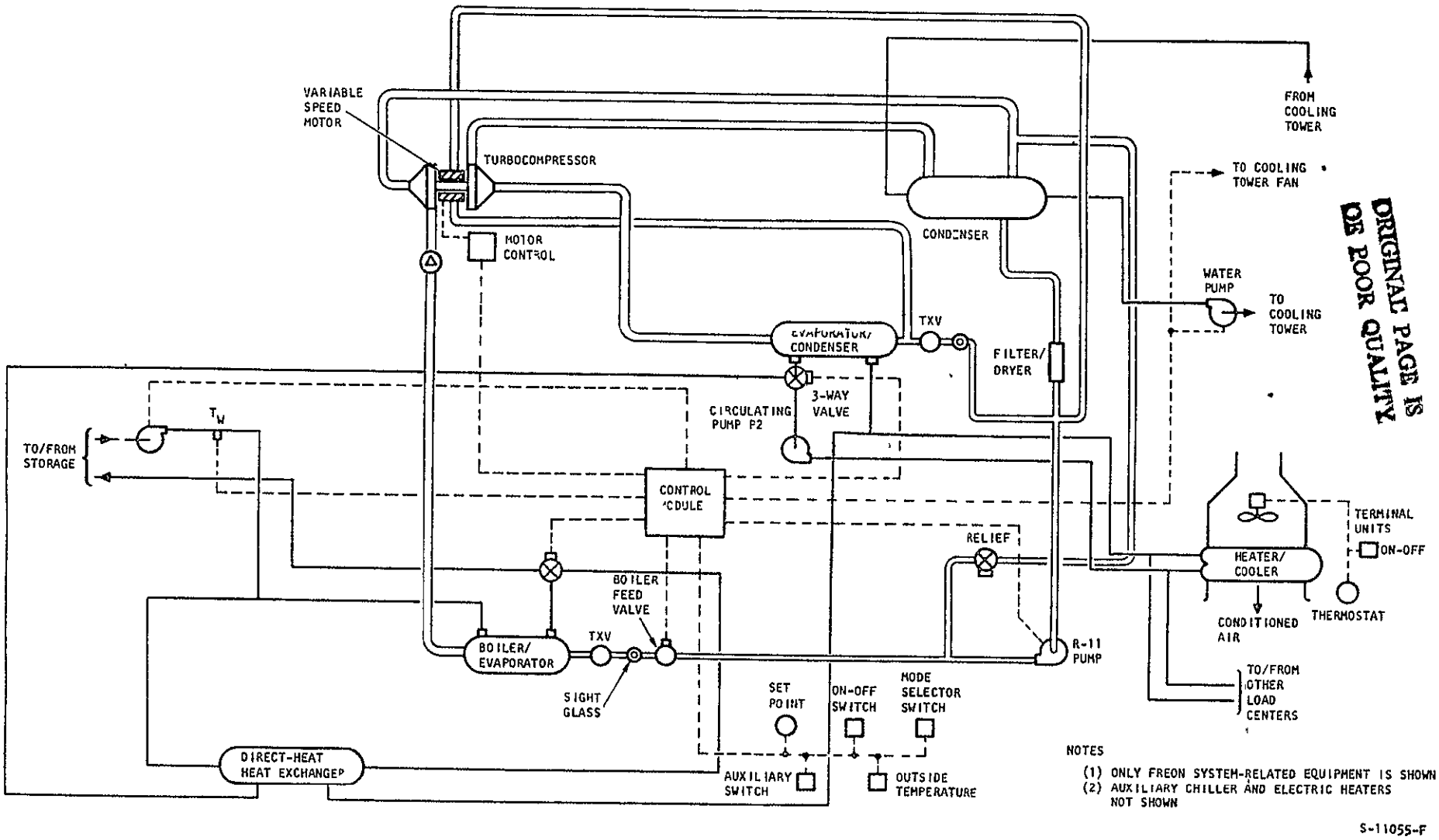


Figure 4. 75-Ton/1600-KBTUH Cooling and Heating Freon Subsystems Schematic (Houston)

Status of Instrumentation System Planning Information (ISPI)

Site	Revision	Remarks
Allaire Park, N.J.	B	Revision B submitted May 23, 1978. Called Mr. G. Mizell of IBM-Huntsville on June 23, 1978 with updated air duct sizes at W400 and W450.
Lawrenceburg, Tn.	A	Revision A submitted May 19, 1978. Provided Mr. Mizell with insulation thicknesses for each system loop on June 23, 1978
Harrisonburg, Va.	--	Original version ISPI submitted June 27, 1978.
Novato, Ca.	--	No action as yet, site recently reactivated.
St. Louis, Mo.	--	No action, site not yet determined.
Los Angeles, Ca.	--	No action, site not yet determined.
Houston, Tx.	D	Submitted June 29, 1978, 4 temperature probes and one flowmeter deleted, 1 wattmeter added to measure R-11 pump electrical energy.
Las Vegas, Nv.	D	Revision D submitted May 31, 1978. Revision E in progress to incorporate latest Houston site instrumentation changes noted above.

Program Documentation

a. Eighteenth Monthly Status Report 76-13110(18), dated June 9, 1978 (DR500-11).

B. Quarterly Contractor Financial Management Report (DR500-27).

Other publications were submitted during May to the parties listed as tabulated below:

Submittal Date	To	Subject
6-15-78	J. Clark (NASA/MSFC)	Freon Selector Valve Proposal
6-22-78	J. Clark (NASA/MSFC)	Drawings SK-60516 and SK-60562 (of the solar collector temperature sensor installation)
6-27-78	J. Clark and C. Reichelderfer (of Dunham-Bush, Inc.)	Harrisonburg, Virginia, Site ISPI (no revision)
6-29-78	J. Clark and E. Samfield (of the Univ. of Houston)	Houston, Texas, Site ISPI, Revision D

SYSTEM DEVELOPMENT

The activities reported below involve heat pump component design, fabrication and testing, and heat pump package development.

Component Design, Fabrication and Test

1. Turbomachine

(a) 3-Ton Unit

Two units were shipped to Dunham-Bush for test. When tested at AiResearch, both units exhibited no unusual characteristics. One unit was damaged in shipment, but when bench-tested at Dunham-Bush, it appeared to be satisfactory. When it was installed and operated in the heat pump system, noise occurred at approximately 58,000 rpm. The system was shut down and the unit removed. The second unit was installed and the results were identical, i.e.--noise at 58,000 rpm. The units were returned and examined. One unit appeared to have been out of balance causing excessive rubbing. The second unit exhibited only minor marks which may have resulted from rubbing. Both rotors have been rebalanced and one unit has been built and tested in excess of 60,000 rpm at AiResearch. It was decided that the Dunham-Bush system would be shipped and set up at AiResearch. This has been accomplished and testing should begin by mid-July.

(b) 25-Ton Unit

A unit with increased tie-bolt torque was installed in the system and tested for several hours at speeds in excess of 38,000 rpm and up as high as 42,000 rpm. No hitting occurred. The unit was disassembled and inspected. Everything appeared to be in good condition. The unit was cleaned, reassembled and bench tested. It has been shipped to Dunham-Bush for package tests.

Unit No. 2 will be available for test July 15, 1978.

(c) 75-Ton Unit

Unit No. 2 was tested in the laboratory and exhibited a condition where the turbine wheel became warm in approximately 2 minutes. This can only be caused by rubbing. Upon disassembly, it was found that the teflon coating had not been properly applied and that flaking was occurring causing the bearing to rub and heat the rotor. New bearings are being fabricated from new material. The unit should be available for test by mid-July

2. Motor Controller

(a) 3-Ton Controller

Tests will be conducted on the heat pump package at AiResearch.

(b) 25-Ton Controller

Maximum load, maximum speed tests have been satisfactorily run. The ability of the motor controller to recover from line voltage interrupts has also been established. Controller No. 1 has been shipped to Dunham-Bush while Controller No. 2 is 30 percent complete.

(c) 75-Ton Controller

Investigation of uneven margin times in the inverter will be concluded when a motor is available.

Controller No. 2 is completed and awaiting checkout. This will be accomplished when a motor is available.

3. System Controller

The interface unit between the system and motor controller has been modified to output the motor speed signal only after the motor controller ready signal is received.

4. R-11 Liquid Pump

(a) 3-Ton Unit

Three pump units were delivered in March. Testing is now at the subsystem level.

(b) 25-Ton Unit

Parts have been received for three pumps. One pump has been tested and shipped to Dunham-Bush. Flow rate for this unit was slightly low because of internal leakage. Rework of this pump (and the remaining two) is being held in abeyance pending system test evaluation.

Heat Pump Design, Fabrication and Test

1. Components

Two additional four-way reversing valves have been received for the 3-ton heat pump for a total of four. The four-way reversing valve for the 25-ton machine is now promised for June 30 delivery but was not received during the month.

Two interchangers for the 75-ton machine have been received and are mounted on the base.

2. Assembly

Two 3-ton heat pumps are assembled and ready for installation of the turbocompressor and R11 pump. Assembly of the 75-ton units will proceed on a two shift basis. The turbocompressor, R-1 pump and reversing valve will be installed in the 25-ton as soon as possible without interference with work on the 75-ton units.

3. Tests of 3-Ton Heat Pump

A 3-ton turbocompressor and a motor controller were received from AiResearch on June 21. Although the carton was essentially undamaged and the contents were well packed for foam plastic, the motor controller was badly damaged. Components had pulled loose from the mountings and rivets used to attach the door had sheared off.

A second compressor and motor controller were shipped by AiResearch and were received at Dunham-Bush on June 22. The first compressor was bench tested and appeared to operate satisfactorily. The compressor and motor controller were then installed on the 3-ton tested unit and the system was evacuated and charged with 75 lb of R11.

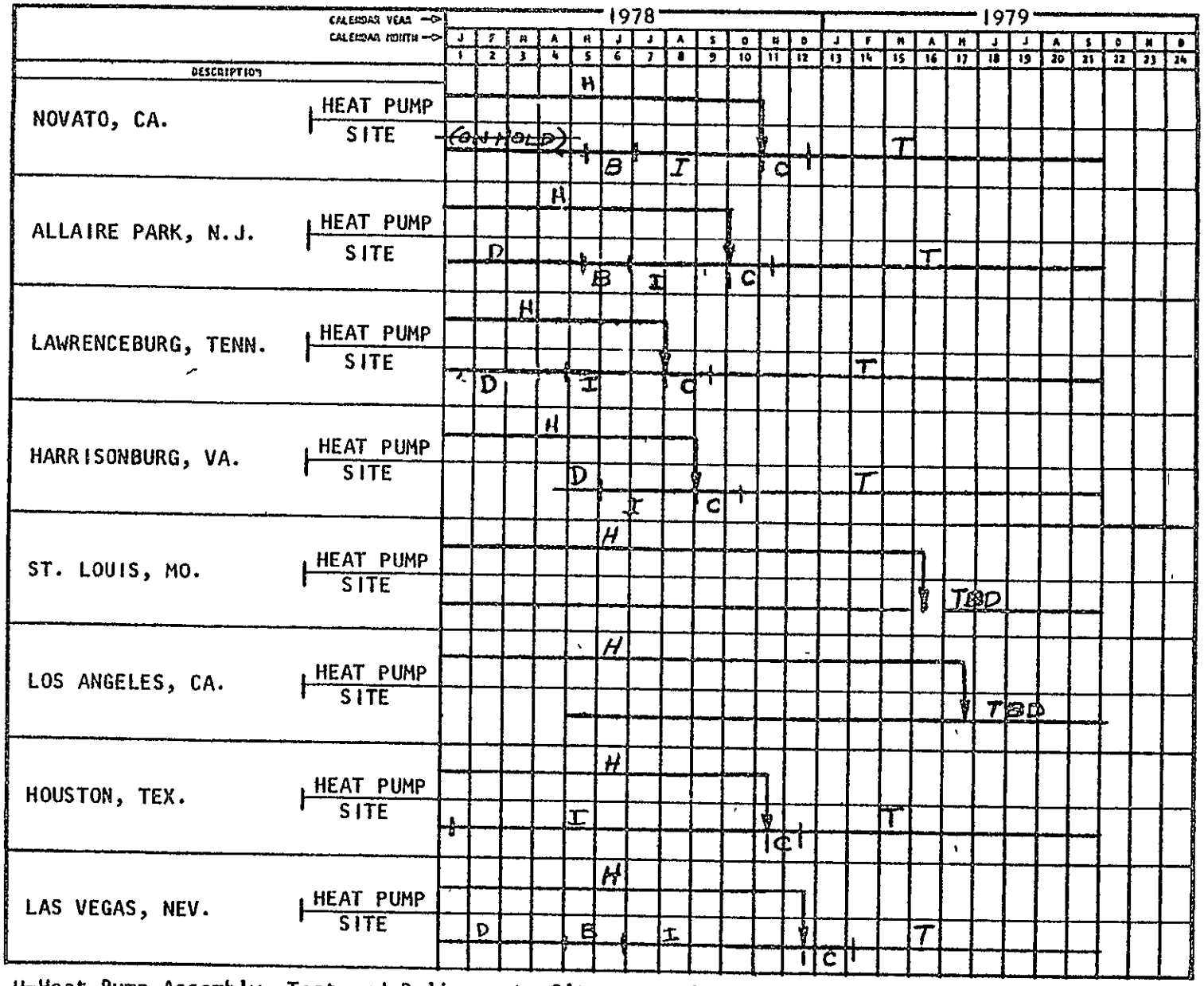
Tests were started on June 23. With the unit in the cooling mode, speed of the compressor was raised to 55,000 rpm. Suction lines were getting cold when a rattling noise started. Slowing the compressor down to about 45,000 rpm reduced the noise. Increasing the speed caused the noise to return. The compressor was removed from the system. No visible abnormalities were found. A dial indicator placed on the end of the shaft revealed no runout.

The second turbocompressor was installed in the machine. The heat pump system was evacuated and charged with 75 lb of R11. It was again run in the cooling mode for about 5 minutes at 45,000 rpm. When the speed was increased to 55,000 rpm, the same noise mentioned previously occurred. When the compressor was slowed down to 45,000 rpm, the noise disappeared but returned when speed was increased to 55,000 rpm. The motor temperature increased, probably because of the low pressure differential and insufficient R11 flow through the motor. At 55,000 rpm, the motor was pulling maximum current. The current limiter was operating, resulting in speed fluctuation of about 100 to 200 rpm. The turbocompressor was shut down and removed for inspection. Again there were no visible signs of damage and the rotor turned freely by hand. Both compressors were returned to AiResearch for analysis. (See Page 8, Section 1a.)

APPENDIX A

SITE STATUS CHARTS (ATTACHMENTS)

Chart	Title
1	Operational Test Site Status
2	Heat Pump Development and Test Schedule (Lawrenceburg, Tenn.)
2a	Heat Pump Development and Test Schedule (Harrisonburg, Va.)
2b	Heat Pump Development and Test Schedule (Allaire State Park, N.J.)
2c	Heat Pump Development and Test Schedule (Novato, Ca.)
2d	Heat Pump Development and Test Schedule (St. Louis, Mo.)
2e	Heat Pump Development and Test Schedule (Los Angeles, Ca.)
2f	Heat Pump Development and Test Schedule (Houston, Tx.)
2g	Heat Pump Development and Test Schedule (Las Vegas, Nev.)
3	Operational Test Site Subsystem Schedule (Allaire State Park, N.J.)
4	Operational Test Site Installation Schedule (Allaire State Park, N.J.)
3a	Operational Test Site Subsystem Schedule (Lawrenceburg, Tenn.)
4a	Operational Test Site Installation Schedule (Lawrenceburg, Tenn.)
3b	Operational Test Site Subsystem Schedule (Harrisonburg, Va.)
4b	Operational Test Site Installation Schedule (Harrisonburg, Va.)
3c	Operational Test Site Subsystem Schedule (Novato, Ca.)
4c	Operational Test Site Installation Schedule (Novato, Ca.)
3d	Operational Test Site Subsystem Schedule (St. Louis, Mo.)
4d	Operational Test Site Installation Schedule (St. Louis, Mo.)
3f	Operational Test Site Subsystem Schedule (Houston, Tx.)
4f	Operational Test Site Installation Schedule (Houston, Tx.)
3g	Operational Test Site Subsystem Schedule (Las Vegas, Nev.)
4g	Operational Test Site Installation Schedule (Las Vegas, Nev.)
5	Heat Pump Delivery Schedule

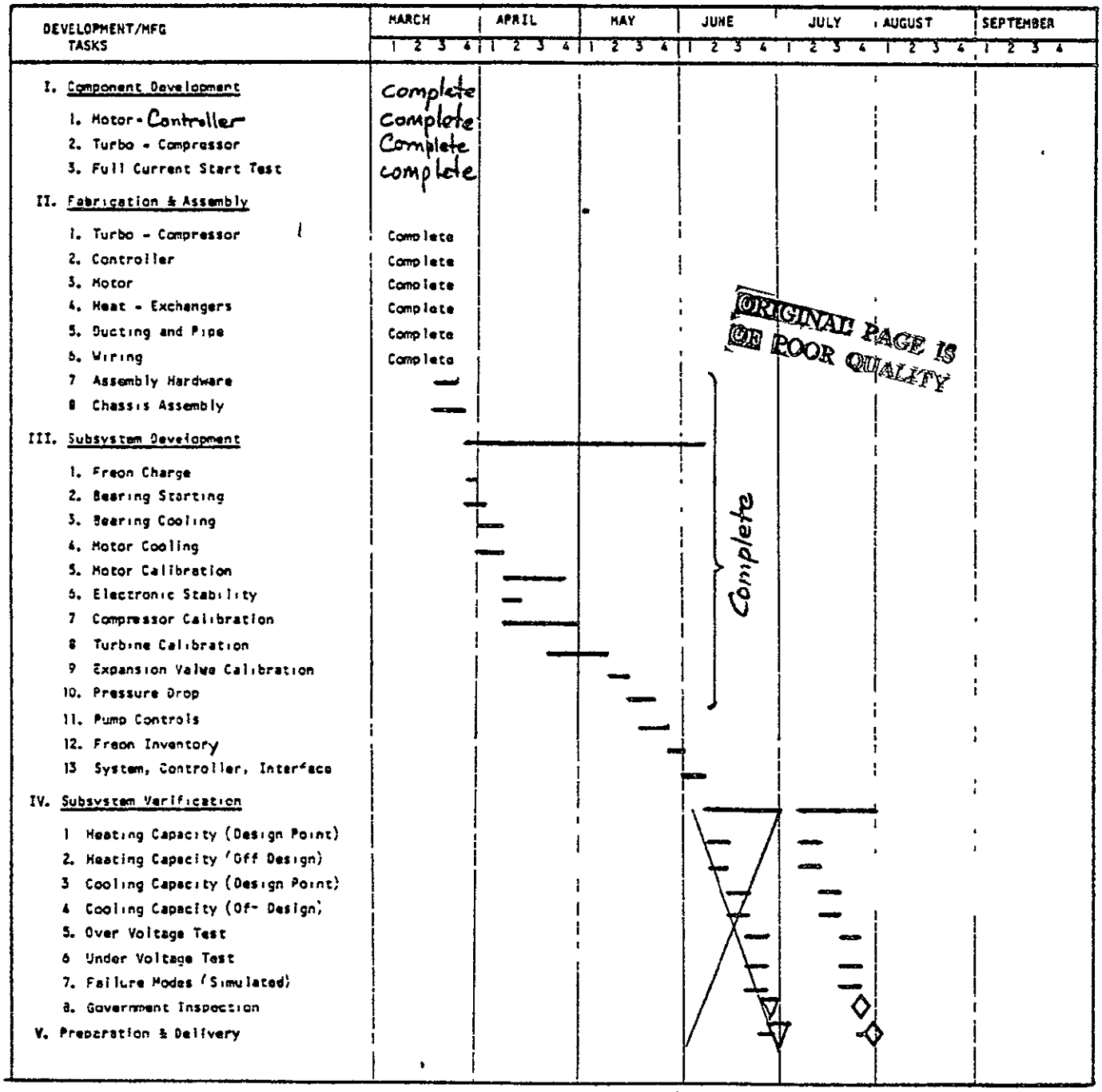


H-Heat Pump Assembly, Test and Delivery to Site
D-System Installation Design
B-System Installation Bids
C-System Installation Checkout
T-System Test Operations
I-System Installation

SOLAR HEATING AND COOLING SYSTEMS OPERATIONAL TEST SITE STATUS

CHART 1
Date: 6-12-78

SOLAR HEATING AND COOLING SYSTEM
HEAT PUMP DEVELOPMENT AND TEST SCHEDULE
UNIT: 3-1 (LAWRENCEBURG)

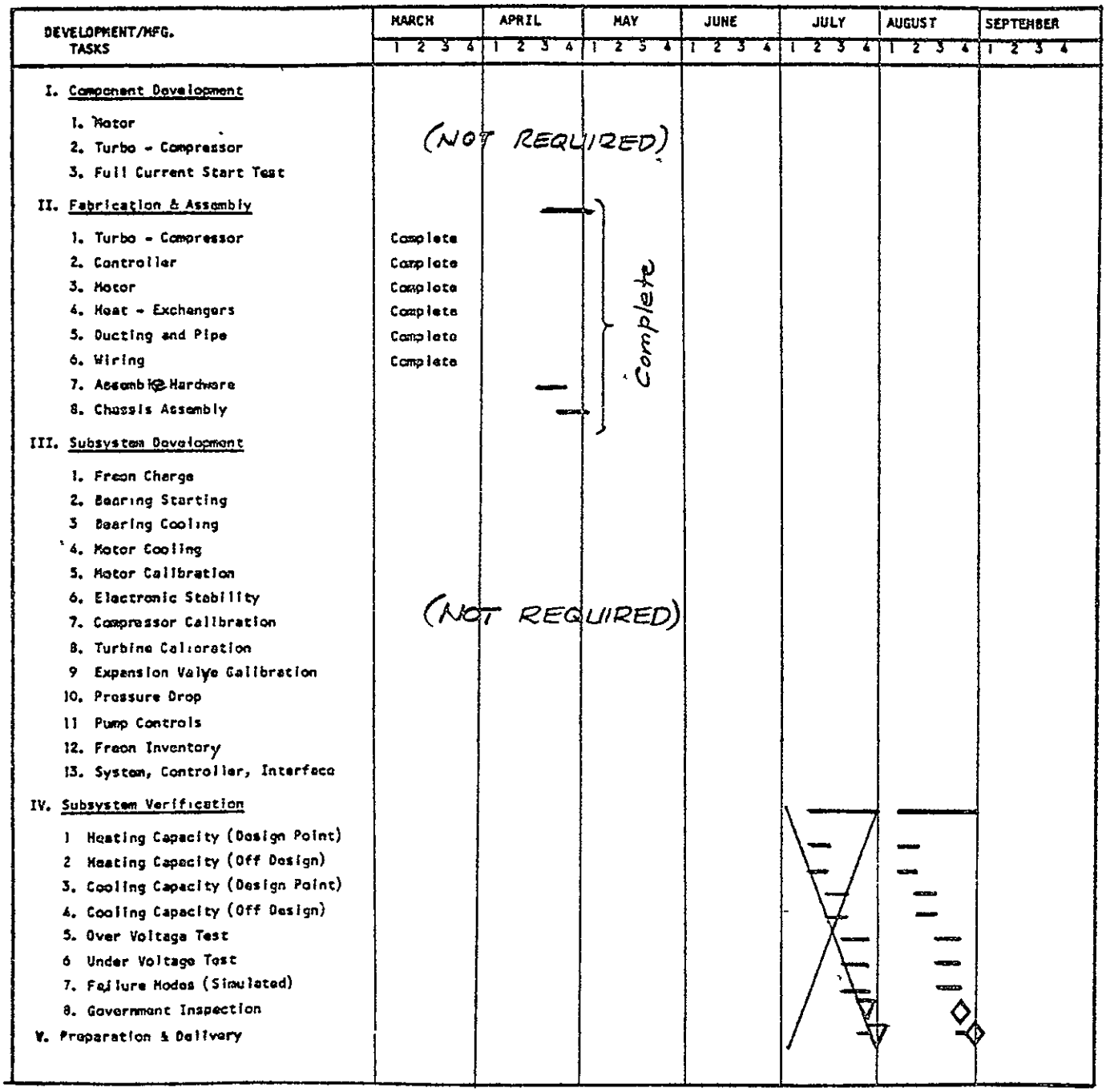


AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

▽ Original milestone
◇ Rescheduled milestone

CHART 2
Date: 6-12-76

SOLAR HEATING AND COOLING SYSTEM
HEAT PUMP DEVELOPMENT AND TEST SCHEDULE
UNIT: 3-2 (HARRISONBURG)

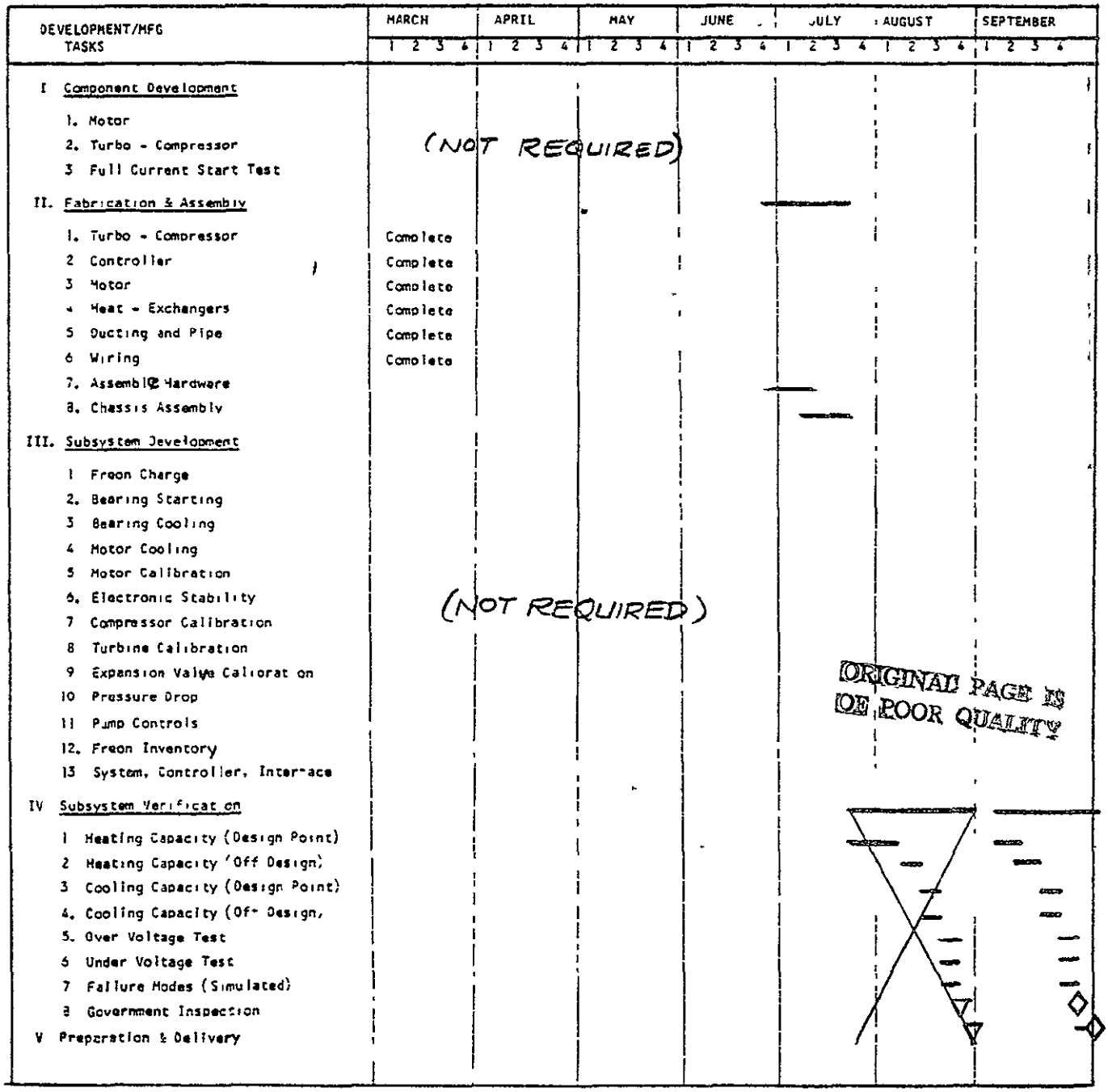


GARRETT AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

▽ Original milestone
◇ Rescheduled milestone

CHART 2a
Date. 6-12-78

SOLAR HEATING AND COOLING SYSTEM
HEAT PUMP DEVELOPMENT AND TEST SCHEDULE
UNIT: 3-3 (ALLAIRE)

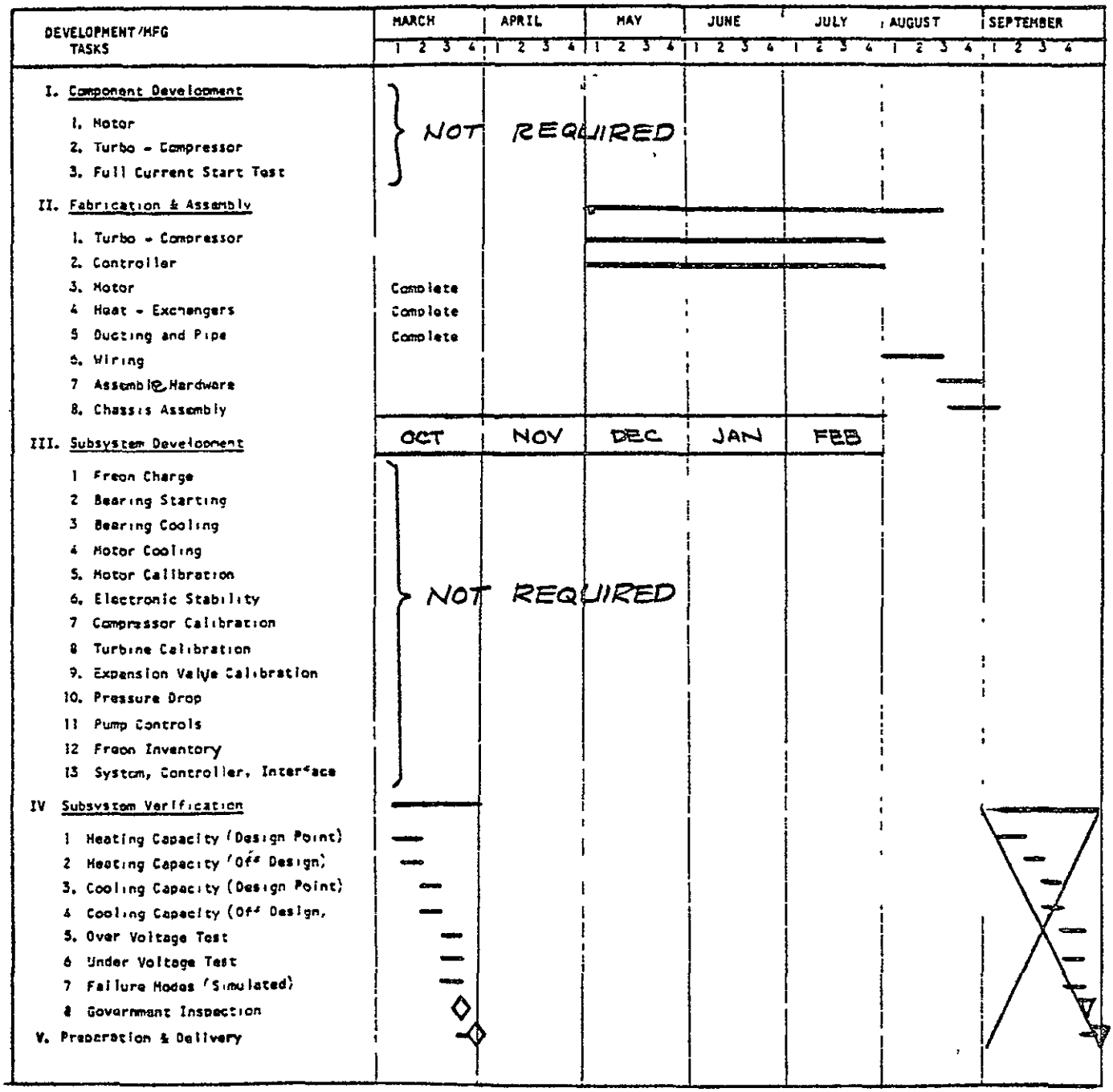


AIRESEARCH MANUFACTURING COMPANY
OF CALIFORNIA

▽ Original milestone
◇ Rescheduled milestone

CHART 2b
Date: 6-12-78

SOLAR HEATING AND COOLING SYSTEM
HEAT PUMP DEVELOPMENT AND TEST SCHEDULE
UNIT: 3-4 (NOVATO)

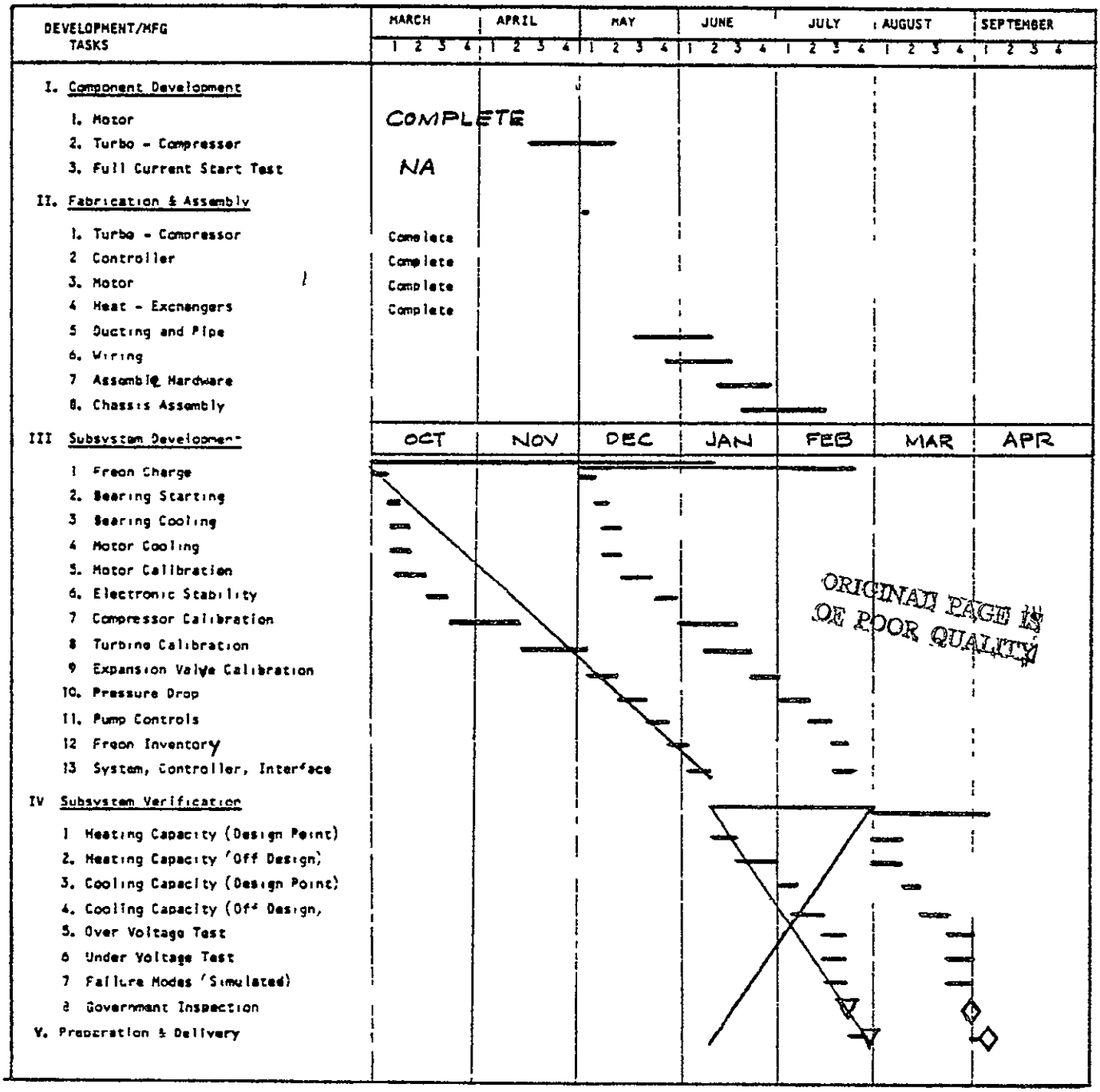


AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

▽ Original milestone
◇ Rescheduled milestone

CHART 2C
Date: 6-12-78

SOLAR HEATING AND COOLING SYSTEM
HEAT PUMP DEVELOPMENT AND TEST SCHEDULE
UNIT: 25-1 (ST. LOUIS)

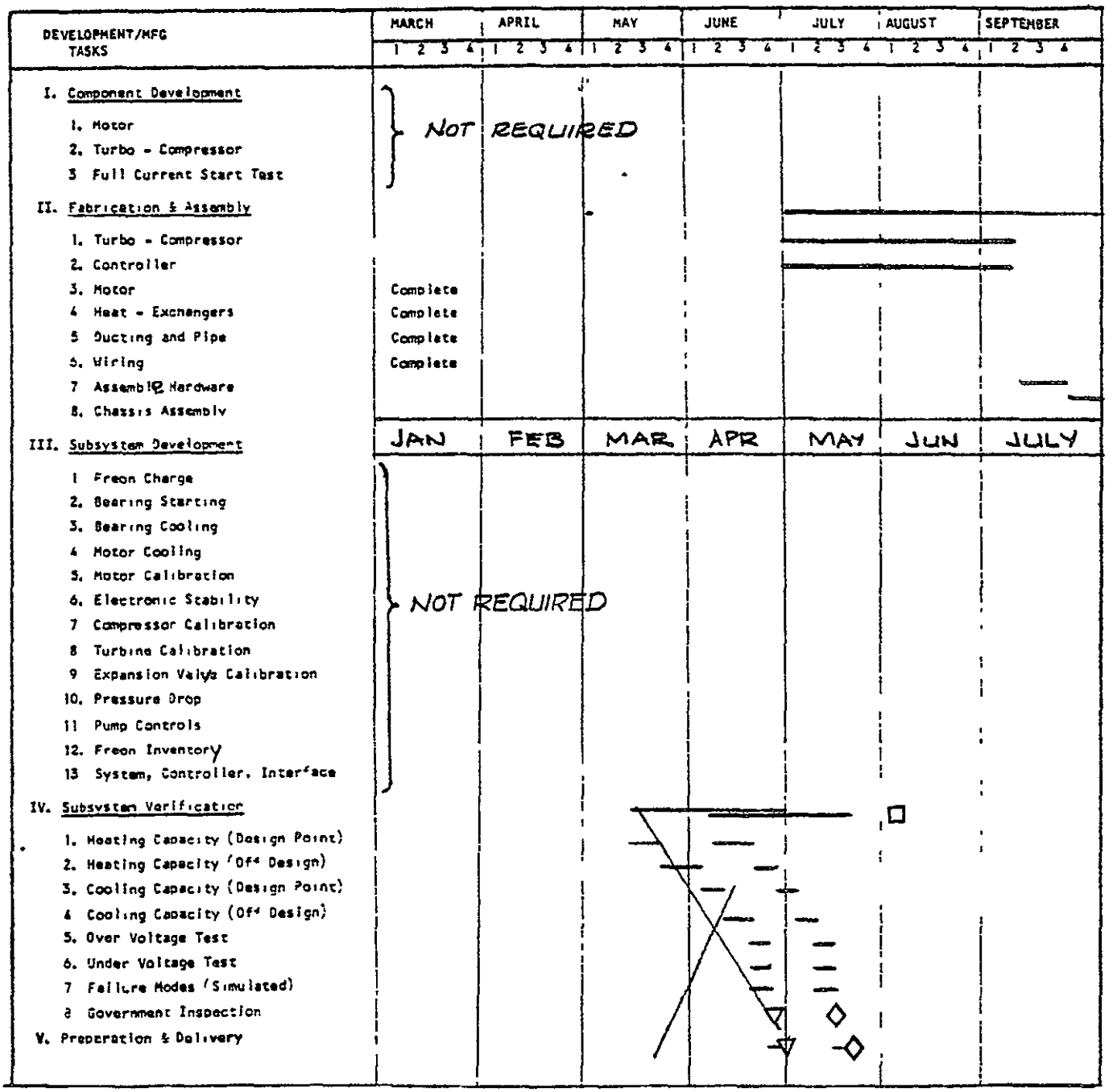


AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

▽ Original milestone
◇ Rescheduled milestone

CHART 2d
Date: 6-12-78

SOLAR HEATING AND COOLING SYSTEM
HEAT PUMP DEVELOPMENT AND TEST SCHEDULE
UNIT: 25-2 (LOS ANGELES)

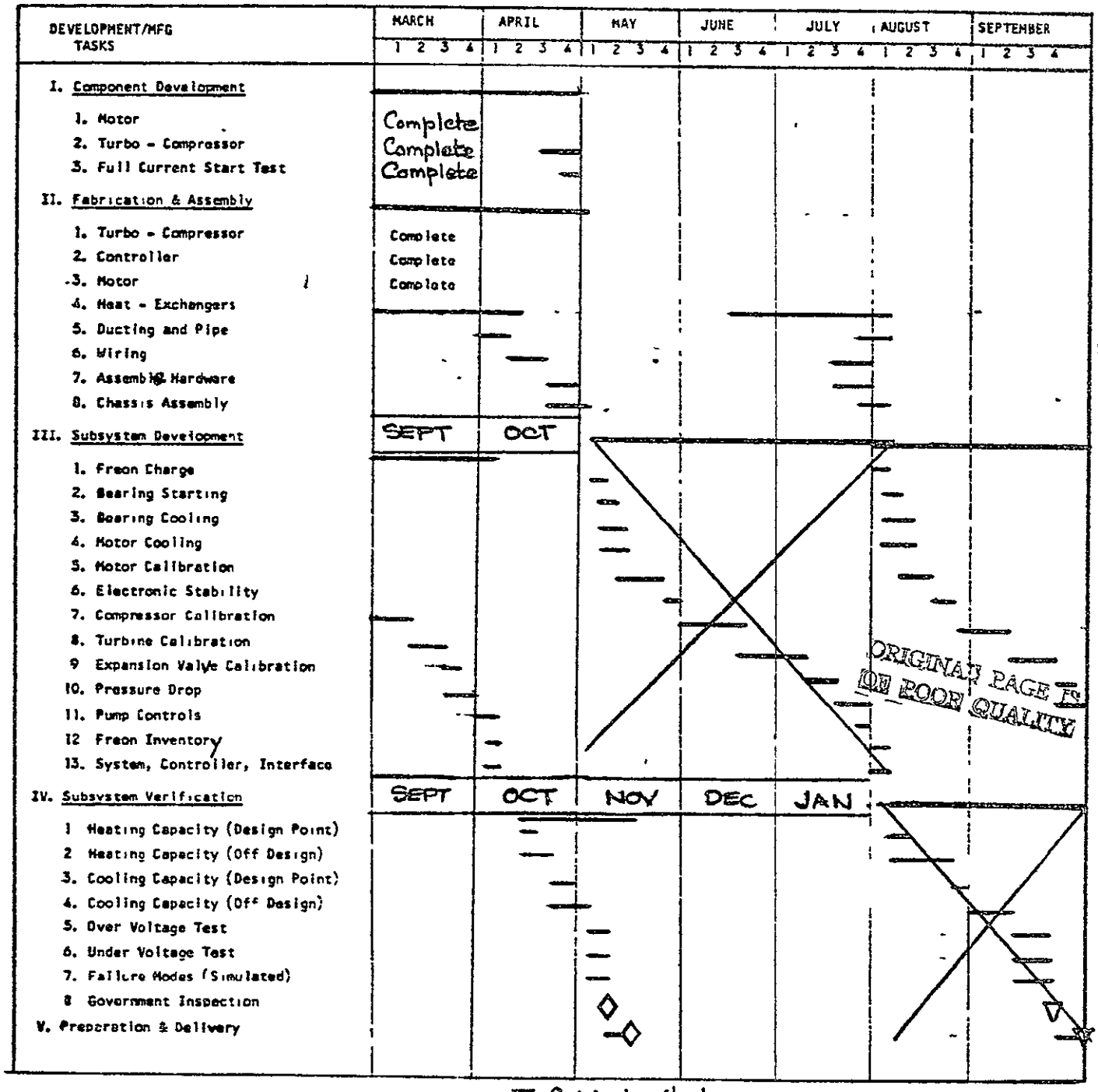


AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

▽ Original milestone
◇ Rescheduled milestone
□ This scheduled may be expedited one month Should the St. Louis unit delivery be delayed by change of site.

CHART 2e
Date. 6-12-78

SOLAR HEATING AND COOLING SYSTEM
HEAT PUMP DEVELOPMENT AND TEST SCHEDULE
UNIT: 75-1 (HOUSTON)

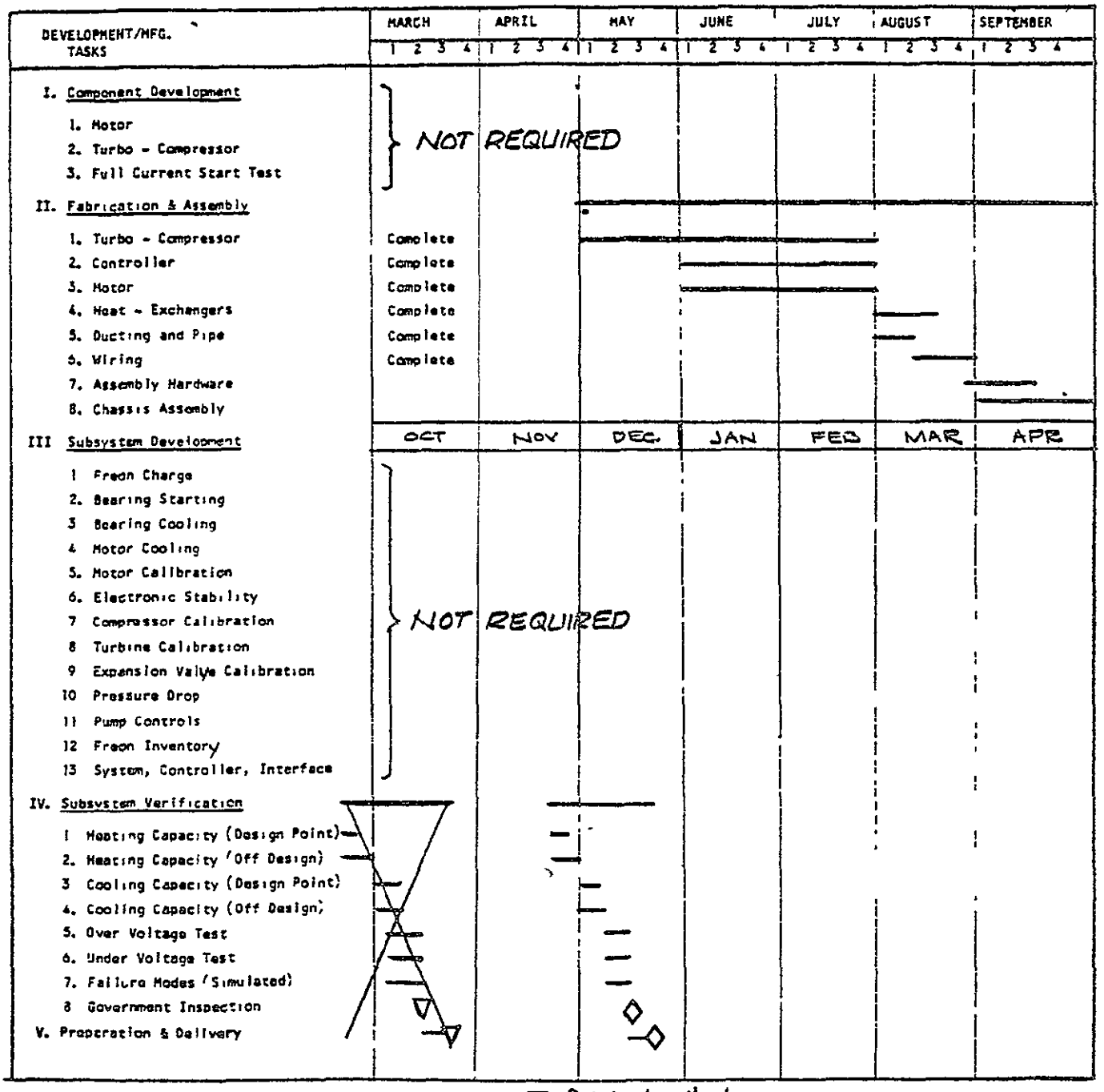


AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

▽ Original milestone
◇ Rescheduled milestone

CHART 2B
Date: 6-12-78

SOLAR HEATING AND COOLING SYSTEM
HEAT PUMP DEVELOPMENT AND TEST SCHEDULE
UNIT: 75-2 (LAS VEGAS)



AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

▽ Original milestone
◇ Rescheduled milestone

CHART 29
Date. 6-12-78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE SUBSYSTEM SCHEDULE

SITE ALLAIRE STATE PARK, NJ

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SUBSYSTEM												
• Heat Pump (See Chart 1)									△	◇		
• Collector S/S												
1 Develop Reqmts.	COMPLETE				1	◇						
2 Delivery												
• Storage S/S												
1. Develop Specs.	COMPLETE											
2. Procure							△		◇•			
3. Delivery												
• Data S/S												
1. Develop ISPI 12/16/77 ←												
2. Review & Approve					HHH		△					
3. Procure	(NASA)											
4. Delivery	(NASA)							◇				
• System Controller S/S												
1. Manufacture	COMPLETE											
2. Ship to D/B							△					
3. Delivery									△	◇		
• DHW - Preheater												
1. Develop Specs	COMPLETE											
2. Procure									◇•			
3 Delivery							△					
OTHER MAJOR COMPONENTS												
• Cooling Tower												
1 Develop Specs	COMPLETE											
2 Procure									◇•			
3. Delivery							△					
• Auxiliary Heater												
1 Develop Specs	COMPLETE											
2. Procure												
3 Deliver							△		◇•			

△ Original milestone ◇ Rescheduled milestone • General contractor procured item

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 3
Date 6-12-78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE INSTALLATION SCHEDULE

SITE ALLAIRE STATE PARK, N.J

INSTALLATION/OPERATION TASKS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BLDG. CONSTRUCTION/MOD												
1. Design	COMPLETE											
a. System Req. Inputs	COMPLETE											
b. Design Reviews	?											
2 Construction												
a. Collector Interface					△							
b Backup Syst. Interface						△						
c. Other Equip Interface						△						
SOLAR SYSTEM INSTALLATION												
1. A&E Selection	COMPLETE											
2 Sys Installation Design	COMPLETE											
3 Select Contractor					△	◇						
4 Install Collector S/S												
5. Install Storage S/S												
6. Install DHW Preheat S/S												
7 Install Data S/S												
8 Install Sys Control S/S												
9. Install Heat Pump S/S												
SYSTEM CHECKOUT												
1. Leakage Test												
2. Balance Collector Field												
3. Wiring C/O and Test												
4. Functional Test All Modes												
5. Instrumentation Verification												
6 System Turn-On										△	◇	
7. System Acceptance Tests												
OPERATIONAL TESTING												
1. Data Acquisition												
2. Schedule Maintenance	TBD											
3. Performance Reports											⊗	△

△ Original milestone ◇ Rescheduled milestone

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 4
Date 6-12-78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE SUBSYSTEM SCHEDULE

SITE LAWRENCEBURG, TENN.

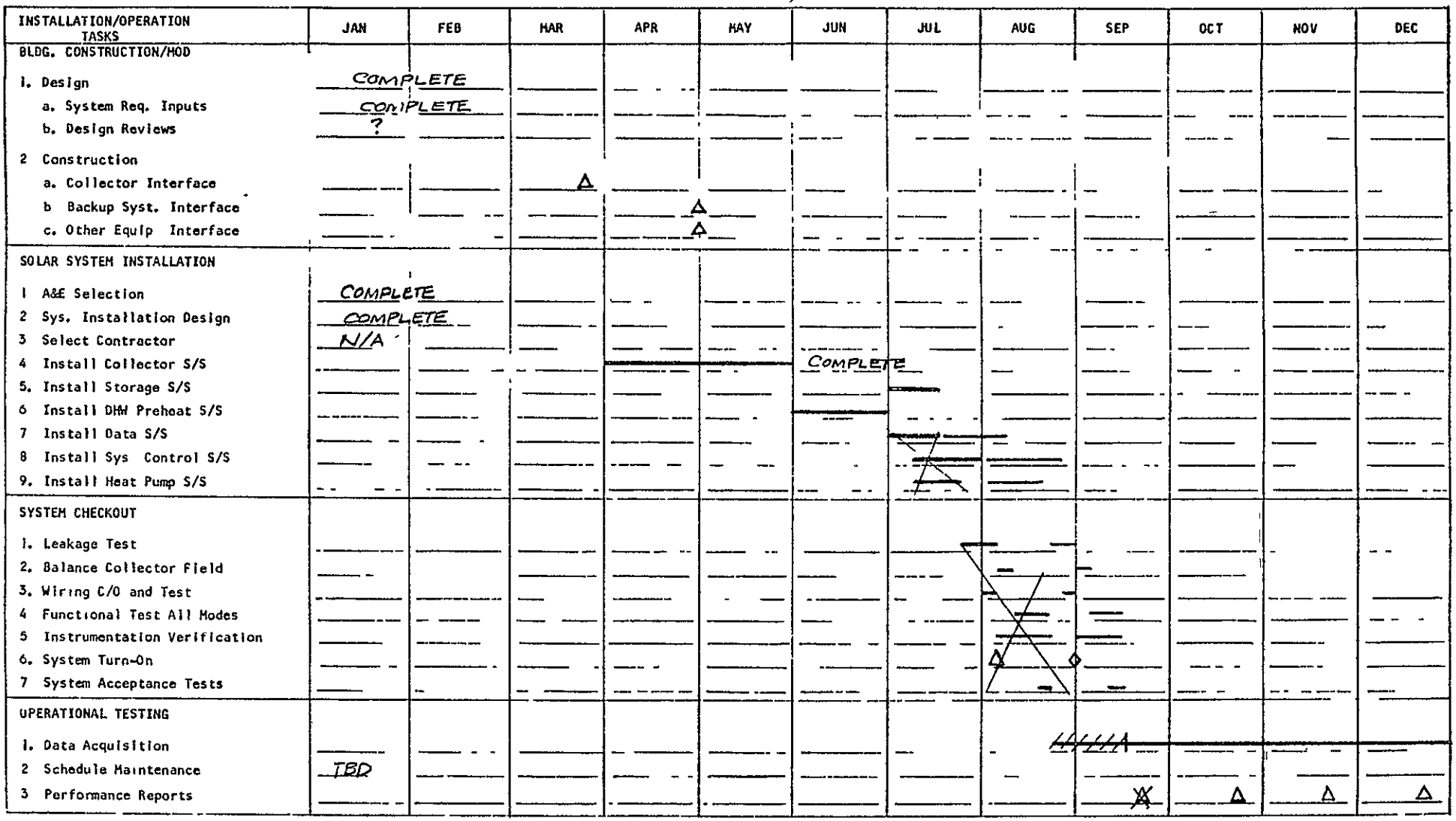
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SUBSYSTEM												
• Heat Pump (See Chart 1)							△	◇				
• Collector S/S												
1 Develop Reqmts	COMPLETE											
2 Delivery			△									
• Storage S/S												
1. Develop Specs.	COMPLETE											
2. Procure												
3. Delivery							△					
• Data S/S												
1. Develop ISPI												
2 Review & Approve					4/1	△						
3. Procure	(NASA)											
4. Delivery	(NASA)						◇					
• System Controller S/S												
1. Manufacture	COMPLETE											
2 Ship to D/B	N/A											
3. Delivery							△	◇				
• DHW - Preheater												
1 Develop Specs	COMPLETE											
2 Procure						•						
3 Delivery						△						
OTHER MAJOR COMPONENTS												
• Cooling Tower												
1 Develop Specs	COMPLETE											
2 Procure						•						
3 Delivery						△						
• Auxiliary Heater												
1. Develop Specs	N/A											
2. Procure	N/A											
3 Deliver	N/A											

△ Original Milestone ◇ Rescheduled milestone • General contractor procured item

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 3a
Date 6-12-78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE INSTALLATION SCHEDULE
SITE LAWRENCEVILLE, TENN.



△ Original milestone ◇ Rescheduled milestone

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 4a
Date 6-12-76

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE SUBSYSTEM SCHEDULE

SITE HARRISONBURG, VA

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SUBSYSTEM												
• Heat Pump (See Chart 1)								△	◇			
• Collector S/S												
1 Develop Reqmts	COMPLETE											
2 Delivery				△								
• Storage S/S												
1 Develop Specs.	COMPLETE											
2 Procure												
3. Delivery						△	◇					
• Data S/S												
1 Develop ISPI												
2. Review & Approve							△					
3. Procure	(NASA)											
4. Delivery	(NASA)						◇					
• System Controller S/S												
1 Manufacture	COMPLETE											
2. Ship to D/B						△						
3 Delivery						◇			◇			
• DHW - Preheater												
1. Develop Specs	COMPLETE						N/A					
2 Procure							N/A					
3 Delivery						△	N/A					
OTHER MAJOR COMPONENTS												
• Cooling Tower												
1 Develop Specs	COMPLETE											
2. Procure												
3. Delivery					△		◇					
• Auxiliary Heater												
1 Develop Specs	N/A											
2. Procure	N/A											
3. Deliver	N/A											

△ Original milestone ◇ Rescheduled milestone

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 3b
Date 5-4-78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE INSTALLATION SCHEDULE
SITE HARRISONBURG, VA

INSTALLATION/OPERATION TASKS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BLDG CONSTRUCTION/MOD												
1. Design	COMPLETE											
a. System Req. Inputs	COMPLETE											
b. Design Reviews	?											
2. Construction												
a. Collector Interface				△								
b. Backup Syst. Interface						△	◇					
c. Other Equip. Interface						△	◇					
SOLAR SYSTEM INSTALLATION												
1. A&E Selection	COMPLETE											
2. Sys. Installation Design	COMPLETE											
3. Select Contractor	N/A											
4. Install Collector S/S												
5 Install Storage S/S												
6. Install DHW Preheat S/S						N/A						
7. Install Data S/S												
8 Install Sys. Control S/S												
9. Install Heat Pump S/S												
SYSTEM CHECKOUT												
1. Leakage Test												
2. Balance Collector Field												
3 Wiring C/O and Test												
4. Functional Test All Modes												
5 Instrumentation Verification												
6. System Turn-On									△	◇		
7 System Acceptance Tests												
OPERATIONAL TESTING												
1. Data Acquisition												
2. Schedule Maintenance	TBD									X	△	△
3 Performance Reports												

△ Original Milestone ◇ Rescheduled Milestone

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 46
Date 5-4-78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE SUBSYSTEM SCHEDULE

SITE NOVATO, CALIF.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SUBSYSTEM												
• Heat Pump (See Chart 1)										△	◇	
• Collector S/S												
1. Develop Reqmts.	COMPLETE											
2. Delivery						△		◇				
• Storage S/S												
1. Develop Specs												
2. Procure												
3. Delivery							△		◇			
• Data S/S												
1. Develop ISPI												
2. Review & Approve								◇	△			
3. Procure	(NASA)											
4. Delivery	(NASA)								◇			
• System Controller S/S												
1 Manufacture												
2. Ship to D/B	N/A											
3. Delivery										△	◇	
• DHW - Preheater												
1 Develop Specs	COMPLETE											
2 Procure												
3 Delivery						△		◇				
OTHER MAJOR COMPONENTS												
• Cooling Tower												
1 Develop Specs	N/A											
2. Procure	N/A											
3. Delivery	N/A											
• Auxiliary Heater												
1 Develop Specs	(NASA)											
2. Procure	(NASA)											
3. Deliver						△		◇				

△ Original Milestone ◇ Rescheduled Milestone • General contractor procured item

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 3C
Date 6-18-76

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE INSTALLATION SCHEDULE

SITE NOVATO, CALIF

INSTALLATION/OPERATION TASKS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BLDG. CONSTRUCTION/MOD												
1. Design	~~COMPLETE~~											
a. System Req. Inputs	~~COMPLETE~~					△ ◇						
b. Design Reviews	(NASA)						◇					
2. Construction												
a Collector Interface									◇			
b. Backup Syst Interface							△		◇			
c. Other Equip Interface								△	◇			
SOLAR SYSTEM INSTALLATION												
1 A&E Selection					△	◇						
2 Sys. Installation Design							△		◇			
3, Select Contractor								△	◇			
4. Install Collector S/S												
5. Install Storage S/S												
6. Install D&W Preheat S/S												
7. Install Data S/S												
8. Install Sys. Control S/S												
9. Install Heat Pump S/S												
SYSTEM CHECKOUT												
1 Leakage Test												
2. Balance Collector Field												
3 Wiring C/O and Test												
4. Functional Test All Modes												
5 Instrumentation Verification												
6 System Turn-On												◇
7. System Acceptance Tests												
OPERATIONAL TESTING												
1 Data Acquisition												
2 Schedule Maintenance	TBD											
3 Performance Reports												1/22 → △

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 4C
Date 6-12-78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE SUBSYSTEM SCHEDULE

SITE St. Louis, Mo.

1979 → | 1978 →

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SUBSYSTEM												
• Heat Pump (See Chart 1)			△									
• Collector S/S												
1. Develop Reqmts							COMPLETE					
2 Delivery								△				
• Storage S/S												
1 Develop Specs												
2. Procure												
3 Delivery										△		
• Data S/S												
1 Develop ISPI												
2 Review & Approve												
3. Procure							NASA					
4. Delivery							NASA					
• System Controller S/S												
1. Manufacture												
2 Ship to D/B	N/A											
3. Delivery			△									
• DHW - Preheater												
1 Develop Specs												
2 Procure												
3 Delivery								△				
OTHER MAJOR COMPONENTS												
• Cooling Tower												
1 Develop Specs							COMPLETE					
2. Procure												
3. Delivery								△				
• Auxiliary Heater												
1 Develop Specs	N/A											
2. Procure	N/A											
3. Deliver	N/A											

SCHEDULE SHOWN MAY BECOME OBSOLETE IF THIS SITE IS RELOCATED

ORIGINAL PAGE IS OF POOR QUALITY

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 3d
Date 6-12-78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE INSTALLATION SCHEDULE

SITE St Louis, Mo

1979 → 1978 →

INSTALLATION/OPERATION TASKS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BLDG. CONSTRUCTION/MOD												
1. Design							COMPLETE					
a System Req Inputs							COMPLETE					
b. Design Reviews							(NASA)					
2. Construction												
a. Collector Interface												
b. Backup Syst. Interface							N/A					
c. Other Equip. Interface							N/A					
SOLAR SYSTEM INSTALLATION												
1. A&E Selection							N/A					
2. Sys Installation Design							COMPLETE					
3, Select Contractor												
4. Install Collector S/S												
5. Install Storage S/S												
6. Install DHW Preheat S/S							N/A					
7. Install Data S/S												
8 Install Sys. Control S/S												
9. Install Heat Pump S/S												
SYSTEM CHECKOUT												
1 Leakage Test												
2 Balance Collector Field												
3. Wiring C/O and Test												
4 Functional Test All Modes												
5. Instrumentation Verification												
6. System Turn-On												
7 System Acceptance Tests												
OPERATIONAL TESTING												
1. Data Acquisition												
2 Schedule Maintenance	TBD											
3. Performance Reports					Δ	Δ						

SCHEDULE SHOWN MAY BECOME OBSOLETE IF THIS SITE IS RELOCATED

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AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 4d
Date 6-12-78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE SUBSYSTEM SCHEDULE

SITE HOUSTON, TEX

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SUBSYSTEM												
• Heat Pump (See Chart 1)										△	◇	
• Collector S/S												
1 Develop Reqmts	COMPLETE					△ ◇						
2 Delivery												
• Storage S/S												
1. Develop Specs.	COMPLETE											
2. Procure												
3 Delivery						△						
• Data S/S												
1 Develop ISPI (11-15-77)												
2 Review & Approve												
3. Procure	(NASA)											
4. Delivery	(NASA)					◇						
• System Controller S/S												
1 Manufacture	COMPLETE											
2 Ship to D/B	N/A											
3. Delivery										△	◇	
• DHW - Preheater												
1 Develop Specs												
2 Procure												
3. Delivery								△				
OTHER MAJOR COMPONENTS												
• Cooling Tower												
1 Develop Specs	N/A											
2. Procure	N/A											
3. Delivery	N/A											
• Auxiliary Heater												
1. Develop Specs	N/A											
2 Procure	N/A											
3 Deliver	N/A											

△ Original milestone ◇ Rescheduled milestone

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 3f
Date 6/12/78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE INSTALLATION SCHEDULE

SITE Houston, Tex

INSTALLATION/OPERATION TASKS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BLDG. CONSTRUCTION/MOD												
1. Design	COMPLETE											
a. System Req. Inputs	COMPLETE											
b. Design Reviews	(NASA)											
2. Construction												
a. Collector Interface						△	◇					
b. Backup Syst. Interface	N/A											
c. Other Equip. Interface	N/A											
SOLAR SYSTEM INSTALLATION												
1. A&E Selection	N/A											
2 Sys. Installation Design	COMPLETE □											
3. Select Contractor	COMPLETE											
4. Install Collector S/S												
5. Install Storage S/S												
6. Install DHW Preheat S/S												
7 Install Data S/S												
8. Install Sys Control S/S												
9. Install Heat Pump S/S												
SYSTEM CHECKOUT												
1. Leakage Test												
2 Balance Collector Field												
3. Wiring C/O and Test												
4. Functional Test All Modes												
5. Instrumentation Verification												
6 System Turn-On										△	◇	
7 System Acceptance Tests												
OPERATIONAL TESTING												
1. Data Acquisition												
2. Schedule Maintenance	TBD											
3. Performance Reports (MONTHLY)												△→1/85

△ Original milestone ◇ Rescheduled milestone □ Except for Instrumentation

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 4f
Date 6/12/78

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SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE SUBSYSTEM SCHEDULE

SITE LAS VEGAS, NEV

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SUBSYSTEM												
• Heat Pump (See Chart 1)											△	◇
• Collector S/S												
1. Develop Reqmts	COMPLETE											
2. Delivery						△		◇				
• Storage S/S												
1. Develop Specs.	COMPLETE											
2. Procure												
3 Delivery						△				◇		
• Data S/S												
1. Develop ISPI (12-12-77)												
2 Review & Approve												
3. Procure	(NASA)											
4. Delivery	(NASA)						◇					
• System Controller S/S												
1. Manufacture												
2. Ship to D/B	N/A										△	◇
3. Delivery												
• DHW - Preheater												
1. Develop Specs	COMPLETE											
2. Procure												
3. Delivery						△				◇	•	
OTHER MAJOR COMPONENTS												
• Cooling Tower												
1 Develop Specs	COMPLETE											
2. Procure												
3. Delivery							△			◇	•	
• Auxiliary Heater												
1. Develop Specs	N/A											
2. Procure	N/A											
3. Deliver	N/A											

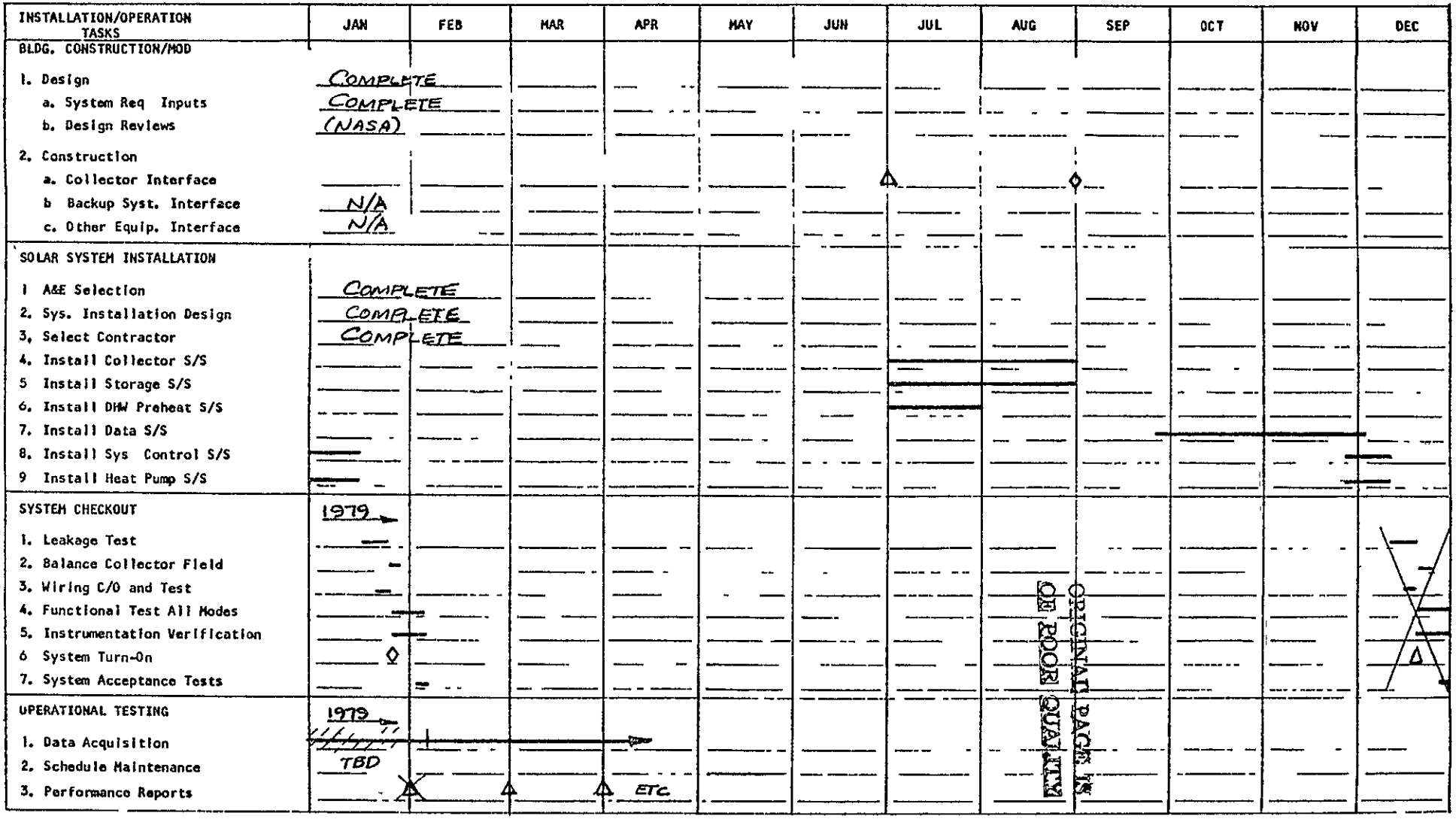
△ Original Milestone ◇ Rescheduled Milestone • General contractor procured item

AMES RESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 39
Date 6/12/78

SOLAR HEATING AND COOLING SUBSYSTEMS
OPERATIONAL TEST SITE INSTALLATION SCHEDULE

SITE LAS VEGAS, NEV.



△ Original milestone ◇ Rescheduled Milestone

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA

Chart 49
Date 6/12/78

Size	Unit	Turbocompressor	Motor Control	Freon Pump	Heat Pump Complete	Start Test	Test Time, Weeks	Test Complete	Ship Date	Intended Site
3 Ton	#1	Returned	Returned	Returned	Complete	7-13**	4	8-10	8-17	Lawrenceburg, TN
	#2	7-20	7-20	7-20	7-28	7-31	4	8-25	8-31	Harrisonburg, VA
	#3	7-27	7-27	7-27	8-4	8-28	4	9-25	10-2	Allaire Park, N.J.
	#4	8-15	8-15	8-15	9-15	9-25	4	10-25	11-1	Novato, CA
25 Ton	#1	Shipped	Shipped	Shipped	7-28	12-15*	14	3-30	4-7	St. Louis, MO
	#2	8-1	9-1	8-1	10-1	3-30	6	5-15	5-22	Los Angeles, CA
75 Ton	#1	Shipped	7-20	Rec.	7-24	7-24	6	8-31	9-9	Houston, TX
	#2	7-28	7-28	Rec.	9-5	9-5	13	12-5	12-12	Las Vegas, NV

*Testing of the 25-ton system will start earlier if a break occurs in the 75-ton system testing.

**At AiResearch

Heat Pump Delivery Schedule

CHART 5
Date: 7-18-78