ET 21007 f-2

DOE/ET/21007--T5

MASTER

10-MWe SOLAR-THERMAL CENTRAL-RECEIVER PILOT PLANT

MARTIN MARIETTA CORPORATION

PHASE II PLANNING

AC03-79ET21007

AUGUST 1979

DOCUMENT NUMBER: 400500 6P

APPROVAL:

P R Brown

Paul R. Brown
Program Manager
Collector Systems

DISCLAIMER

FOREWORD

This document is submitted in response to the requirements of DOE Contract No. DE-AC03-79ET21007 dated 9/5/78, Collector Subsystem Statement of Work, Phase I Task C.2.

TABLE OF CONTENTS

		PAGE
1.0	INTRODUCTION	1
1.1	Scope	1
1.2	Purpose	1
2.0	APPLICABLE DOCUMENTS	1
3.0	MIRROR MANUFACTURING AT PUEBLO, COLORADO	2
3.1	Mirror Assembly Production Flow	3
3.2	Mirror Assembly Production and Training Schedule	8
4.0	HELIOSTAT ASSEMBLY AND INSTALLATION	9
4.1	Component Planning and Training Activities	9
4.2	Heliostat Assembly Schedule	11
4.3	Heliostat Installation and Checkout Schedule	15
4.4	Tool Schedule	15

Tables

3-1	Mirror Module Tooling	8
4-1	Component Delivery Schedule to Assembly Building	10
4-2	Heliostat Assembly and Installation Schedule	14
4-3	Phase II Assembly and Installation Tools	18

Figures

3-1	Mirror Assembly Plant Layout	4
3-2	Mirror Assembly Fabrication Plan	5
4-1	Assembly Building Operations	12
4-2	Reflective Assembly Sequence	13
4-3	Field Site Installation Operations	16
4-4	Field Installation Sequence	17

1.0 INTRODUCTION

1.1 Scope

This Phase II planning document presents the various considerations related to the Phase II schedules, material control and personnel training required to effectively implement the program.

1.2 Purpose

This document has been prepared to identify the flow charts and schedules required to accomplish fabrication, installation, check-out, and personnel training to support the Pilot Plant schedule. The planning addresses receiving, storage and shipment of raw materials, subassemblies, component, subsystems, and complete assemblies. The vendor activities and the major Martin Marietta facilities are included. These are the Mirror Assembly activities at Pueblo, Colorado and the heliostat assembly and installation activities at the Barstow-Daggett Airport and the solar plant.

2.0 APPLICABLE DOCUMENTS

2.1 The following documents, of the latest issue, form part of this document to the extent specified herein.

2.1.1 Government Documents

DE-AC03-79ET21007 DOE Contract, "10 MWe Solar Thermal Central Receiver Pilot Plant-Collector Subsystem.

2.1.2 Martin Marietta Documents

Plans:

400500 2P Phase II Manufacturing Plan
400500 4P Phase II Operating and Maintenance Equipment
400500 5P Phase II Acceptance Plan

Heliostat Drawings

40E5005132736 Electronics Installation
40M5005132720 Heliostat Assembly
40M5005132730 Reflective Assembly
40M5005132732 Rack Assembly
40M5005132725 Pedestal Assembly
40M5005132721 Drive Mechanism Assembly
40M5005132723 Control Arm
40M5005132724 Drive-Pedestal Interface Adapter
40M5005132731 Heliostat Mirror Assembly

Tooling Drawings

40M5005132761 Canting Tool
40M5005132764 Rack/Reflective Assembly Fixture/Dolly
40M5005132767 Mirror Assembly-Dolly
40M5005132762 Drive Mechanism Assembly Fixture
40M5005132768 Reflective Assembly Handling Sling
40M5005132763 Drive Mechanism Lifting Device
40M5005132777 Transporter Rack-Drive Units
40M5005132773 Transporter Rack-Reflective Assembly
40E5005132778 Drive Motor-Direct Drive Control Box
40E5005132XXX Checkout Console-Drive Unit
40E5005132XXX Encoder Zero Set Indicator
40E5005132779 Lifting Adapter-Pedestal
40M5005132766 Adapter Plate - Talyvel
40M5005132771 Field Canting Tool
40E5005132775 HC/HFC Stimulator
40E5005132774 Manual Control Box
40M5005132772 Protective Cover - Mirror
40M50051327XX Encoder Bias Measurement System

Manufacturing Procedures and Instructions

40M5002M Assembly Canting Procedure
40M5001I Heliostat Installation Instructions
40M500XX Rack Assembly Procedure (TBS)
40M500XX Reflective Assembly Procedure (TBS)
40M500XX Mirror Assembly Procedure (TBS)
40M500XX Drive Mechanism Assembly (TBS)
40M500XX Reflective Assembly Cleaning and Loading Procedure (TBS)

3.0 MIRROR MANUFACTURING AT PUEBLO, COLORADO

The Phase II mirror assembly will be fabricated in a dedicated mirror assembly plant. This plant will be located at the Pueblo Army Depot,12 miles east of Pueblo, Colorado. This location was

selected to both aid in national economics and full employment and to provide the most cost effective mirror production. The aid to national economics is achieved by providing employment in an area that became employment distressed due to cutbacks at the Pueblo Army Depot. The cost effectivity of this location will be achieved by: (1) off-site overhead rates; (2) availability of semiskilled labor at reasonable rates; (3) low facility lease and operating costs; and (4) close proximity to the Denver Division, which provides a base for management control, facility, tooling, and technical support. This location requires a significant transportation effort. However, the benefits and savings far outweigh the transportation costs.

The mirror assembly manufacturing building is well suited to this activity. The building was originally designed as a manufacturing facility for missiles, and thus incorporates many manufacturing capabilities required for mirror assembly manufacturing. This reduces the facility setup and tear down costs. A layout of the mirror assembly plant is shown in Figure 3-1.

3.1 Mirror Assembly Production Flow

Mirror assemblies will be fabricated during Phase II in essentially the same manner as was done for Phase I except high volume tooling will be used. Figure 3-2 shows the production flow. Briefly summarized, the process consists of the following:

(1) Material receiving and inspection - This task provides the material control to ensure smooth material flow into production. Inspection will be limited to verifying quantities and entering material into inventory control. A full time warehouseman will be used to provide inventory control for all raw materials and to assure proper material flow of limited life components. The storage locations for the major components (mirror, steel, and honeycomb core) are shown on the facility floor plan Figure 3-1.

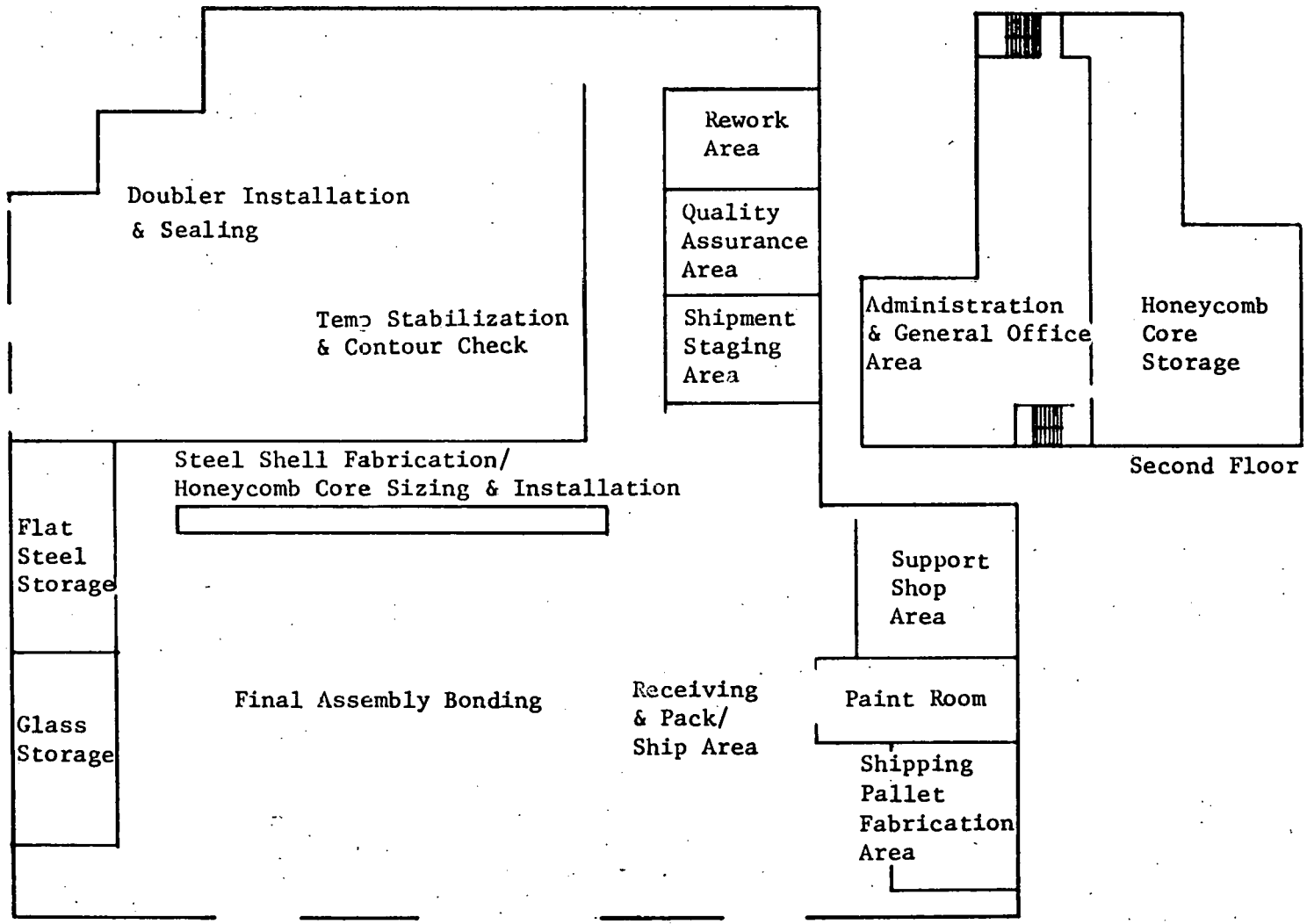


Figure 3-1 Mirror Assembly Plant Layout

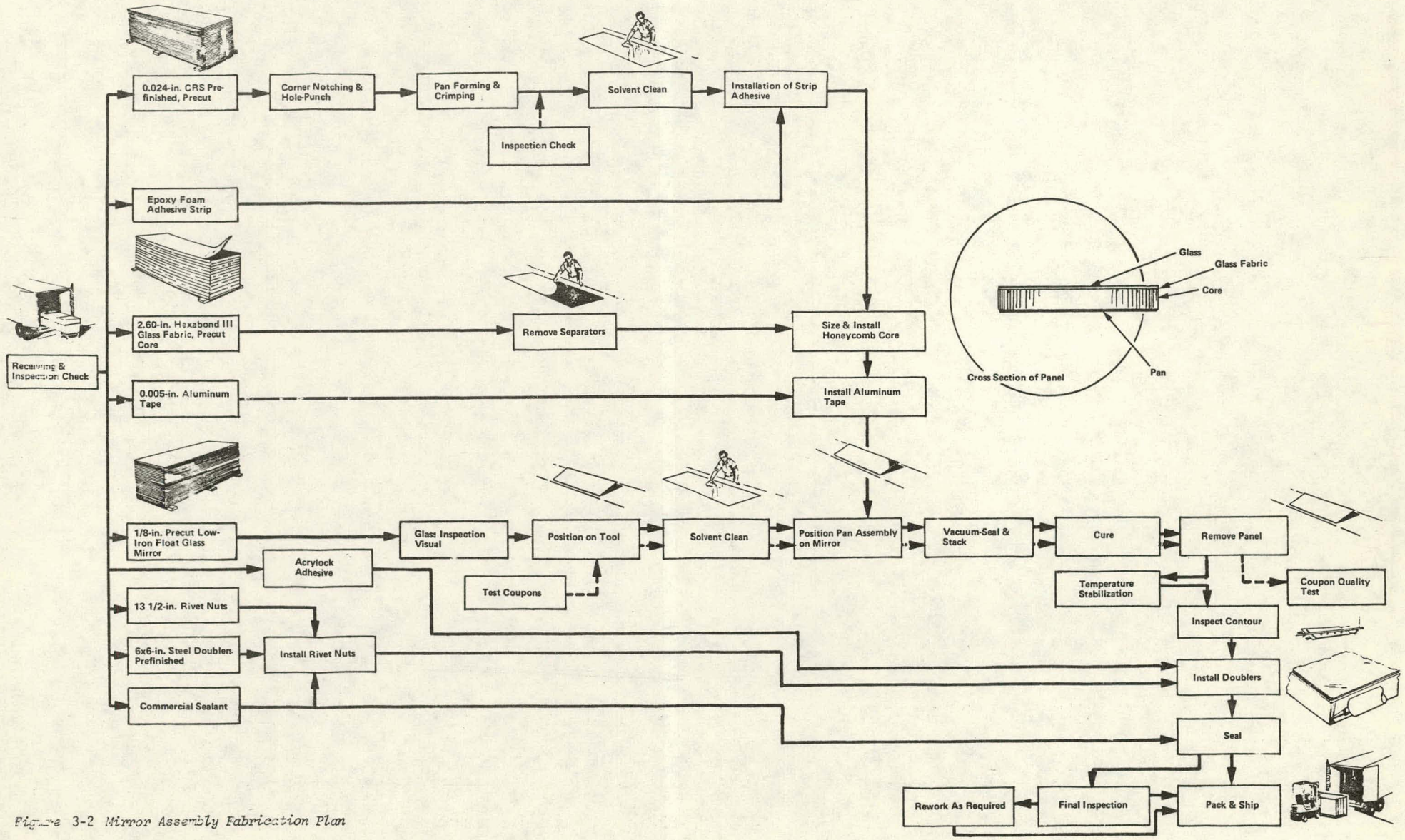


Figure 3-2 Mirror Assembly Fabrication Plan

Since the honeycomb core is pre-coated with adhesive it will be stored in an airconditioned area.

(2) Steel pan preparation - This task consists of assembly line inspection of the steel pan material, notching the corners, punching the doubler locating holes, bending the edges of the steel to form a pan, and crimping the pan edges. This operation will be accomplished on specialized Phase II high volume tooling designed specifically for this task.

(3) Mirror assembly layup - This task consists of assembling the mirror assembly components before bonding. The layup is identical to that done during Phase I except on a production line basis. The layup consists of assembling the foam adhesive, honeycomb core, and aluminum tape into the pan, laying this assembly over the mirror on the bond tool, and vacuum bagging the assembly.

(4) Mirror assembly bonding - This task consists of raising the mirror assembly to the curing temperature while holding it in place against the forming bond tool with a fast acting vacuum bag. Although the bonding process will be conceptually the same as that used for Phase I, we have developed a new tooling technique that will eliminate use of the large curing oven. This will increase mirror production rates and reduce production cost.

(5) Contour and bond inspection - This task consists of stabilizing the mirror assembly temperature, verifying the mirror surface contour is within design limits and verifying the bond is good. Contours will be inspected by physically measuring the contour with a contour gage. The bond will be verified on a sampling basis (approximately one in every 20) by making test coupons that will be destructively tested in flatwise tension to verify bond integrity. Contour inspection will be done before sealing and doubler installation to prevent expending labor and materials on any assemblies that will not meet quality control requirements.

(6) Doubler installation - This task consists of installing and sealing the riv-nuts in the doublers and bonding the doublers onto the back of the mirror assembly. This operation is performed using locating tooling to verify correct doubler location. The bond system used is a rapid cure modified acrylic adhesive selected for its assembly line compatibility, high strength, and long life properties. Unlike many other adhesive systems it also forms an excellent long-life seal.

(7) Mirror assembly operations - Mirror assembly operations between bonding and sealing will be performed in a dehumidfied area to ensure that no moisture is trapped within the assembly. The mirror assembly will be sealed using manually controlled semiautomatic assemblyline techniques. This includes using bulk sealer meter and mix subsystems and new preparation, sealing and QC inspection techniques to eliminate seal imperfections experienced during Phase I. The mirror assembly will be completely sealed before it leaves the dehumidified area.

(8) Final inspection and rework - All mirror assemblies will pass a final inspection before pack and ship. Rework and touchup will be performed as required where practical. Unusable mirrors and mirror assemblies will be scrapped.

(9) Pack and ship - Completed mirror assemblies will be packed on specially designed reusable pallets for shipment to the Barstow final assembly facility. These pallets will provide maximum packing density at minimum cost. Each pallet will hold 14 mirror assemblies packaged on edge. The mirror assemblies will be bonded onto the pallets with padded support frames around the assemblies. These frames will remove point loads that could damage the assemblies in a structural package. The assemblies will be shipped via semitrailer with 16 pallets per trailer. This provides the maximum shipping density possible to minimize shipping costs. In addition, the semitrailers will be equipped to pick up honeycomb core on the return trip and thus provide the maximum efficiency in shipping.

3.2 Mirror Assembly Production and Training Schedule

The mirror assembly production facility will be set up and production techniques verified during the first six months after Phase II contract award. This will also require that all mass production tooling (Table 3-1) be designed, fabricated or purchased, installed and checked out during the same 6 month period.

Mirror assembly production is scheduled to begin on 2 June 1980 with a single shift training operation. This shift will have a two week training and process certification period. The 2nd and 3rd shifts will begin training on 16 June 1980 and 23 June 1980 respectively. Each of these shifts will have a one week training period before their production count begins. Production will then continue on a 5-day-per-week 3-shift basis until the required 23,500 mirror assemblies have been produced. The completion of the mirror assembly production is scheduled for mid April 1981.

Table 3-1 Mirror Module Tooling

Name	Quantity
Bond Tools with Power Controls	16 each
Mirror Loading Station with Boom	8 each
Pan Assembly Handling Carts	12 each
Steel Notch/Punch Tool	1 each
Steel Forming/Crimp Tool	1 each
Sealer Dispensing Guns	2 each
Sealer Application Station	2 each
Contour Check Tool	1 each
H/C Core Installation Tool	1 each
Steel Sheet Loading Tool	1 each
Vacu-Lift Device	10 each
Miscellaneous Handling Carts	29 each

4.0 HELIOSTAT ASSEMBLY AND INSTALLATION

4.1 Component Planning and Training Activities

Components will be delivered from the various vendors to the Assembly Building (Hanger No. 6 at the Barstow-Daggett Airport). Deliveries will be made at a rate of 50 heliostats worth per week. For example, each heliostat requires 1 pedestal and two encoders. Therefore 50 pedestals and 100 encoders will be delivered per week. The initial deliveries will be made starting July 1, 1980. This will provide a one month's backlog of hardware by the time field installation starts on August 4, 1980. Storage of the electrical/electronic units and small structural units will be within the assembly building. The larger structural units will be stored in leased aircraft-type nose hangers located within 300 ft of the assembly building. In addition to providing a one-month's backlog, the early units will be used for training the "hands-on" job shop personnel by the Martin Marietta supervision, validating the assembly procedures and tooling, and resolving any potential assembly area problems. The initial job shop lead personnel will receive training starting four weeks prior to August 4, 1980. Additional job shop personnel will start two weeks prior to August 4 and the remainder (lower level jobs) will start on August 4. This staggered reporting schedule will provide for sufficient training of each group to ensure that the initial production rates can be achieved by the required starting date.

The component delivery schedule is shown in Table 4-1. There are no raw materials identified in this table because only completed units will be delivered to the assembly building.

Table 4-1 Component Delivery Schedule to Assembly Building[2]

Component	Initial Delivery Date	Final Delivery Date	Quantity Delivered Per Week	Total Quantity Including Spares[1]
Encoders	07/01/80	04/01/81	100	3957
Motors		04/01/81	100	3957
Limit Switches		04/01/81	200	7869
Cabling		04/01/81	50	1966
HFC		02/09/81	3	69
HC		03/27/81	50	1922
Pedestals		03/27/81	50	1957
Pedestal Interface Adapter		03/27/81	50	1958
Control Arms		03/27/81	100	3916
Rack Assembly		03/27/81	200	7832
Elevation Beam		03/27/81	50	1958
Power Control Boxes		03/27/81	50	1958
Drive Mechanism	07/01/80	03/27/81	50	1958
Facets	See Paragraph 3.2 →			

Notes: [1]Spares are included for 2 years

[2]Table is based on 1956 heliostats. Quantities and dates will be adjusted if total heliostat number is revised.

4.2 Heliostat Assembly Schedule

Two major units will be assembled in the Assembly Building - the Drive Mechanism Assembly and the Reflective Assembly. The flow diagram for these operations is shown in Figure 4-1. The components which will be attached to the drive mechanism are the motors, encoders, limit switches and brackets, and the control arms. Four collocated stations will be used for the drive assembly operation. These four stations will enable the production rate of 9-10 units per day to be maintained. The encoders will be set to mechanical zero using the Encoder Zero Set Indicator. Next the drive mechanism will be fully checked out with the Drive Mechanism Checkout Console. The units will be placed on the Drive Mechanism Transporter and moved to the field site for installation on the pedestals.

The reflective assembly operations are shown in Figure 4-1 in flow chart form and in Figure 4-2 pictorially. The bar joists will be bolted to the elevation beams and moved to the support rack holding area. These units are then moved to the reflective assembly area for installation of the mirrors with previously installed mounting studs. The entire unit is then installed in the canting fixture where each facet is adjusted to a predetermined distance from the rack structure. The assembly is removed from the fixture, covers are installed and the unit is loaded onto the mirror transporter. A maximum of five mirror assemblies will be transported at one time the two miles distance to the solar site. The heliostat assembly and installation schedule is shown in Table 4-2. As shown, the assembly and installation rate is 9 heliostats per day for the first three months. After this, the daily rate is 10 per day to adjust for progress on the learning curve.

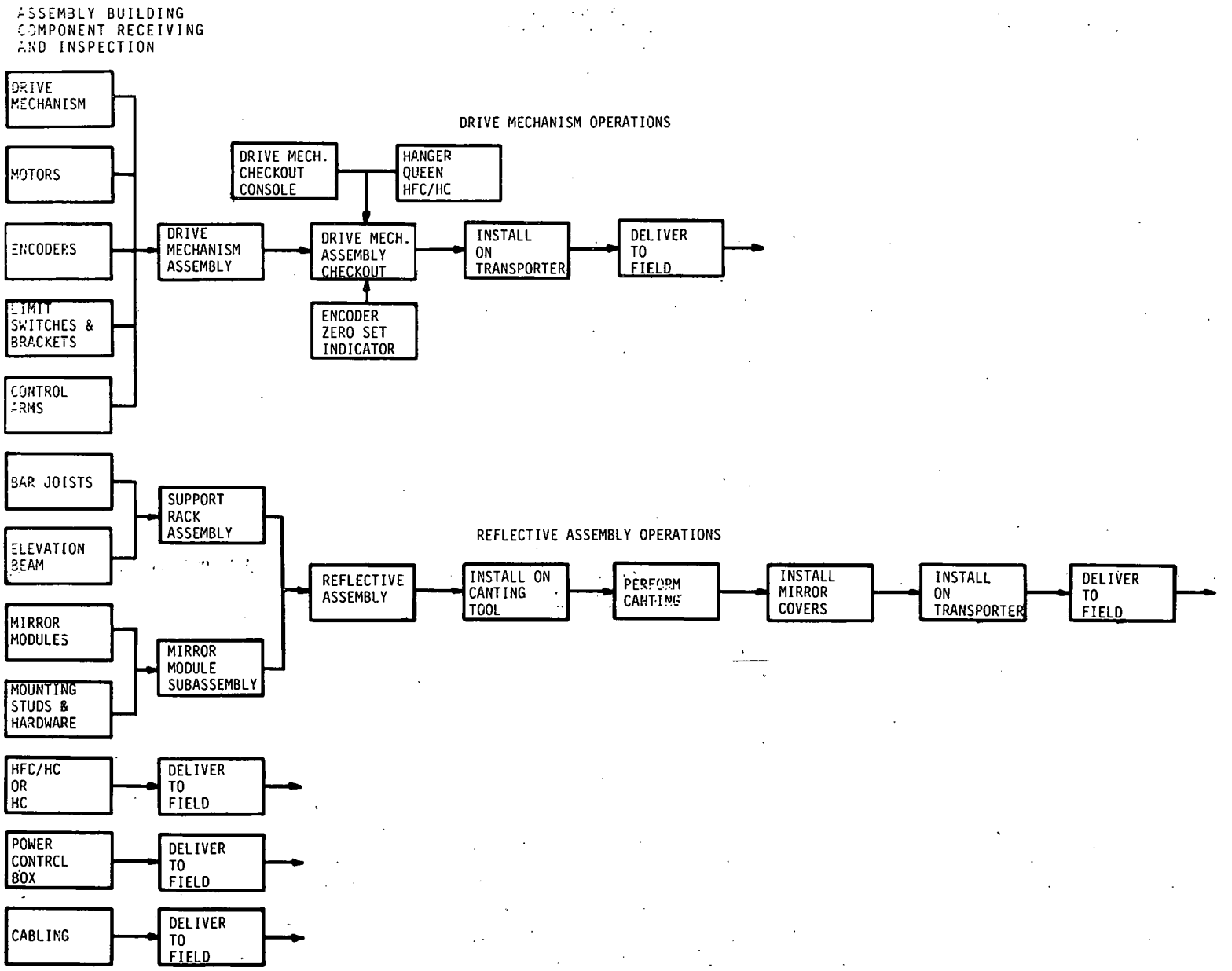


FIGURE 4-1 ASSEMBLY BUILDING OPERATIONS

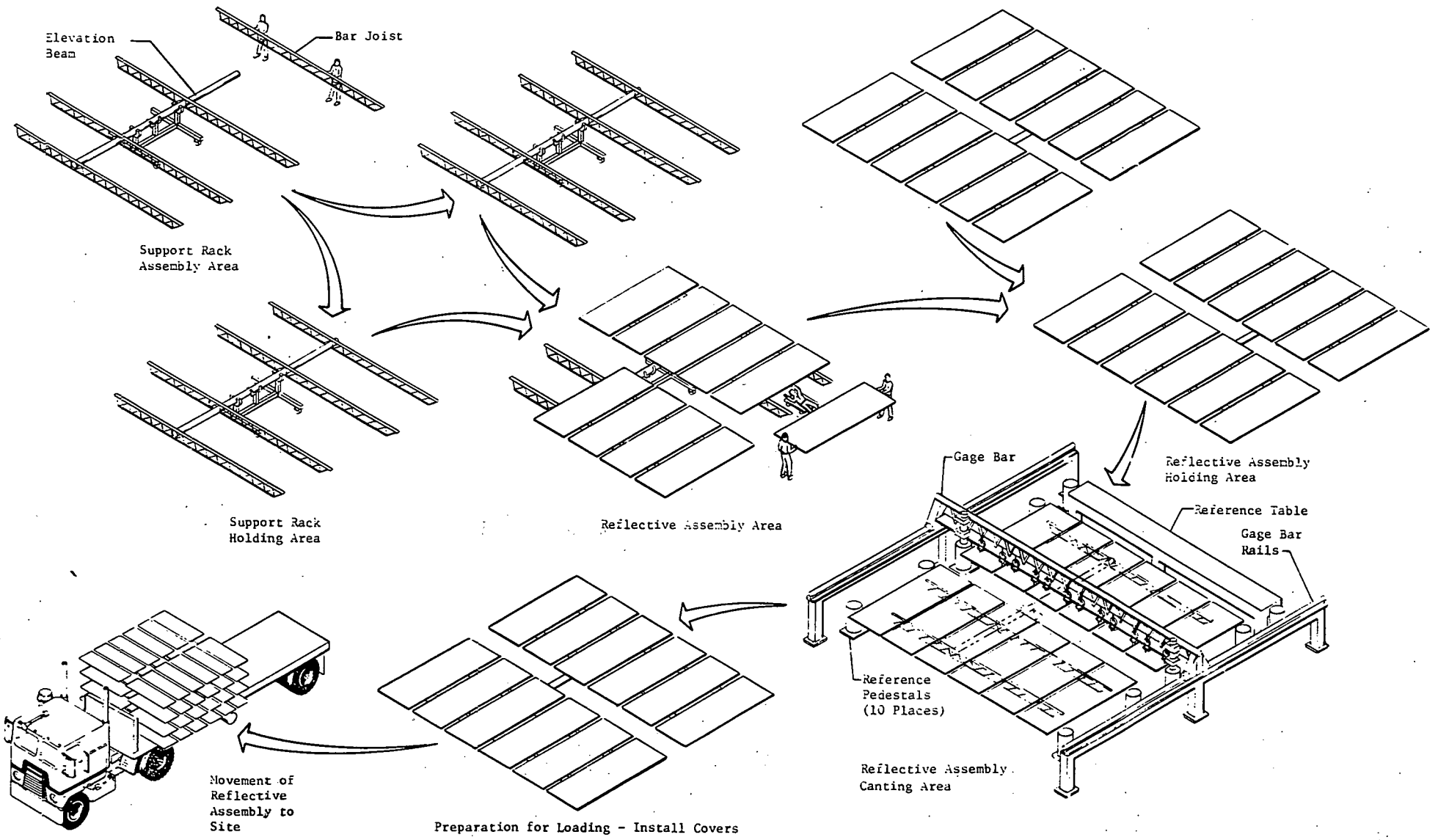


Figure 4-2 Reflective Assembly Sequence

Table 4-2 Heliostat Assembly and Installation Schedule

	Month	Working Days Per Month	Average Daily Assembly & Installation Rate	Monthly Total
1980	August	20	9 (Note 3)	170
	September	21	9	189
	October	23	9	207
	November	18	10	180
	December	18	10	180
1981	January	20	10	200
	February	20	10	200
	March	22	10	220
	April	21	10	210
	May	20	10	200
			Total	1956

NOTES:

1. Starting date is 4 August 1980 - Completion date is 29 May 1981.
2. Working days per month do not include weekends and holidays.
3. The daily rate for August 1980 is slightly less than 9 to allow for start-up operations.
4. Total shown above is for 1956 heliostats. If other quantities are required, the same production rates will be maintained with the starting or completion dates adjusted accordingly.

4.3 Heliostat Installation and Checkout Schedule

The field site installation operations are shown in Figure 4-3 in flow chart form and in Figure 4-4 pictorially. Pedestals will be delivered directly from the vendor or nose hanger storage area and installed on the foundations. The power control box will be connected to the field supplied power cables. The drive mechanism will be mounted on the pedestal top and leveled using the leveling tool and the direct drive tool to rotate the drive around the azimuth axis. Installation of the reflective assembly will be achieved by bolting the elevation beam to the control arms. This will be followed by cabling installation, HFC/HC or HC installation, and heliostat checkout. The installation schedule will be as shown in Table 4-2. Installations will take place at the same rate as the assemblies.

Heliostat checkout will occur at the same rate as the installation rate except that checkout will be the next day following installation. Checkout will be performed with the Manual Control Boxes, stimulators and the HAC.

4.4 Tool Schedule

Table 4-3 presents the tools which will be used at the heliostat assembly building and at the solar plant. All the tool part numbers which end in digits have been previously designed in Phase I. These tool designs will be updated, where required to accommodate any Phase II design changes, during the first two months of Phase II. The tool drawing numbers which end in XX will be designed also during the first two months of Phase II. Tool fabrication and procurement of the various units will occur from February 1, 1980 through June 1, 1980. Tools will be initially delivered to the Daggett Assembly Building on May 1, 1980 for installation and checkout prior to the first heliostat installation scheduled for August 1, 1980.

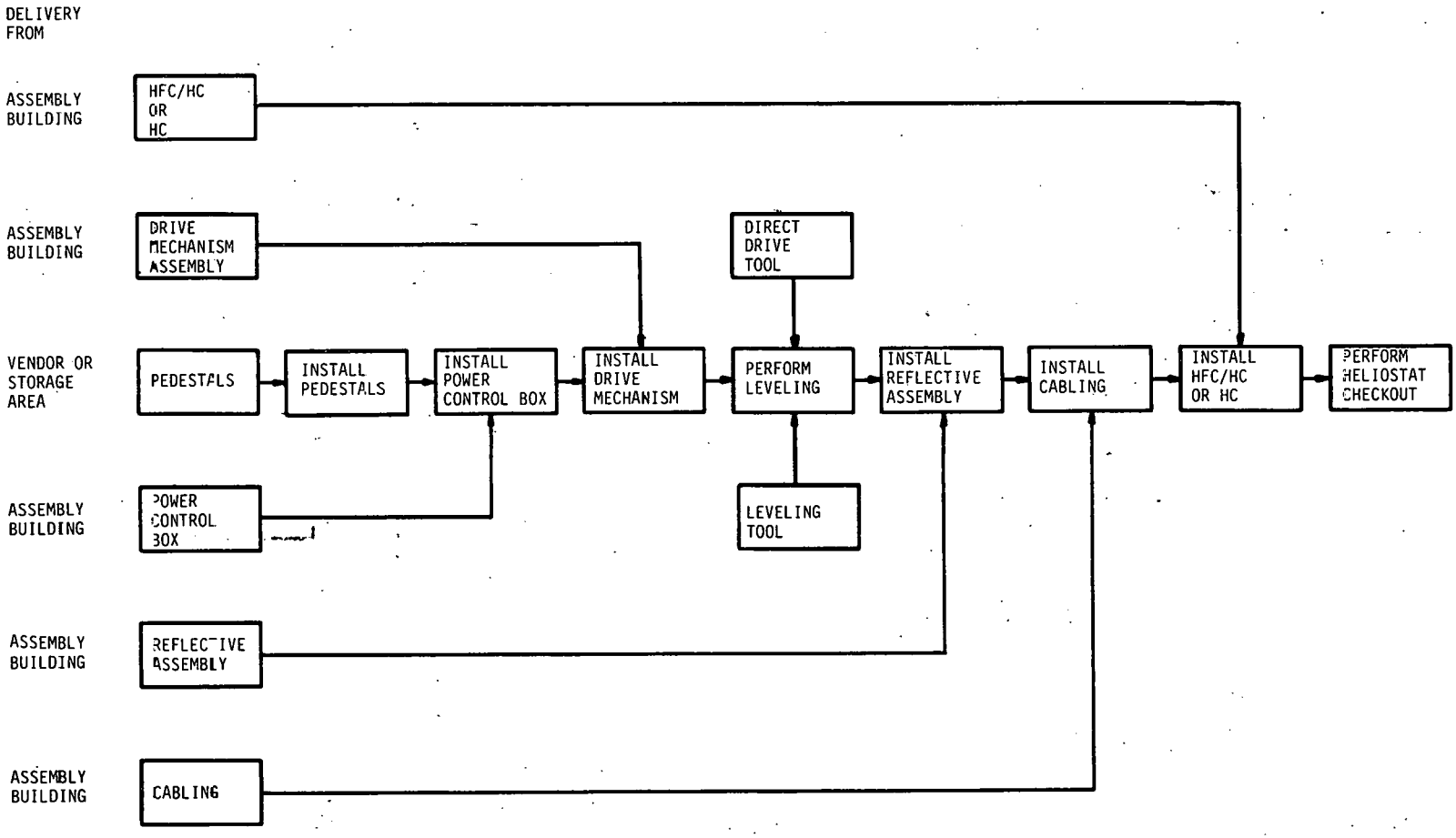
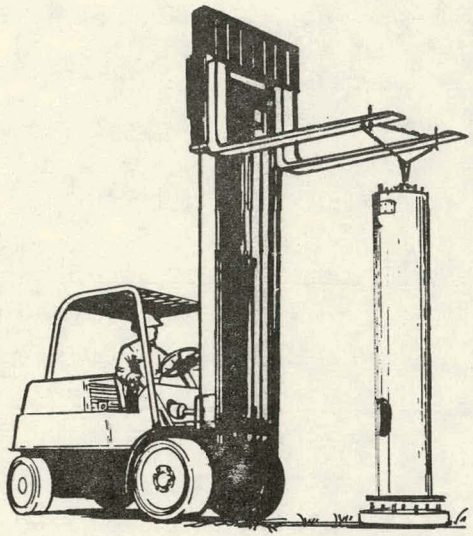
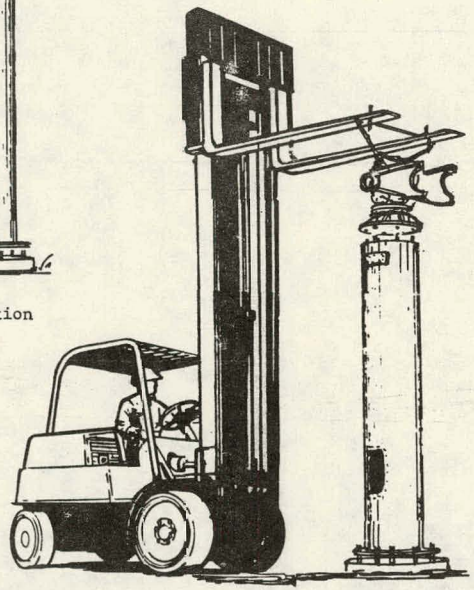


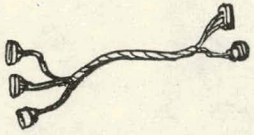
FIGURE 4-3 FIELD SITE INSTALLATION OPERATIONS



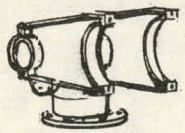
Pedestal Installation



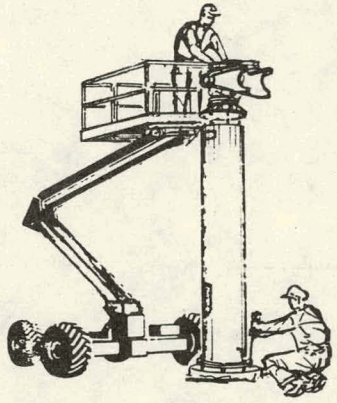
HC/HFC
Electronics



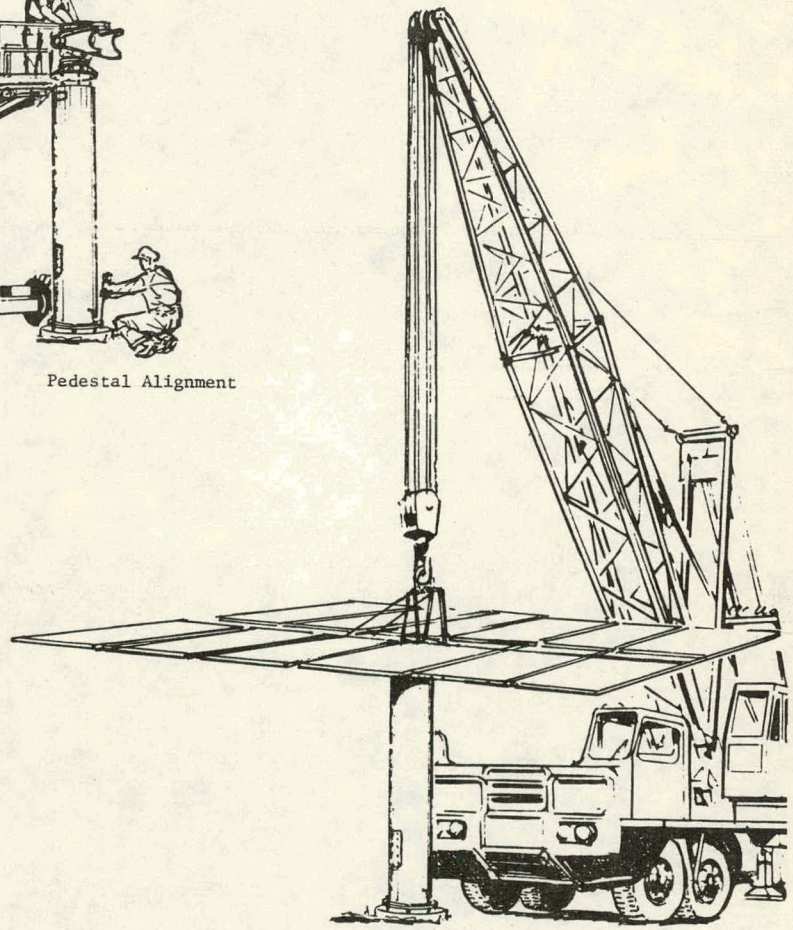
Cable Assembly



Drive Mechanism
HC/HFC and Cable
Installation



Pedestal Alignment



Reflective Assembly
Installation

Figure 4-4 Field Installation Sequence

Table 4-3 Phase II Assembly and Installation Tools

Part Number	Name	Quantity
40M5005132761	Canting Tool	1 each
40M5005132764	Rack/Reflective Assembly Fixture/Dolly	10 each
40M5005132767	Mirror Assembly/Dolly	8 each
40M5005132762	Drive Mechanism Assembly Fixture	4 each
40M5005132768	Reflective Assembly Handling Sling	4 each
40M5005132763	Drive Mechanism Lifting Device	20 each
40M5005132777	Transporter Rack-Drive Units	2 each
40M5005132773	Transporter Rack-Reflective Assembly	4 each
40E5005132778	Drive Motor-Direct Drive Control Box	4 each
40E5005132XXX	Checkout Console-Drive Unit	1 each
40E5005132XXX	Encoder Zero Set Indicator	2 each
40E5005132779	Lifting Adapter-Pedestal	2 each
40M5005132766	Adapter Plate-Talyvel	2 each
40M5005132771	Field Canting Tool	2 each
40E5005132775	HC/HFC Stimulator	3 each
40E5005132774	Manual Control Box	6 each
40M5005132772	Protective Cover-Mirror	540 each
40M50051327XX	Encoder Bias Measurement System	1 each
	Air Compressor-30 CFM at 150 psi	1 each
	AC/DC Welder-350 amp	1 each
	Shop Tools (hand tools)	As Required
	Jig Transits	2 each
	Optical Level	1 each