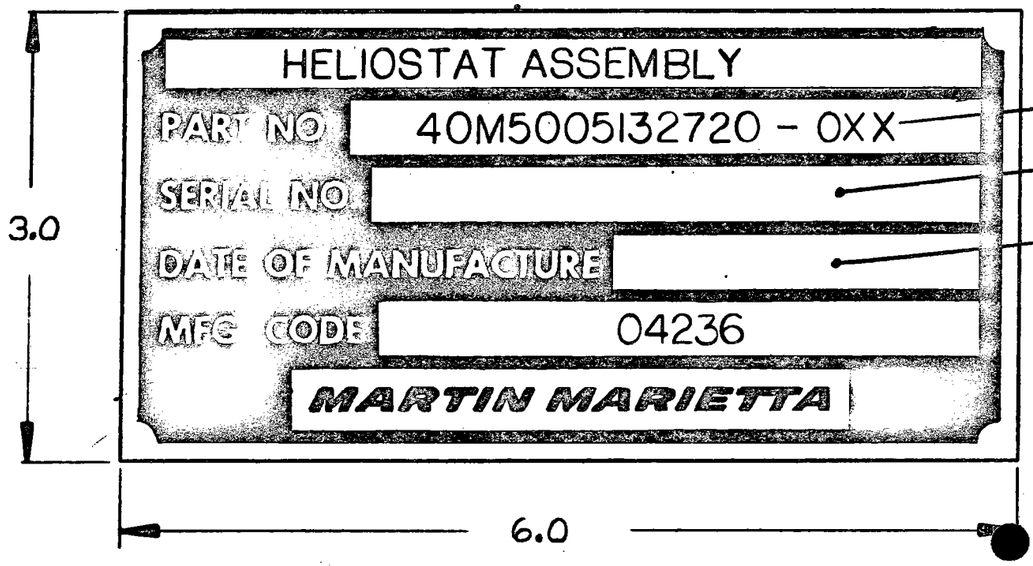
NSHP 2447
1318

1318

MMC HELIOSTAT
REVISIONS FOR
SOLAR ONE

1318

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
	INITIAL RELEASE RR-9122-001	12-15-80 1-2-81	D PHIPPEN DBielenberg
±	ADDED -002 AND PART NO TO BE STAMPED ON IT CORRECTED PART NO FOR -001 -010 WAS -009 RC 9144-002	6-11-81 6-12-81	D PHIPPEN W. Schmitt



010 FOR -001
019 FOR -002

PRINT SERIAL NO. ASSIGNED SEQUENTIALLY BY MANUFACTURING

INSERT WEEK ENDING COMPLETION DATE

NOTES:

1. USE 3/16 LETTERS

QUANTITY/DASH NO.	PART NO.	ZONE	SER SYM	DESCRIPTION	STOCK SIZE	MATERIAL OR VENDOR	ISSUE COND	MATERIAL SPECIFICATION	FINISH OR MFR CODE	CHG
	-002			IDENTIFICATION PLATE	3.0x6.0	ALUMINUM				
	-001			IDENTIFICATION PLATE	3.0x6.0	ALUMINUM				

LIST OF MATERIAL

CALC WT	DASH NUMBER	NEXT ASSY	USED ON	FINAL ASSY	TEST
		APPLICATION		QTY REQD	
	-002	40M5005132720		1	
	-001	40M5005132720		1	

INTERPRET DWG PER MIL-STD-100
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
AND ARE AFTER PLATING
TOLERANCES ON:

FRACTIONS	DECIMALS .X	DECIMALS .XX	DECIMALS .XXX	ANGLES
± 1/32	± .1	± .03	± .010	± 1/2°

MACHINED SURFACES ✓

MIL-1-6500 STATUS

INTERCHANGEABLE	
REPLACEABLE	
UNCONTROLLED	

DRAWN BY	DEPT	DATE	D PHIPPEN 0485 12-10-80
CHECKER			DBIELENBERG 1-2-81
STRESS ENGR			W. Schmitt 1-8-81
WT ENGR			
MATL ENGR			
RELIABILITY			
GR ENGR			DBielenberg 1-2-81
PROJECT			M Frobaldo 1-9-81
CUST RPRSNTV			

MARTIN MARIETTA CORPORATION

MARTIN MARIETTA AEROSPACE, DENVER DIVISION, P. O. BOX 179, DENVER, COLORADO 80201

10MWe SOLAR POWER PLANT
IDENTIFICATION PLATE
HST ASSY

SIZE	CODE IDENT NO.	
B	04236	40M5002132702
SCALE FULL		SHEET 1

BRUNING 44-141 25527

DEN 061603(1-75)

SHEET 2 CANCELLED

NOT REQUIRED

CHG.	SIZE	CODE IDENT. NO.	
A	A	04236	40M500 1132711
	SCALE	PAGE 1 of 1	SHEET 2 of 3

DRAWING NO

REVISIONS

REV	SH	DESCRIPTION	DATE	APPROVED
		Initial Release RR-9000-001	10/6/78	
A		Document Update - Documents "As-Built" Configuration Cancelled Sheet 2 of 3 RW9013-001	6-19-79	W. Logue
0		Page 4, Added Para. 1.2 Page 12, Revised Para 3.3.20 RELEASED FOR PRODUCTION RW9020-001	12/21/79	D Bilenberg
1		Page 4, Added -010 Part No. to Para. 1.2. Sheet 3, Added Dim for -010 RW9047-001	3/10/80	D Bilenberg
2		Incorporated DCN 2 on SH 3	4/1/81	D Bilenberg

																			REV
																			SH
	A	A	A	0	A	A	A	A	A	A	A	1	A	A	1	REV	REV STATUS OF SHEETS	
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	SH		

DRAWN BY M.Frohardt	DEPT	DATE 10-04-78
CHECKER D Bilenberg		10-6-78
GR ENGR		
PROJECT M Frohardt		10-6-78

MARTIN MARIETTA CORPORATION
DENVER DIVISION, POST OFFICE BOX 179, DENVER, COLORADO 80201

10 MWe Solar Pilot Plant

Combined Azimutn ard Elevation Drive - Heliostat

PROCUREMENT DOCUMENT

SIZE	FSCM NO.	DWG NO	REV
A	04236	40M500 1132711	2

CONTRACT NO.	SCALE	PAGE	SHEET
		1 of 15	1 of 3

INDEX

1.0 SCOPE

1.1 General - This specification establishes the performance, design, construction, and testing requirements for a Heliostat combined azimuth and elevation drive unit.

1.2 Classification - The drive unit shall be CLASSIFIED by Martin Marietta part numbers as follows:

Part Number	Nomenclature	Usage
40M500 1132711-009	Drive Unit	S/N 0001 thru 006
40M500 1132711-010	Drive Unit	S/N 0007 and up

2.0 APPLICABLE DOCUMENTS

2.1 General - The following documents form a part of this specification to the extent specified herein. In case of conflict between the requirements of this specification and any reference documents, the requirements of this specification shall govern.

2.2 Documents

AGMA STD: 201.02 Coarse-Pitch Gears - Tooth Proportions
211.02 Surface Durability, Helical Gears
221.02A Strength Rating, Helical Gears
440.04 Cylindrical Work Reducers

3.0 REQUIREMENTS

3.1 General - The drive units are to be designed and manufactured to high grade commercial practice consistent with the following performance, reliability, life and servicing requirements.

Emphasis is to be given to design concepts offering economic manufacturing capability in large quantities including commonality of components.

3.2 Division of Design Responsibility - The Contractor, in conjunction with Martin Marietta, shall provide a production design of the drive mechanism in accordance with the requirements of this specification.

The contractor shall perform certain of the design tasks with Martin Marietta support with a division of responsibility as follows:

Contractor

1) Provide a minimum cost, producible packaged design.
2) Select materials, finishes and tolerances consistant with the requirements. Gear materials shall be selected by Martin Marietta Corporation.
3) Calculate the bearing loads and select low cost, high production bearings.
4) Prepare production drawings of all details and assemblies.
5) Calculate the strength of all components, including fastening of gears to the shaft, except for the gear tooth loading and gear wear.

Martin Marietta Corporation

1) Specify gear design, i.e. type, pitch, number of teeth, face width, material, etc.
2) Calculate deflections in all the elements of the Drive Mechanism.
3) Review and approve drawings prior to production of parts.

Martin Marietta Corporation and Contractor will jointly arrive at optimum low cost configuration.

Martin Marietta Corporation retains the responsibility for the strength and integrity of all interface requirements providing specified material strengths are met.

Martin Marietta Corporation also assumes responsibility for all gear design including the degree of the worm gear irreversibility. To obtain the irreversibility feature, the lead angle must be equal to or less than the static angle of friction--see paragraph 3.3.8.

Suppliers manufacturing go-ahead will be contingent upon the Martin Marietta Corporation approval of the supplier drawings and a review of the supplier bearing loading and bearing deflection analysis.

The gears, in the sizes shown in Table I, for the elevation axis have been tested satisfactorily by the Martin Marietta Corporation to the static and dynamic loads defined in paragraph 3.3.4. Azimuth gear proportions and material selection (see Table I) are based on elevation test data.

TABLE I

DESCRIPTION	DIAMETRAL PITCH	# TEETH	PITCH DIAMETER	WIDTH	BORE	PRESS. ANGLE	HELIX ANGLE/ LEAD ANGLE	MATERIAL	ROCKWELL HARDNESS SURFACE	ROCKWELL HARDNESS CORE
WORM AZ&EL	10.5 Axial	1 THD	1.286	2.375	N/A	25°	4°14'	AISI 8620 STL	58-62C	25C(MIN)
PINION AZ&EL	8	15	2.0024	2.125	N/A	20°	20°33'	AISI 8620 STL	58-62C	25C(MIN)
WORM GEAR AZ&EL	10.5 AXIAL	60	5.714	1.000	1.633	25°	N/A	SAE CA863 Manganese Bronze	-	98B
GEAR AZ	8	70	9.3446	1.750	4.250	20°	20°33'	AISI 8620 STL	58-62C	25C(MIN)
GEAR EL	8	88	11.7476	1.750	4.032	20°	20°33'	AISI 8620 STL	58-62C	25C(MIN)

CHG. A

SIZE A

SCALE

CODE IDENT. NO. 04236

PAGE 7 of 15

40M500 1132711

SHEET 1 of 3

3.3 Requirements

3.3.1 Dimensions - Envelope and interfacing requirements shall conform to Sheet 3 of 3.

3.3.2 Weight - The weight of the unit is relatively unimportant and should in no manner interfere with the economic viability of the design.

3.3.3 Design Features - The drive unit shall be totally enclosed and weather-proof.

Bearings and gear quality shall be controlled so as to meet the backlash requirements specified in paragraph 3.3.4.

3.3.4 Performance

GEAR RATIOS:

AZIMUTH:

Helical Stage	4.67:1
Worm Stage	60:1

ELEVATION:

Helical Stage	5.87:1
Worm Stage	60:1

BACKLASH:

Backlash of the completed assembly shall be measured on the output shaft by rotating the output shaft sufficient to remove all backlash, including that of the worm gear mesh, and shall not exceed:

Azimuth	3 milliradians max
Elevation	4 milliradians max

DUTY CYCLE:

AZIMUTH	.75 Rev per day in one arc-min increments clockwise. (Tracking)
	.75 Rev per day at the rate of one revolution in 16 minutes counter-clockwise. (Slew)
ELEVATION:	.25 revolution per day in one arc-min increments both CW and CCW. (Tracking)

.75 Rev per day at the rate of one revolution in 16 minutes. (Slew)

OUTPUT, DRIVE TORQUE REQUIREMENT (OPERATIONAL):

	MAX DESIGN LOADS	
	TRACKING	SLEW
AZIMUTH:	2180 ft-lbs	5225 ft-lbs
ELEVATION:	2180 ft-lbs	6190 ft-lbs

Estimated number of output gear meshes while operating, based on azimuth loads of 5225 foot-lbs and elevation loads of 6190 foot-lbs.

% of Design (Slew) Operating Load	Frequency %	No of Output Gear Meshes in 30 Years
0 to 1.5%	29%	209,583
to 6%	21%	151,767
to 13%	19%	137,313
to 23%	14%	101,178
to 37%	8%	57,816
to 53%	5%	36,135
to 72%	3%	21,681
to 142%	1%	7,227

OUTPUT SHAFT NON-OPERATIONAL STATIC LOADS:

AZIMUTH MAX: 7473 ft-lbs*

ELEVATION MAX: 16,000 ft-lbs*

*Loads do not occur simultaneously

FREQUENCY OF OCCURRENCE:

% of Max Non-Operational Load	Instances per Year
60%	50
80%	4
100%	1

In elevation these non-operational loads will occur at the same gear/pinion tooth contact.

3.3.5 Life - The units shall have a 30-year life as a design goal. This shall be accomplished with minimum preventative maintenance and with minimum replacement of degradable elements such as shaft seals.

3.3.6 Housing Strength and Deflections - Under the design tracking torque requirements on both axes, the stiffness of the gearbox housing shall be such to

limit the deflection of the elevation output shaft with respect to the azimuth shaft to within .044 Mr (0.15 arc minutes) - not including bearing deflection.

The analysis to verify this requirement will be conducted by the Martin Marietta Corporation's Stress Engineering in conjunction with the Vendor's design personnel.

3.3.7 Input Torque - Input torque, at both the azimuth and elevation input shafts, with no load applied to the output shafts shall not exceed 60 in-lb.

3.3.8 Gear Design - To provide irreversibility the worm lead angle for self-locking shall not exceed $4\frac{1}{2}^{o}$ in both azimuth and elevation. The material for all gears are called out in Table I.

3.3.9 Environment - The units shall be designed to operate in accordance with the foregoing requirements throughout a temperature range from $+32^{o}$ to $+122^{o}F$, at reduced requirements from $+16^{o}F$ to $+32^{o}F$, and to withstand non-operational environments, including rain, hail, sand storms, and temperatures ranging from $-9^{o}F$ to $122^{o}F$.

3.3.10 Output Shaft/Output Gear Interface - The output gear shall be assembled to the output shaft in a manner that precludes any possibility of relative angular motion under worst case torque and load condition.

3.3.11 Bearings - Bearings shall have negligible contribution to gear backlash and to be capable of complying with the load, deflection, and life requirements defined above. They shall be installed so there is minimum looseness between the inner race and the shaft, between the outer race and its housing, except where preload is adjusted.

3.3.12 Seals and Pressure Relief - Static seals and gaskets shall be completely oil tight. Dynamic seals shall exhibit essentially no measurable leakage. Double Viton oil seals shall be provided at the azimuth and elevation out-put shafts and single Viton seals at other seal areas.

The unit shall be completely enclosed to the outside environment, but shall be provided with an expansion chamber to relieve internal pressures due to changes in external temperature or pressure.

3.3.13 Lubrication - Lifetime lubrication is the design goal with oil submerged gear meshes and bearings. The lubrication shall be Mobilux EP 023 semi-fluid extreme pressure grease or equivalent. An oil drain shall be provided so the lubricant can be serviced during the life of unit. The drive unit shall be filled with the proper amount of lubricant prior to delivery.

3.3.14 Positional Feedback Provisions - The gear box shall have provisions for an azimuth axis output shaft encoder and an elevation axis output shaft encoder adapter as defined on Sheet 3.

3.3.15 Motor Mounting and Shaft Coupling - The drive units shall have provision for direct attachment of the Bodine type 42D3-E motor or its equivalent. The worm shaft shall have provisions for direct engagement of the motor output shaft.

3.3.16 Output Shaft Material Selection - Since determination of the output shaft size is based on deflection (and a modulus E of 30×10^6 lbs/in^2), any good commercial grade steel is acceptable.

3.3.17 Identification of Matched Parts - Match bored gear castings and matched gear elements shall be identified to prevent improper assembly during any subsequent servicing that may prove necessary.

3.3.18 Identification - Each unit shall be identified with the following information:

Manufacturers Part No.
Manufacturers Serial No.
Date of Manufacture.
Martin Marietta Part No.
Martin Marietta Designation.

3.3.19 Material Compatibility - Materials selected, including lubricants and seal materials shall be mutually compatible throughout the operating environment.

3.3.20 Corrosion Protection - All external housing surfaces excluding the motor attachment, shall be finished as follows:

Steam Clean (or equiv.) all surfaces, provide one coat of Strontium Chromate primer

(Kansas Paint 63418 or equiv) and one coat of acrylic hyperthane finish coat

(Kansas Paint 84 series or equiv, color number 25630 Federal Standard 595a) The steel shafts external surface shall have an acceptable commercial protective finish.

3.3.21 Design Review and Drawing Approval - A formal final design review shall be convened prior to manufacturing go-ahead. At this time a mutual agreement upon the design will be ratified by both parties with drawing approval by the Martin Marietta Corporation. The vendor's design shall be adequately supported by analysis in all critical areas, including tooth bending and hertz stress analyses, bearing loads calculation and efficiency predictions, etc. Subsequent drawing change must have the Martin Marietta Corporation approval prior to incorporation.

4.0 VERIFICATION REQUIREMENTS

4.1 General - This section describes the requirements for the verification process during design, fabrication and development, acceptance and qualification test programs.

4.2 Design Assurance Tests - Design assurance testing will be conducted by Martin Marietta utilizing existing foundations and preprepared test equipment. Testing will include maximum bending moment tests, maximum torque tests, combination bending moment and torque tests, irreversibility and functional tests.

Structural deflections and drive power requirements will be assessed throughout the course of these tests.

Following these tests, the unit will be disassembled and inspected for any evidense of lack of structural integrity or degradation of bearings and gear elements. The disassembly and inspection shall be conducted by contractor personnel at either the contractor or Martin Marietta facilities.

4.3 Product Acceptance Tests - Each unit shall be accompanied by a test and assembly report referencing the serial number of each unit and defining:

a. Output shaft backlash. (Applied torque for backlash measurement 1200 in-lb).

b. Input torque to overcome friction with no applied load.

A data sheet comparable to and containing the information as shown on the suggested Quality Data form (as shown on page 14) shall be attached to each individual drive unit.

5.0 DATA AND DOCUMENTATION

5.1 General - All detail and assembly drawings shall be restricted to standard sizes of "A" (9x12), "B" (11"x17"), "C" (17"x22" or 18"x24") "D" (24"x36") and "E" (30"x42"). Each drawing shall be identified with a STMPO* assigned number or the title block shall have provisions for the addition of this 9 digit number prior to delivery.

5.2 Deliverable Documents - The contractor shall provide one reproducible copy of the following minimum documentation.

1) Detail and assembly drawings.
2) The design analysis or summary of the analysis performed.
3) The Assembly Procedures used by the Contractor in assembling the Drive Mechanism.
4) The Acceptance Test Procedure used as criteria for controlling the Quality.
5) Recommended Maintenance procedures.
6) Repair/replacement instructions. (Phase II only)

6.0 PREPARATION FOR DELIVERY

6.1 Shipping - The method of shipping, type of container or method of packaging shall be in accordance with intra and interstate shipping codes and std commercial practices for equipment of this type.

*Solar Ten Megawatt Project Office

QUALITY DATA

PART _____ NAME S/N XXXX
(Martin Marietta Part No. Manufacturers Serial No.
Combined Azimuth and Elevation Drive

Item No.	MANDATORY VERIFICATION POINT (MVP)	Verified By
1.0	Identification and Configuration Manufacturers Part No. _____ Date of Manufacture _____	
2.0	Assembly - Unit has been assembled to assembly procedure #_____	
2.1	Lube - Unit has been filled with proper type and amount of lubricant.	
3.0	Test - Unit has been tested per acceptance test plan #_____	
3.1	Required Data a) Output Shaft Backlash (with _____ in-lb applied torque) Azimuth _____MR Elevation _____MR b) Input Torque (with no load applied to output shaft) Azimuth _____in lbs Elevation _____in lbs	
4.0	Certification of Compliance The manufacturer certifies that materials, processes, assembly and test procedures used in this procurement are in accordance with the Purchase Contract. _____ Contractor Quality Representative	
5.0	Martin Marietta Quality Acceptance _____ Martin-Marietta Quality Representative	

SIZE	CODE IDENT. NO.	
A	04236	40M500 1132711
CHG. A	SCALE	PAGE 15 of 15 SHEET 1 of 3

E-49D(1-68)

DRAWING NO

REVISIONS

REV	SH	DESCRIPTION	DATE	APPROVED
		Initial Release RR9005-001	2/8/79	
A		Revised to provide two different motor speeds RW9025-001	6/20/79	
0		RELEASE FOR PRODUCTION RW9026-001	1/18/80	
		3.5 Revised motor torque requirements and speed droop requirements.		
		3.12 Added boot seal requirement, pin assignments, and direction of rotation.		
		4.0 Added test requirements and certificate of conformance requirements.		
1		3.4 Added requirement for drain holes in rain cover.	6/6/80	
		3.12 Changed wire size from #18 to #16.		
		All pages--removed PD from Dwg. No.		
		4.0 Added - - "in accordance with the vendors normal procedures." RW9073-001		

																			REV
																			SH
								1	1	1	1	1	1	1	1	REV	REV STATUS OF SHEETS		
								8	7	6	5	4	3	2	1	SH			

DRAWN DEPT DATE
M. Hart 1/18/80
CHECKED
D. Silverberg 1/18/80
ENGR
M. Orchard 1-21-80
PROJECT
K. Weeks 1/18/80

MARTIN MARIETTA CORPORATION
DENVER DIVISION, POST OFFICE BOX 179, DENVER, COLORADO 80201

10 MW$_e$ SOLAR PILOT PLANT
GEARMOTOR

SIZE	FSCM NO	DWG NO	REV
A	04236	40E500 1132712	1

CONTRACT NO

SCALE	PAGE	SHEET
	1 of 8	

1.0 SCOPE

This specification describes the required performance, manufacturing, and test requirements of totally enclosed, permanent magnet, D.C., front flange mounted gearmotors for driving heliostats located in the SW U.S. desert environment. These devices will henceforth be referred to as the gearmotors. Part number 40E5001132712-019 is the elevation gearmotor; part number 40E5001132712-020 is the azimuth gearmotor. The Bodine Electric Company part number for this type of gearmotor is 42X4BEPM-E4.

2.0 APPLICABLE DOCUMENTS

None

3.0 REQUIREMENTS

The gearmotors are to be designed and manufactured to high grade commercial practice with the following performance, reliability, life, servicing and mounting requirements.

3.1 Dimensions and Mounting Requirements

The motor mounting scheme is diagrammed in Figure 1.

3.2 Weight

The weight of the gearmotor is relatively unimportant and should in no manner interfere with the economic viability and adequate ruggedness of the design.

3.3 Operating Attitude

The operating attitude of the gearmotor is with the motor shaft axis horizontal.

3.4 Motor Type and Housing Construction

The motor shall be of the nonventilated (TENV) totally enclosed variety. The integrated motor and gearbox shall be housed in a rainproof and dust proof enclosure. Drain holes shall be provided in the rain cover--five holes approximately .09 in. in diameter in a 3/4-inch pattern. Explosion proof requirements do not pertain. The output shaft shall be fitted with a shaft seal. (Shaft and seal will be isolated from the weather when the gearmotor is installed.)

3.5 Performance

The following performance requirements shall be met under the most adverse combination of operating temperature and duty cycle and pertain to both directions of rotation.

	Operating Mode	
	High Speed	Low Speed
Azimuth Gearmotor		
Minimum output speed at no load, rpm	14	1.5
Maximum running load torque, in-lb	960	480
Elevation Gearmotor		
Minimum output speed at no load, rpm	21	2.3
Maximum running load torque, in-lb	840	420

The following applies to both gearmotors:

Speed droop at maximum operating load torque: optional, up to 50% at high speed, up to 85% at low speed.

Starting load torque: less than running load torque.

Pull up torque: less than running load torque.

Load Inertia: 1.5 lbs in^2.

Output Shaft Backlash: Standard commercial practice.

3.6 Duty Cycle and Operating Mode - Elevation Gearmotor

High Speed Operating Mode: The normal duty cycle for this mode is two continuous periods of energization each day through a torque cycle varying as indicated in Figure 2. The peak torque will vary from cycle to cycle from 150 to 840 in lbs, the maximum being encountered during no more than one cycle in 10 years. During the majority of these 11-minute operating cycles, the peak torque will be less than 200 in-lb.

Low speed operating mode: In this operating mode, the motor will be turned on intermittently throughout a twelve-hour day. Each time the motor is turned on in the low speed mode, the on time will be approximately one second. The off time between steps will average approximately ten seconds. In infrequent cases (not more than once per day) the off time between steps could be as short as one second for a maximum time of three minutes.

The peak torque load of 475 in-lb in this operating mode will not be experienced more than once a year for an operating time of not more than one minute. During the majority of the operating time, the peak torque will be less than 200 in-lb.

3.7 Duty Cycle and Operating Mode--Azimuth Gearmotor

The duty cycle and operating modes for the azimuth gearmotor are similar to those for the elevation gearmotor, except that the peak torque requirements are greater as shown in paragraph 3.5.

3.8 Life

The design goal life of the gearmotor is 30 years operating under the duty cycle and operating mode described above with the need for servicing minimized.

3.9 Electrical

The supply voltage to the motor armature will be provided from a Martin Marietta Corporation motor controller. The output voltage of the controller will be full-wave rectified 120 volt single phase a-c when the motor is operated at slew speed. When the motor is operated at track speed, the output voltage of the controller will be full-wave rectified 18 volt single phase a-c.

3.10 Corrosion Protection

All external surfaces, including interfaces but excluding the motor attachment, shall be painted white (color 25630 per Federal Standard Standard 595A) in accordance with good commercial practice.

3.11 Material Compatibility

Materials selected, including lubricants and seal materials shall be mutually compatible throughout the operating environment.

3.12 Electrical Connections

The gearmotor shall have a sealed jacketed weather resistant cable with #16 AWG color-coded wire at least 12 inches long. Connectors shall be provided on the motor pigtails--Cannon SS3R and SS3P on the azimuth and elevation motors respectively.

A boot seal (Cannon 317-1397-000 or 317-1399-000) shall be supplied over the junction of the pigtail and the Cannon SS3R or SS3P connectors as protection against the weather.

Pin assignments shall be as follows:

Elevation Gearmotor	Azimuth Gearmotor
1-Black	1-Green
2-White	2-Black
3-Green	3-White

The direction of rotation of the gearmotor shaft as seen looking into the gearmotor shaft shall be as follows:

Elevation Gearmotor		Azimuth Gearmotor	
1 positive 2 negative	CCW	2 positive 3 negative	CCW
1 negative 2 positive	CW	2 negative 3 positive	CW

3.13 Nameplates

All parts shall be labeled with a permanent nameplate listing, as a minimum; manufacturer, part number, serial number and date of manufacture.

3.14 Environment

The gearmotors shall be designed to meet the foregoing requirements under the following environmental conditions:

Operating Temperature - -10°C to 50°C Ambient Air

Non-Operating Temperature - -30°C to 50°C Ambient Air

Environment Exposure

- direct sunlight

Rain - 75 mm per 24 hour period

Hail - 25.4 mm diameter 0.9 specific gravity hailstones at 23m/sec.

Ice Load - 50 mm

Snow Load - 250 Pa (5 - psf)

Dust - as encountered in a Southwest U.S. desert environment.

4.0 QUALITY ASSURANCE

The vendor shall perform at least the following physical inspection and performance test on each gearmotor in accordance with the vendor's normal procedures.

4.1 Physical Inspection

4.1.1 Perform visual inspection of gearmotor for physical defects, oil leakage and overall appearance.

4.1.2 Verify leads are at least 12 inches long.

4.1.3 Verify length of output shaft is 2 inches from mounting face.

4.1.4 Check shaft for endplay.

4.1.5 Test for proper backlash.

4.1.6 Check lubricant level.

4.1.7 Check for brush seating.

4.1.8 Check brush caps.

4.1.9 Check all screws for tightness.

4.2 Performance Test

4.2.1 Each gearmotor shall be run in, in accordance with the vendor's normal procedure.

4.2.2 Check for proper shaft rotation.

4.2.3 Check for proper speed.

4.2.4 Check for noise under load.

4.2.5 Check motor current and power.

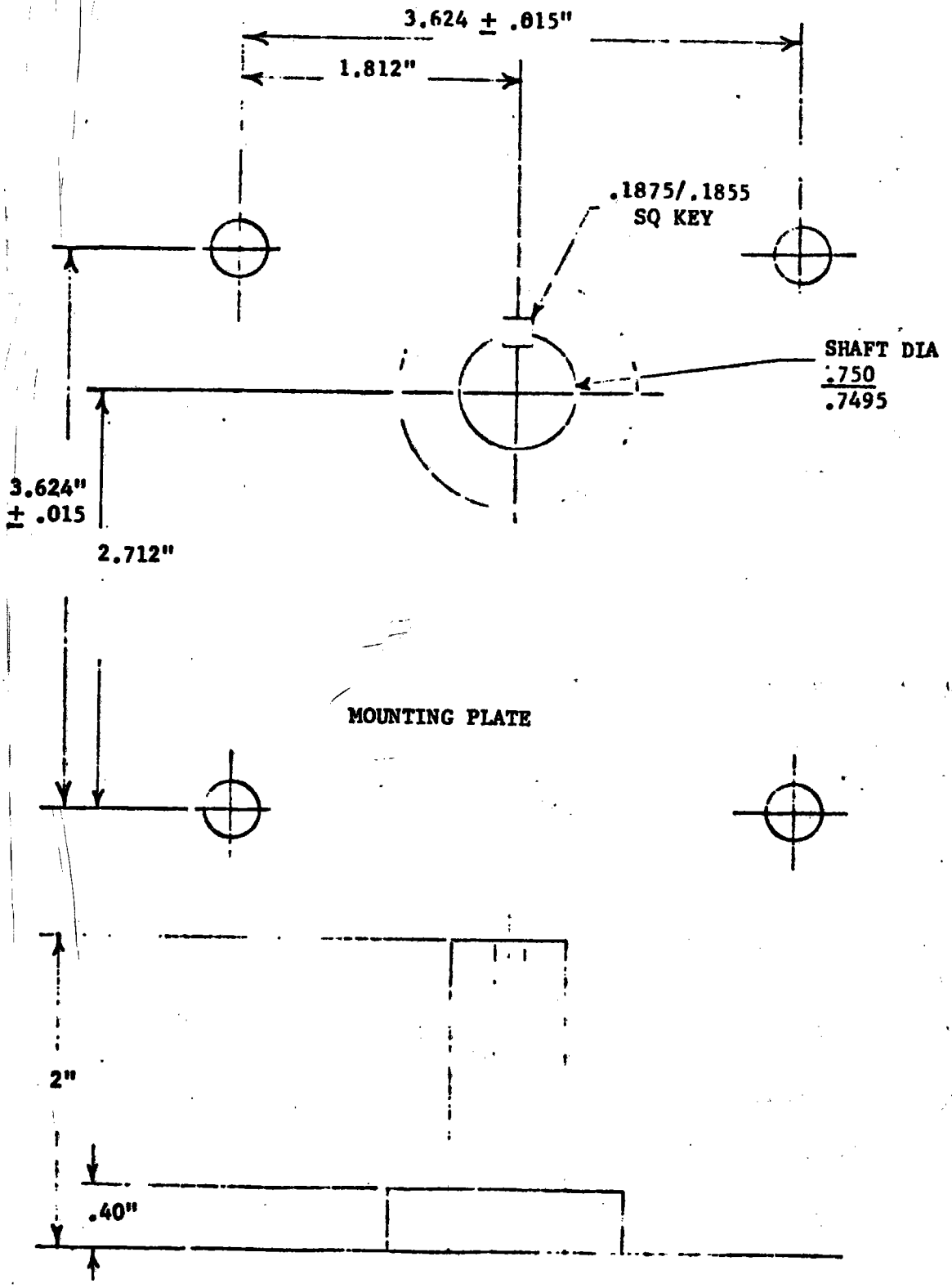
4.2.6 Perform hy-pot test.

4.3 Certificate of Conformance

A certificate of conformance shall be supplied with each lot of gearmotor shipped, certifying that the above physical inspection and performance tests have been performed on each gearmotor and that the gearmotors are in conformance with this specification.

5.0 PREPARATION FOR DELIVERY

The gearmotors shall be packaged for shipment in accordance with the suppliers normal procedures to prevent damage to the gearmotors.

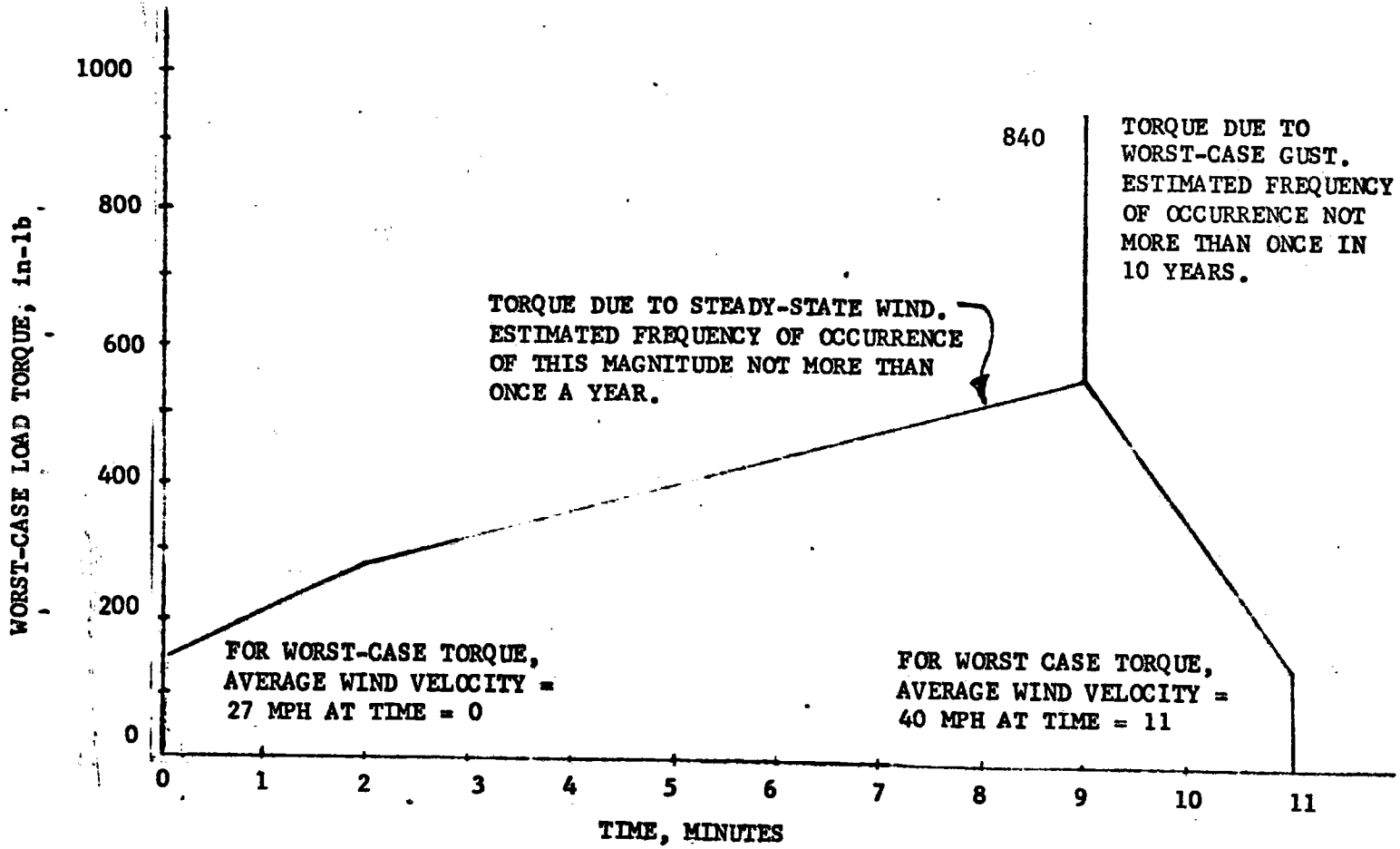


SHAFT DIAGRAM

FIGURE 1 MOUNT SPECIFICATION

SIZE	CODE IDENT. NO.	
A	04236	40E500 1132712
CHG. 1	SCALE	PAGE 7 of 8 SHEET

WIND GUSTS CAN OCCUR AT ANY TIME DURING THIS CYCLE AND INCREASE THE LOAD TORQUE BY A FACTOR UP TO 1.69.



NOTE: DURING THE MAJORITY OF THESE 11-MINUTE CYCLES, THE PEAK LOAD TORQUE WILL BE LESS THAN 200 in-lb.

FIGURE 2 WORST-CASE LOAD TORQUES (ELEVATION GEARMOTOR)

CHG.	SIZE	CODE IDENT. NO.	PAGE	SHEET
1	A	04236	8 of 8	40E500 1132712

SCALE

REVISIONS

REV	SH	DESCRIPTION	DATE	APPROVED
		Initial Release RR9005-001	2/8/79	
0		RELEASE FOR PRODUCTION RW9024-001 Rewritten	1/24/80	
1		REVISED DIMENSIONS IN FIGURE 1 RW9078-001	4/10/80	

																			REV
																			SH
										0	1	0	0	0	1	REV	REV STATUS OF SHEETS		
										6	5	4	3	2	1	SH			

DRAWN BY DEPT DATE

CHECKER

GR ENGR

PROJECT

MARTIN MARIETTA CORPORATION
DENVER DIVISION P.O. BOX 179
DENVER, COLORADO 80201

10 MW_e SOLAR PILOT PLANT
ENCODER

SIZE	CODE IDENT NO.	
A	04236	40E500 1132713

SCALE | PAGE 1 of 6 | SHEET

1.0 SCOPE

This specification describes the Incremental Optical Encoder for use on 10 MWe Solar Pilot Plant. The unit part number is 40E500 1132713-019.

2.0 APPLICABLE DOCUMENTS

None

3.0 REQUIREMENTS

3.1 Mechanical Specifications

3.1.1	Dimensions	See Figure 1.
3.1.2	Shaft Diameter	Standard: .3747/.3745 dia.
3.1.3	Shaft Loading	Up to 20 lbs Axial and 15 lbs Radial
3.1.4	Shaft Runout	.0005 T.I.R.
3.1.5	Starting Torque at 25°C	5.0 Oz. In. Max.
3.1.6	Bearings	Class ABEC 7 with Molybdenum Disulphide Lube
3.1.7	Shaft Seal	Carbon-Glass-Teflon with Garter Spring or equivalent
3.1.8	Shaft	416 Stainless Steel
3.1.9	Housing and Cover	Die Cast Aluminum
3.1.10	Finish	Anodized per Mil-A-8625 Type II, Class I except on mounting surfaces (see Figure I)
3.1.11	Bearing Life (mfg's specifications	2×10^8 Revs at rated shaft loading. 5×10^{10} Revs at 10% of rated shaft loading.
3.1.12	Moment of Inertia	4.1×10^{-4} Oz. In. Sec.^{2}
3.1.13	Operating Speed	.01 RPM
3.1.14	Slew Speed	0.1 RPM
3.1.15	Weight	15 Oz. Max.
3.1.16	Nameplate	The encloder shall be labeled with a permanent nameplate listing, as a minimum: manufacturer, part number, serial number, date of manufacture and Martin Marietta part number.

3.2	Electrical Specifications	
3.2.1	Code	Incremental
3.2.2	Deleted	
3.2.3	Cycles per Shaft Turn	2^{11} (2048)
3.2.4	Supply Voltage	+5 VDC $\pm$5%
3.2.5	Current Requirements	200 Ma Max
3.2.6	Output Format	4 Channels (A, B, $\overline{A}$ & $\overline{B}$) in quadrature $\pm$27° and Index (Z & $\overline{Z}$). See Figure 2.
3.2.7	Output	From DM7830/883B Line Drivers (or equivalent).
3.2.8	Illumination	Incandescent Lamp, derated for 160,000 hours life.
3.2.9	Bake	Electronics to be baked 160 hours at 60°C.
3.3	Environmental Specifications	
3.3.1	Temperature Operating Non-Operating	 -10°C to 50°C -30°C to 50°C
3.3.2	Environmental Exposure	Direct Sunlight
3.3.3	Rain	75 MM per 24 hours
3.3.4	Hail	25.4 MM diameter 0.9 specific gravity hailstones at 23 M/Sec
3.3.5	Ice Load	50 MM
3.3.6	Snow Load	250 Pa (5-psf)
3.3.7	The encoder shall be sealed against water and dust.	
3.4	Termination	From MS3102R18-1P Connector

Pin	Function
A	A
B	B
C	Z
D	+5V
F	Ground
G	Case Ground
H	$\overline{A}$
I	$\overline{B}$
J	$\overline{Z}$

4.0 QUALITY ASSURANCE

The vendor shall submit an acceptance test procedure for Martin Marietta approval. The vendor shall perform acceptance tests in accordance with the approved test procedure. Data from these tests shall be serialized to allow for traceability and shall be supplied with the units.

5.0 PREPARATION FOR DELIVERY

The encoders shall be packaged for shipment in accordance with the suppliers normal procedures to prevent damage to the encoder.

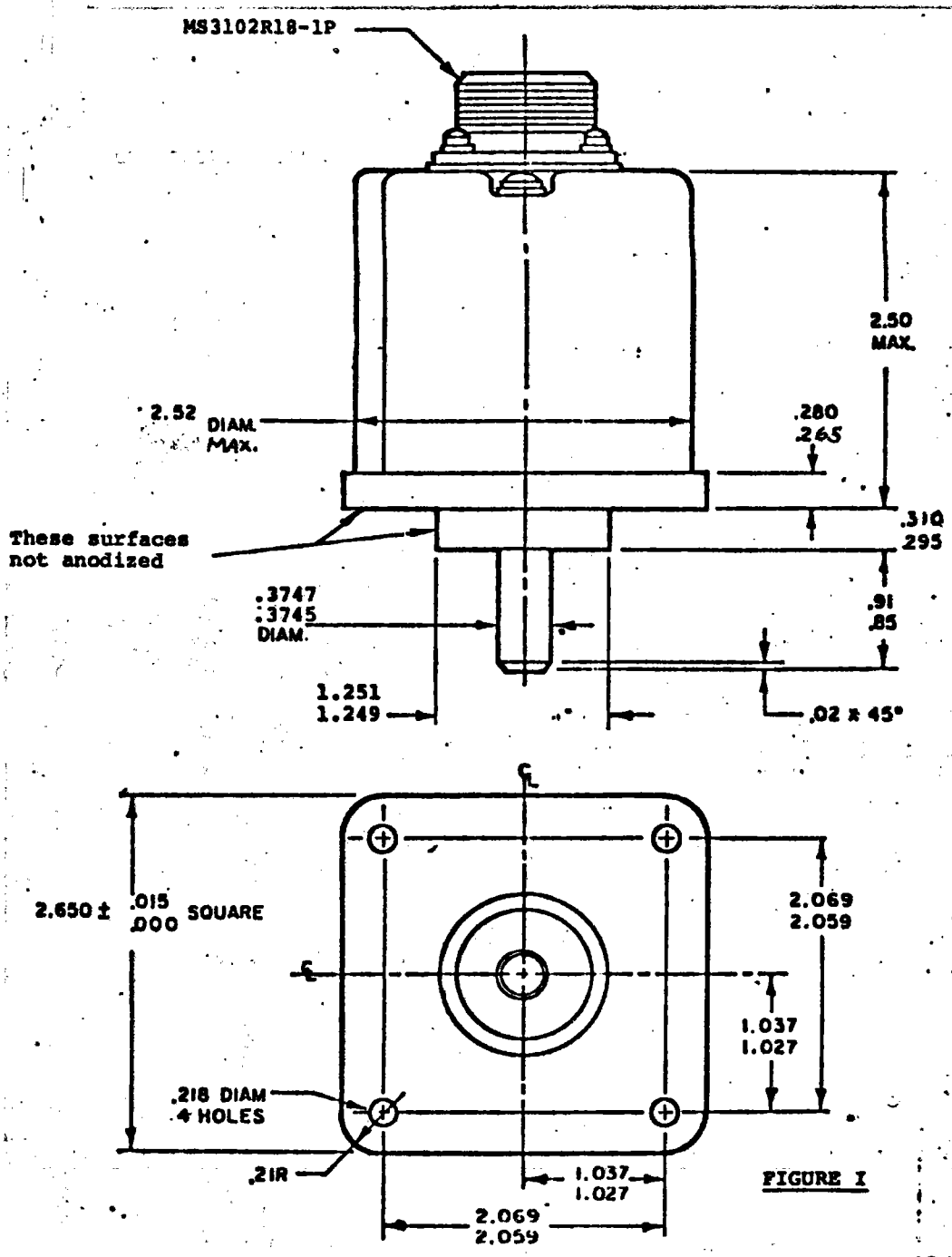
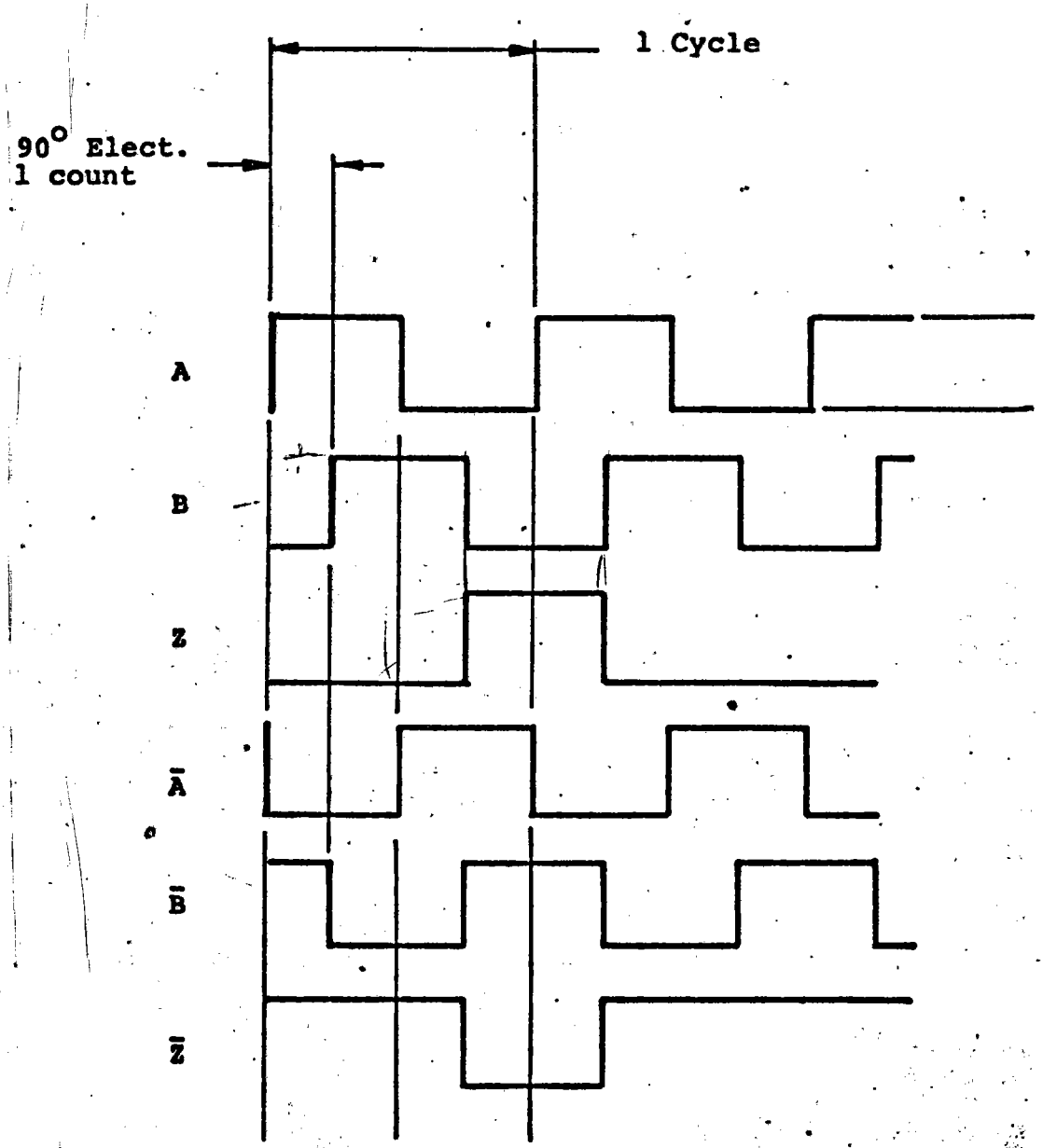


FIGURE I

SIZE	CODE IDENT. NO.	
A	04236	40E500 1132713
CHG. 1	SCALE	PAGE 5 of 6 SHEET



CCW ROTATION
VIEWING SHAFT

FIGURE 2

SIZE	CODE IDENT. NO.	
A	04236	40E500 1132713
CHG. 0	SCALE	PAGE 6 of 6 SHEET

E-49D(1-68)

DRAWING NO. 40E5001132716

MFG CONTROL NO N/A

REVISIONS

LTR	SH	DESCRIPTION	DATE	APPROVED
		INITIAL RELEASE RR9058-005		
0		RELEASE FOR PRODUCTION RW9121-001	80 DEC 12	MHL

																			REV
																			SH
															0	REV	REV STATUS OF SHEETS		
															1	SH			

DRAWN BY D. Powell	DEPT 0510	DATE 4/10/80
CHECKING	N/A	
GROUP ENGR		
STRESS	N/A	
WEIGHT	N/A	
QA - H.R. Warden 1-5-81		
CUSTOMER RPRSNTV	N/A	
PROGRAM RPRSNTV		

MARTIN MARIETTA CORPORATION
POST OFFICE BOX 179, DENVER, COLORADO

HC/HFC Electronic Substitute Parts List

SIZE	CODE IDENT NO.	
A	04236	40E5001132716
SCALE	PAGE 1 of 9	SHEET 1

E-5030 (9-69)

REVISIONS

SYM	PAGE	DESCRIPTION	DATE	APPROVED
		Initial Release		

CHG 0	SIZE A	CODE IDENT NO. 04236	40E5001132716
	SCALE	PAGE 2	SHEET 1

1.0 CONTENTS PAGE

2.0 SCOPE

This document contains substitution requirements for both screened and unscreened components effective on the Heliostat Controller and Heliostat Field Controller assemblies.

3.0 CAPACITORS

PART NO.	MFG.	SUBSTITUTE	MFG.
1620473X90358C2	Sprague	T120A473M035AS	Kemet
162D156X0015EE2	Sprague	T120B186M010AS	Kemet
162D226X0015EE2	Sprague	T120B186M010AS	Kemet

4.0 RESISTORS

4.1 Discrete Resistors

PART NO.	MFG.	SUBSTITUTE	MFG.

4.2 Resistor Networks

PART NO.	MFG.	SUBSTITUTE	MFG.
4308R-101-682	Bourns	784-1-R6.8K	Beckman
		750-81-R6.8K	CTS

5.0 INTEGRATED CIRCUITS

PART NO.	MFG.	SUBSTITUTE	MFG.
SNJ54(#)J-00	TI	DM54(#)J/883	NAT
		54(#)J/883B	Raytheon
		54(#)J-03	Raytheon
		54(#)DM	Fairchild
		S54(#)F/B	Signetics
D2114L-3	Intel	D2114AL-4	Intel
2716	Intel	B2716	Intel
MC6803	Motorola	XC6803	Motorola
SNJ55450 J-00	TI	SNJ55450BJ	TI

- Standard Manufacturers Part Representation
(i.e., LS00, L20, H10)

6.0 MISCELLANEOUS

PART NO.	MFG.	SUBSTITUTE	MFG.
JANTX1N5615 Diode	SEMTECH	SS-4922 Diode	SEMTECH
3365/16	3M	455240-16	SPECTRA

MARTIN MARIETTA

DRAWING CHANGE NOTICE

DRAWN BY	CHECKED	JOB UNIT NO.	ISSUE DATE	CHANGE INCORPORATED	CHANGE	PAGE	DRAWING NUMBER
Mary A. Smith	D Bulenberg	RC 9176-001	12/16/81	NO	6	1 OF 1	40M500513271 9

(LINE OUT WORDS NOT APPLICABLE)
REWORK REQUIRED — NO RETEST REQUIRED

LIAISON CALL REF: N/A

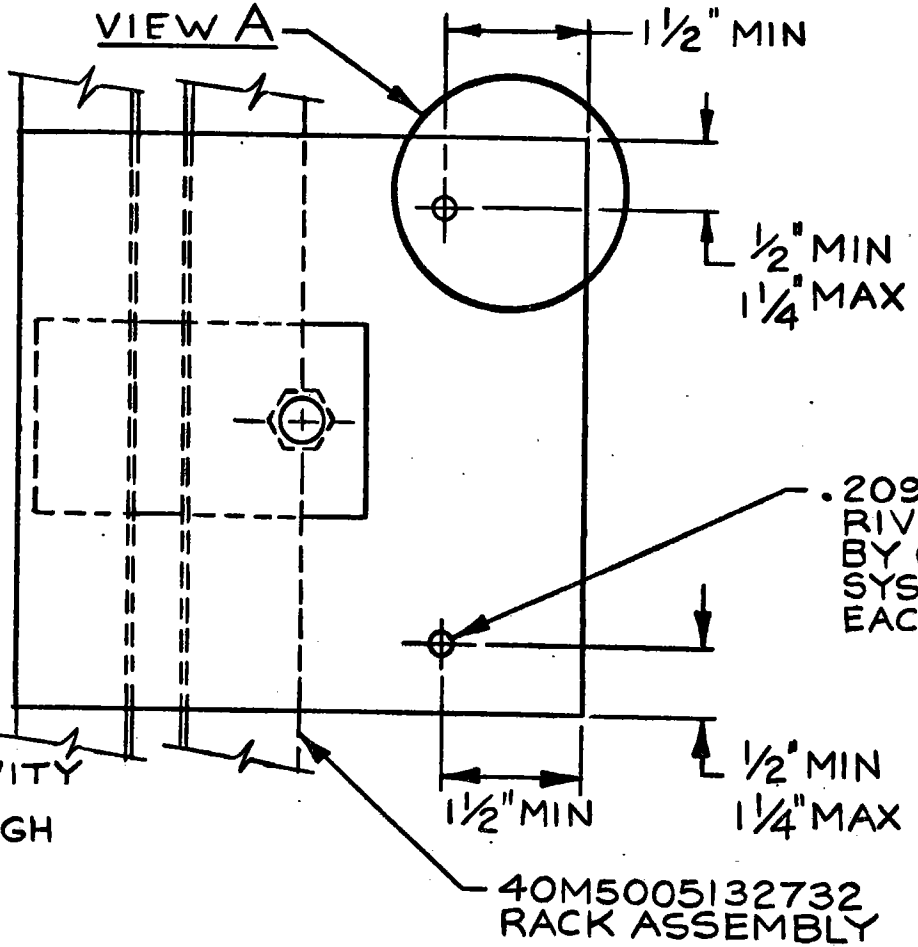
SHEET 1 OF 1

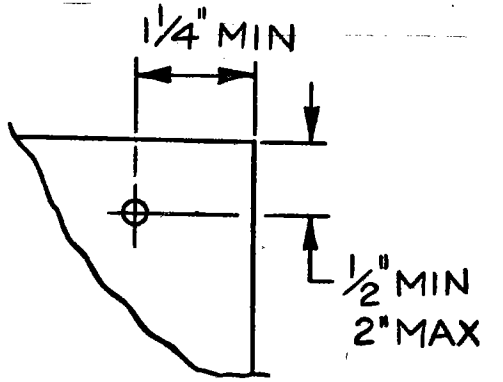
REWORK DCN - DO NOT INCORPORATE

ADD RIVETS AS SHOWN

NOTE:

THIS REWORK IS INITIATED AS A SAFETY MEASURE. IF THE BOND FAILS, THE MIRROR IS CONSIDERED INOPERABLE AND SHOULD BE REPLACED.





VIEW A

APPLIES ONLY TO MIRRORS ADJACENT TO EL. BEAM (2 MIRRORS/HELIOSTAT)

REWORK EFFECTIVITY
MIRROR S/N'S

FROM	THROUGH
02000	02999
06000	06999
09000	09399
17000	19999

(EXCLUSIVE OF SCRAP)

DIM. SHOWN ABOVE APPLIES TO ALL DOUBLERS EXCEPT AS SHOWN IN VIEW A

DRAWING NO. 40I5001132750

REVISIONS

REV	SH	DESCRIPTION	DATE	APPROVED
0		Initial Release	10/26/81	

																		REV
																		SH
													0	0	REV	REV STATUS OF SHEETS		
													2	1	SH			

DRAWN BY: Timothy D. Tarkin DEPT: 0423 DATE: Oct 31, 1981

CHECKER

QR ENGR

PROJECT: W. Stark 10-26-81

CONTRACT NO.

MARTIN MARIETTA CORPORATION

DENVER DIVISION, POST OFFICE BOX 179, DENVER, COLORADO 80201

Heliostat Array Controller
Equipment List

SIZE	FSCM NO.	DWG NO	REV
A	04236	40I500 1132750	0

SCALE	PAGE	SHEET
	1	

E-603D(5-78)

EQUIPMENT LIST

QUANTITY	MODEL NO	
2	7863	General Purpose Digital Computer . Extended Precision Hardware Floating Point . 128K Bytes of Error-correcting Solid State Memory . Power Fail/Auto Start . Direct Memory Input/Output Processor Dual Bus . Special Firmware FORTRAN
2	3320	Battery Backup
4	3691	Memory, 128K Bytes, MOS with ERCC
2	3765	Moving Head Disc/Console Controller
2	3109	Communications Processor Option
4	4903	Peripheral Controller Interfaces
2	4906	Peripheral Controller Switch
5	4811	Asynchronous Interface, RS232
2	4824	Serial Link, High Speed
1	4227	Line Printer, 280 LPM, with Controller
2	1907-A-2	Universal Communications Controller, 32 Line
1	1930-2A	Universal Communications Chassis 2 Port Primary
1	1930-2B	Universal Communications Chassis 2 Port Expansion
8	1931	Asynchronous Interface, RS232
2	TI 820	TI820 KSR Terminal
1	4228	Line Printer, 150 CPS
2	ISC 8001	ISC 8001, Color CRT
2	1999	Chromatic, 1999, Color Graphics CRT
2	3648	Memory Expansion Unit
4	3693	Memory, 128K Bytes, MOS with ERCC
2	3321	Battery Backup, Memory Expansion
2	4148	Magnetic Tape Unit
1	4411	Card Reader, 300 CPM, with Controller
1	60-DC	True Time WWV Receiver
1	A60FS	True Time Antenna
	N/A	Miscellaneous Interconnecting Cables

NOTE: Equipment Interconnections defined by Computer Supplier.

	SIZE	FSCM NO.	DWG NO.	REV
	A	04236	401500 1132750	
	SCALE	PAGE 2	SHEET	

E-49D(5-78)

DRAWING NO. 40E5001132770

MFG CONTROL NO. N/A

MARTIN MARIETTA DASH NO.	AUTHORIZING NSR/A NO.	PART NO. (REF)	MFG CODE	NAME	ADDRESS

SEE PAGE 2 FOR INITIAL RELEASE AND REVISIONS

	REV STATUS OF SHEETS
0	REV
1	SH

DRAWN BY F MOORE	DEPT 0510	DATE 6/17/80
CHECKING		
GROUP ENGR M. Vanderby		6/18/80
STRESS		
WEIGHT		
COMPONENTS APPL		
CUSTOMER RPRSNTV		
PROGRAM RPRSNTV M Richards		6-26-80
RELIABILITY		
QA- Wm Sandow		1-5-81

MARTIN MARIETTA CORPORATION
POST OFFICE BOX 179, DENVER, COLORADO

STIMULATOR, MANUAL CONTROL & ENCODER TEST TOOL -
SUBSTITUTE PARTS LIST

SIZE	CODE IDENT NO.	
A	04236	40E5001132770

SCALE —x— PAGE 1 SHEET 1

C-5440(1-68)

REVISIONS

SYM	ZONE	DESCRIPTION	DATE	APPROVED
		INITIAL RELEASE RR9058-007	6/18/80	
0		RELEASE FOR PRODUCTION RW9121-001	12/12/80	

SIZE	CODE IDENT NO.	
A	04236	40E5001132770
CHG 0	SCALE	PAGE 2 SHEET 1

BRUNING 44-1 4093-20

E-490(1-68)

1.0 CONTENTS

SIZE	CODE IDENT NO.	
A	04236	40E5001132770
CHG O	SCALE	PAGE 3 SHEET 1

2.0 SCOPE

This document contains substitution requirements for both screened and unscreened components effective on the heliostat stimulator, manual control, and encoder zero set unit assemblies.

3.0 CAPACITORS

PART NO.	MFG.	SUBSTITUTE	MFG.
150D226X9020B2	SPRAGUE	ST513C226K020N	SIEMENS
M39003/01-2023	MIL. SPEC.	M39003/01-2572J	MIL. SPEC.

4.0 RESISTORS

4.1 Discrete Resistors

PART NO.	MFG.	SUSTITUEE	MFC.
RLR07-1502	DALE	RC07-1502 RLR07C1502FR	Allen- Bradley Dale
RLR07-2002	DALE	RC07-2002 RLR07C2002FR	Allen- Bradley Dale
RN65D62R0FR	Corning	RC07-62	Allen-Bradley
RLR07C1505FR	Dale	RCC7-1505	Allen-Bradley

4.2 RESISTOR NETWORKS

PART NO.	MFG.	SUBSTITUTE	MFG.
316A560K	Allen-Bradley	316A564	Allen-Bradley
316A2700	Allen-Bradley	316A272	Allen-Bradley

5.0 INTEGRATED CIRCUITS

PART NO.	MFG.	SUBSTITUTE	MFG.
D2114L3	Intel	D2114AL-4 D2114L3	Intel Intersil
MC8T28P	Motorola	DS8T28N N8T28N	Adv. Micro. Signetics
SN55450BJ	TI	SNJ55450BJ	TI
SN5486J	TI	JM38510/00701BCB	Signetics
SN54S40J	TI	SNJ54S40J	TI
SN54LS279J	TI	SNC54LS279J S54LS279F/883B	TI Signetics
SN54LS123J	TI	54LS123J/883B	Raytheon
SN54LS74J	TI	54LS74J/883B	Raytheon
SN54LS00J	TI	SNC54LS00J JM38510/30001BCB	TI TI
SN5407J	TI	SNC5407J JM38510/00803BCB	TI TI
DM5404NB	Natl	SNC5404J JM38510/00105BCB	TI Motorola
DM54155	Natl	S54155F/883B	Signetics
SN5406N	TI	SNC5406J	TI
SNJ54LS04	TI	SNC54LS04J JM38510/30003 BCB	TI TI
SNJ54LS04	TI	SNC54LS04J	TI
SN54LS367AJ	TI	SNJ54LS367AD	TI
DM54154NB	Natl	SNC54154J	TI
5420N	Signetics	F5400DM	Natl
SN55110-J-00	TI	SNJ55110AJ SN55110AJ	TI TI
SN55108-J-00	TI	SNJ55108BJ	TI

5.0 INTEGRATED CIRCUITS (continued)

PART NO.	MFG.	SUBSTITUTE	MFG.
CD4030C	Natl	SCL4030BE CD4030AE	Siliconix RCA
SNJ54LS02J	TI	S542S02F/883B	Signetics
SNJ54153J	TI	S54153F/883B	Signetics
SNJ54LS193J	TI	S54LS193J/883B	Signetics
SNJ54LS86J	TI	JM38510/30502BCB	Signetics
SNJ54LS373J	TI	SN54LS373J	Signetics

6.0 MISCELLANEOUS

PART NO.	MFG.	SUBSTITUTE	MFG.
572-2121-0603-013	(Dialight)	572-1121-0603-013	(Dialight)
5EB200	ACOPIAN	5E200	ACOPIAN

SIZE	CODE IDENT NO.	
A	04236	40E5001132770
CODE O	SCALE	PAGE 10 SHEET 1

DRAWING NO.

REVISIONS

REV	SH	DESCRIPTION	DATE	APPROVED
		INITIAL RELEASE RR 9104-001	10/14/80	Frohardt
A 0	1-16	EXTENSIVE REVISION RW 9112-001 RELEASE FOR PRODUCTION RW 9112-002	10/30/80	Frohardt
1		REVISED PARAGRAPHS 5.1.1.1, 5.1.2.2, 5.1.3.1, 5.2.2, 5.4.1.2 WAS 5.4.1.1, 5.4.1.3 WAS 5.4.1.2, 5.4.2.2 WAS 5.4.2.1, 5.4.2.3 WAS 5.4.2.2, 5.4.2.4 WAS 5.4.2.3, 5.4.2.5 WAS 5.4.2.4, ADDED 5.4.2.1 AND 5.4.1.1 RW9125-001	1/8/81	Frohardt by P.C
2		REVISED PARAGRAPHS 3.16 & 7.74 RW 9138-001	2/11/81	Frohardt by P.C D PHIPPEN
3		REVISE PARAGRAPHS 3.4, 3.7, 5.1.2.2, 5.12.2.1, 5.1.2.2.2, 5.1.3.1, 5.4.1.2, 8.8, 8.9 ADDED PARAGRAPHS 3.7.1, 3.10, 3.11, 3.22, 4.25 ADDED 7A and 9A RW9147-001, RW9155-001	5/6/81	

						3		3											REV
						7A		9A											SH
3	0	3	3	0	3	3	1	3	3	1	3	0	1	0	3	REV	REV STATUS OF SHEETS		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	SH			

DRAWN BY J C Melmer DEPT DATE 10-3-80

CHECKER

GR ENGR M Frohardt 10-14-80

PROJECT

S. Vandeusen 10/13/80

K. Lacki 10/14/80

STRESS D. Gault 14 OCT. 80

H R Wanlen 11/4/80

CONTRACT NO.

MARTIN MARIETTA CORPORATION

DENVER DIVISION, POST OFFICE BOX 179, DENVER, COLORADO 80201

MATERIAL CONTROL SPECIFICATION

SIZE	FSCM NO.	DWG NO	REV
A	04236	40M500 1132798	3

SCALE	PAGE	SHEET
	1 of 16	

E-503D(5-78)

1.0 SCOPE

1.1 Application - This document specifies the parameters to be used for control of the materials during fabrication of the heliostat mirror assembly.

1.1.1 Work Station instructions will implement the requirements of this document.

1.2 Engineering Information - The engineering drawing shall specify the following information:

Process control specimens, if other than specified herein.

1.3 Equivalent Government Specifications - There are no equivalent government specifications to this process.

1.4 Special Skills - Operators performing this process shall be qualified for the job performed in accordance with the "Pueblo Manufacturing Process," and "Std. 123.1 Skill Certification," as applicable.

1.5 Validation - These requirements will be satisfied by validation of the Work Station Instructions.

2.0 APPLICABLE DOCUMENTS - The following documents form a part of the specification to the extent specified herein:

2.1 Pueblo Quality Control Document

2.2 Engineering Drawings

40M5005132719	10 MW Mirror Assembly
832AH130200	SSPS Mirror Assembly
40M5001132799	Fabrication Specification

2.3 Industry Specifications

ASTM - D2240 Indentation Hardness of Rubber and Plastics by Means of a Durometer, Test for

ASTM - D1002 Strength Properties of Adhesives in Shear by Tension Loading, Test For

2.4 Standard Procedure - (Pueblo Employee Skill Certification) 123.1 Appendix B

2.5 Work Station Instructions

3.0 MATERIALS

NOTE: Items marked with an asterisk (*) are hazardous materials.

Refer to section (8) for safety precautions and handling instructions.

NOTE: Inspection of materials shall be in accordance with the Pueblo Quality Control Document

NOTE: All codes are referenced to the Martin Marietta Denver System.

3.1 * Solvent, Trichloroethane, Inhibited, Technical

Spec: O-T-620
Code: K543A600

3.2 * Cleaning Solvent, Halocarbon (113) Freon or Genesolv

Spec: MIL-C-81302, Type II
Code: K502B

3.3 Deleted

3.4 Cheesecloth, oil free unsized or Kimwipe or Chicopee NON WOVEN Shop Towel

Spec: Commercial
Code: 05077710RL

Spec: Commercial
Code: 05077730BX

Spec: 8007 Commercial

3.5 Film, Polyethylene or Paper, Kraft

Spec: Commercial
Code: A623A

Spec: Commercial

3.6 * Adhesive, Acrylic, Versilok 204

Spec: Commercial, Hughson Chemicals

3.7 * Adhesive Accelerator, Versilok TS-3108-37 or TA-3873-30B (Red pigmented)

Spec: Commercial, Hughson Chemicals

3.7.1 Pigment, Chromopthal Red 2B

Spec: Commercial

3.8 * Adhesive, Foaming, CYBOND 5001

Spec: Commercial, Am. Cyanamid Co.

3.9 * Honeycomb, Aluminum with Adhesive Hexabond III

Spec: Commercial, Hexcel Corp.

3.10 * Solvent, VM&P Naphtha

Spec: Commercial

3.11 * Solvent, A-1100

Spec: Commercial, Union Carbide

3.12 Fabric, Glass Scrim 1659-56

Spec: Commercial, Hexcel Corp.

3.13 * Sealant, Polyisobutylene JS-780

Spec: Commercial, Tremco Mfg. Co.

3.14 * Sealant, Silicone 795

Spec: Commercial, Dow Corning

3.15 * Paint, touch up, Acrylic Hyperthane parts A&B and Thinner #T-84.

Spec: Commercial, Kansas Paint & Color Co.

3.16 * Primer, Touch up, Strontium Chromate, 63Y18, parts A&B and Thinner #71 Kaepox

Spec: Commercial, Kansas Paint & Color Co.

3.17 * Methyl Ethyl Ketone

Spec: Commercial
Code: K527A100

3.18 * Alcohol, Isopropyl

Spec: TT-I-735
Code: K564A100GL or K564A600DR

3.19 * Adhesive, Epoxy, Scotch Weld 2216 parts A&B

Spec: MMSN308
Code: M358A200

3.20 * Mold release, Drilube 842

Spec: Commercial
Code: N308A200

3.21 Deionized Water

3.22 SEMCO Premeasured Kits, 6 oz. and 2.5 oz. sizes
Spec: Commercial, SEMCO

4.0 EQUIPMENT AND TOOLS:

NOTE: Equipment and tools used in this process shall be cleaned of all visual contamination such as dust, dirt, uncured resins, oil, and grease. Oil and grease are permitted only in those areas where required for equipment lubrication.

NOTE: Items marked with a spacemark (#) shall be certified by Quality and all indicating and recording devices shall be calibrated by Quality in accordance with the Pueblo Quality Control Document.

4.1 Squeeze Bottle, or Safety Plunger Can, Labeled as to Contents

Ref: Commercial

4.2 Beaker, 100 ml Polypropylene

Ref: Commercial
Code: 05821600

4.3 Gun, Hot Air, 500W

4.4 Proportioning Pump System, Graco Model #987-031

Source: Robert Taylor & Sons Inc.

4.5 # Mixing System, Graco Model #500-586

Source: Robert Taylor & Sons Inc.

4.6 Mixer, 5 gal, Binks Model #31-133

Source: Robert Taylor & Sons Inc.

4.7 Gun, Graco Model #208-663

Source: Robert Taylor & Sons Inc.

4.8 Pump, Systems, Graco Model #207-568

Source: Robert Taylor & Sons Inc.

4.9 Gun, Extruding, Graco Model #306-586

Source: Robert Taylor & Sons Inc.

4.10 Die, Extruding for Polyisobutylene

4.11 Equipment, Glass Handling

Gloves, Bettcher Industries Inc., Wizard
Arm Protectors
Body protector
Face Shield
Shin Guards

4.12 Safety Equipment
REF: MDM-F-758-452

4.12.1 Gloves, Edmont-Wilson 29-865, neoprene soft-lined

4.12.2 Gloves, Heat Resistant

4.12.3 Goggles, Am. Optical, A.O.484BAF Chemical Goggle

4.12.4 Chemical Apron, Rubber Apron

4.12.5 Polyethylene Gloves, Disposable

4.13 # Molds, Ceramic with vacuum bag, Contoured

4.14 Pump System, Graco Model 226-252

Source: Robert Taylor & Son Inc.

4.15 Gun

Source: Robert Taylor & Son Inc.

4.16 Die, Extruding

4.17 Doubler Locating & Bonding Tool

4.18 Mechanical exhaust ventilation

Facility Item

4.19 Shop Aids, such as beakers, tongue depressors, clamps, tape, etc. as required

4.20 Rivnut Arbor Press

4.21 Rivnut Header, B.F. Goodrich, Model C-362

Source: William W. Allen Co.

4.22 # Scale 0-1500 gram, graduated to 0.1 gram

4.23 # Oven air circulating, vented to outside

4.24 Alignment and clamping fixture STP 1095

4.25 SEMCO Series 388 automatic mixer

Source: SEMCO

5.0 PROCEDURE

5.1 General Requirements

5.1.1 Cleaning - All areas where adhesive or sealant is to be applied shall be visibly clean, free from contaminants such as dust, dirt, grease, and oil. Cleaning shall be carried out according to (5.1.1.1)

WARNING: All solvents to be accomplished in vent hood (4.18), (8.8). Operators must wear gloves and safety items (4.12) as required.

5.1.1.1 Solvent Wiping - Using a clean cloth saturated with solvent, wet the area to be cleaned with either trichlorethane (3.1), halocarbon (113) Freon (3.2), Methylethylketone (3.17), or isopropyl alcohol (3.18). Wipe all solvents with a clean cheesecloth or Kimwipe before it evaporates. If evidence of contamination remains, repeat the cleaning operation.

5.1.1.2 Packaging - After cleaning, all parts shall be handled with clean gloves, or tooling, and shall be protected from contamination by wrapping in polyethylene film or kraft paper if the parts are not to be processed within the same work shift as when they were cleaned.

5.1.1.3 The parts shall be visually examined for contamination just prior to assembly. Any contaminated part shall be recleaned as specified herein.

5.1.2 Adhesive and Sealants

5.1.2.1 Adhesives and Sealants shall be accomplished only in properly ventilated areas (8.8).

5.1.2.2 See Page 7-A

5.1.2.2.1 Continued mixing of accelerator will be accomplished using a Binks mixer (4.6).

CAUTION: Adhesive and accelerator containers must be kept closed when not in use. Do not transfer materials to other containers for storage.

Red pigment (3.7.1) may be added to the accelerator (3.7) using 100 pbw accelerator to 0.5 pbw of pigment.

5.1.2.2.2 Mate parts to be bonded within 3 minutes after mixing of the adhesive and accelerator. Secure parts, if necessary, to prevent movement during cure. Do not handle or release clamping of parts until 20 minutes after mixing. The allowable bond line thickness is .005 to .060".

5.1.2.2.3 Each lot change, or any time adjustments are made to the metering equipment, expel a small amount of adhesive into an aluminum foil cup or a flat surface to form a specimen 1/8 $+.060\ -.000$ inch thick with a maximum diameter of 2.5 inches. After 20 minutes, strip the beaker or cup away from the adhesive. The material shall exhibit a Shore D hardness of 70 minimum when tested per ASTM-D2240.

5.1.2.2.4 All external bond lines shall extend to at least the edge of the bond area. There shall be no gaps or foreign matter evident in the bond line. A small amount of squeeze out is desirable to ensure that a seal is attained.

5.1.2.2.5 In process control specimen shall be made on each lot of adhesive. The specimen shall be a lap shear of ½ square inch which shall exhibit at least 3000 PSI when pulled to failure at a crosshead speed ≤.050 inches per minute. Use nominally 0.063" aluminum, 6061 T3 or T6 samples, solvent cleaned and sanded with 120-180 grit in bond area. An ideal bond line of .010 inches is desirable.

5.1.2.3 Honeycomb with adhesive (3.9) will be handled and stored per Table 1. The adhesive may be exposed to temperatures under 100°F for short periods not to exceed 2 hours total. Temperature monitors on each container shall not indicate any temperature 100°F or above. If excess temperature/time is exceeded, perform gel test to requalify material.

5.1.2.3.1 Gel Test

5.1.2.3.1.1 A gel test shall be performed on the adhesive for honeycomb with adhesive (3.9) on each lot, or to extend the shelf life if necessary. The adhesive shall not reach a gel point in less than 2 minutes or more than 18 minutes when tested per the following procedure:

A. Set the cure plate to 275 ± 5°F and allow the temperature to stabilize.
B. Place a small amount of the sample in the center of the hot plate.

5.1.2.2 Adhesive (3.6) and accelerator (3.7) shall be mixed together using a Graco proportioning pump system (4.4) set to dispense 10 ± 2 pbw adhesive to 1 pbw accelerator and Graco Mixing system (4.5), or SEMCO premeasured kits (3.22). Mixing of the SEMCO kits shall be performed using the SEMCO series 388 mixer (4.25) with a minimum mix time of 30 seconds or hand stirred to a mix equivalent to the automatic equipment. Hand mixing will be allowed in the same proportions as mechanical mix and in accordance with the manufacturer's instructions. Mixing shall be thorough, and the material shall be uniform in appearance. Mixing shall be accomplished in less than 90 seconds but more than 45 seconds.

C. Start timing with a stop watch immediately when the sample is all on the plate and spread the sample with a circular motion of a 1/2" wide spatula. Use only enough pressure to bring the spatula into a flat position on the hot plate. Make as thin of a layer as possible.

D. Gradually spread the sample over an area. Keep checking sample character of the material.

F. Watch for the appearance of strands of resin, called strings, pulling up with the spatula. When the strings cannot be pulled from the sample without snapping off in a very short distance, stop watch, the gel point has been reached. (Gel point for this method is defined as the point at which resin strings cannot be pulled from the bead without snapping off in a very short distance.)

5.1.2.4 Deleted.

5.1.2.5 Polyisobutylene (3.13) will be applied with Graco pumping equipment (4.8) and extrusion die (4.10) at a temperature not exceeding 260°F.

5.1.2.6 Apply silicone sealant (3.14) with Graco pump (4.14) and application tool so that no gaps or foreign matter are evident in the external bond line.

5.1.2.6.1 Prepare a process control specimen of the silicone sealant by dispensing a layer of at least 1/4 inch deep into a beaker or aluminum foil cup. The specimen shall be tack free within 2 hours. Sufficient cure is determined by a Shore A of 25 minimum when tested per ASTM-D2240.

5.1.2.7 Foaming adhesive (3.8) will be allowed to warm after removal from refrigeration until no moisture condensation is evident on the wrapping. Wrapper may then be removed. Prepare only sufficient material for 1 shift of production. Material remaining at ambient for more than one shift shall be discarded.

5.1.2.7.1 Use polyethylene gloves (4.12.5) when handling foaming adhesive.

5.1.2.7.2 A process control specimen shall be made on each lot of foaming adhesive. A piece at least 2 inches by 1 inch by .050 inches thick shall be cured for 1 hour at each of the selected bond temperatures ± 8°F with a ramp up of approximately 10°F per minute. The cured specimen shall increase in volume at least 4 times. Foaming adhesive shall be cured in properly ventilated area (8.8).

5.1.2.8 Assure that all two part adhesives are mixed well in their container before blending together. Some components experience settling and/or separation after storage.

5.1.3 Coatings

5.1.3.1 See Page 9-B.

5.1.3.2 The acrylic hyperthane (3.15) shall be mixed 4 pbv of part A to 1 pbv of part B. Allow mixed material to set for 15-20 minutes before use. If thinning is necessary use KP&C #T-84 thinner. The paint may be force dried for 20-30 minutes at 120-150°F. The maximum allowed thinner is 20% of the initial volume.

5.1.3.3 The strontium chromate primer (3.16) shall be mixed 4 pbv of part A to 1 pbv of part B. Allow mixed material to set for 15-20 minutes before use. If thinning is necessary use #71 Kaepox thinner. Allow 20-40 minutes cure before applying the finish coat. The maximum allowed thinner is 20% of the initial volume.

5.1.3.4 A process control specimen shall be processed for each lot of paint. The specimen shall not exhibit tackiness after the proper drying time (5.1.3.2 & 5.1.3.3).

5.1.3.5 Paint shall be mixed and applied in a properly ventilated area (8.8).

5.1.4 Records

5.1.4.1 Material Control

5.1.4.1.1 Each container of adhesive, accelerator, sealant, paint, and each package of honeycomb with adhesive shall have valid shelf life data from which shelf life requirements can be determined.

5.1.4.1.2 Shelf life shall be controlled per Table #1.

5.1.4.1.3 Shelf lives can be extended by retest if results are acceptable. Recommend extension of six months for paint and one month for honeycomb adhesive.

5.1.4.1.4 Each package of honeycomb with adhesive (3.9) shall have a temperature monitor afixed to it. This monitor shall indicate the highest temperature the package has been subjected to. The monitor range shall cover $\leq 120^{\circ}F$.

5.1.4.2 Process Control - The work station instructions shall include a method of control of critical process steps. These shall include, but are not limited to the following:

a. Open time between surface preparation and handling;
b. Open time during consecutive bonding operations;
c. Working pot life;
d. Cure cycle; and
e. Mixing ratio on two-component systems.

Material	Mfgr.	Pot Life	Cure Time	Shelf Life	Storage Requirements
Adhesive Versilok 204	Hughson	6 min. when activated with TS-3108-37	Handleable Bond 20 minutes min. @ 75°F	6 months	Store below 110°F
Accelerator Versilok TS-3108-37	Hughson		Full cure 50 minutes min @ 75°F	6 months	Store below 90°F
Foaming Adhesive Cybond 5001	Am. Cyanamid		60 min. @ 235°F to 275°F	6 months	Store at or below 0°F Shop Life of 5 days at 75°F
Adhesive Hexabond III HP347	Hexcel		60 min. @ 235°F to 275°F	45 days	Temp. must never exceed 70°F Recommended shipment at 40°F - 50°F
Polyisobutylene JS 780	Tremco				
Silicone 795	Dow Corning	Cure begins upon exposure to air	Handleable in 2 Hours. Full Strength with Shore A 25 min.	6 months	Store at or below 80°F
Paint Acrylic Hyperthane	Kansas Paint	*	20-30 min. @ 120° - 150°F		Store in warm dry area
Primer Strontium Chromate #63418	Kansas Paint	*	20-40 min.		Store in warm dry area
Adhesive Scotch Weld 2216	3 M	1 hr. after parts A&B are mixed	Handleable Bond 16 hr. full strength 48 hr.	6 months	Store below 110°F

* Usage allowed as long as mixed material is applyable with good appearance.

Table 1 Materials Control Chart

5.2 Honeycomb/Pan Assembly

5.2.1 Clean pan and internal corner clips if required per paragraph (5.1.1.1)

5.2.2 Bond the internal corner clips to the pan using adhesive (3.6 & 3.7) applied in a predetermined pattern specified in the Work Station Instructions and according to paragraph (5.1.2.2), and in a properly ventilated area (8.8).

5.2.3 Apply foaming adhesive per engineering drawings and paragraph (5.1.2.7). Wear rubber gloves (4.12) when handling adhesive, and use only in a properly ventilated area (8.8).

5.3 Mirror/Pan Assembly

5.3.1 Clean the mirror back and edges as required per paragraph (5.1.1.1). The mirror may be cleaned using isopropyl alcohol or water using the method per paragraph 5.3.2.

WARNING: Use special safety equipment when cleaning glass.

5.3.2 Before placing the mirror on the tool, visually check the bond tool (4.13) surfaces to ensure they are free of dust, dirt or other contamination. If cleaning is necessary the tool shall be cleaned using water by wetting the area to be cleaned with water. Wipe all moisture with a clean dry cheesecloth or Kimwipe before it evaporates. If evidence of contamination remains, repeat the cleaning operation.

5.3.3 The joining of the pan assembly to the mirror shall be accomplished within 2 hours of the initial assembly of the honeycomb with the pan. Any longer interval shall require dustproof packing of the pan assembly and storage at less than 70°F. Total time exposure to room ambient before bonding shall not exceed 4 hours.

5.4 Attachment of Plates and Clips

5.4.1 Doubler Plates

5.4.1.1 Clean both surfaces if required per paragraph 5.1.1.1.

5.4.1.2 Place a bead of sealant/adhesive around a rivnut and install it into the doubler with rivnut header (4.21). This shall be accomplished in a properly ventilated area (8.8). Assembly shall be within 3 minutes of mixing adhesive.

5.4.1.3 Apply the adhesive system (3.6), (3.7) to the back of the doubler plate in a predetermined pattern specified in Work Station Instructions. Bond the doublers to the back of the mirror assembly per the engineering drawings, and in a properly ventilated area (8.8).

5.4.2 Edge Channels and External Clips

5.4.2.1 Clean both surfaces if required per paragraph 5.1.1.1.

5.4.2.2 Apply adhesive (3.6 & 3.7) to the inside of the edge channels in a predetermined pattern specified in the Work Station Instructions. Bond the channels to the edge of the mirror per engineering drawings, and in a properly ventilated area (8.8).

5.4.2.3 Bond the external corner clips in place the same as paragraph (5.2.2).

5.4.2.4 Apply silicone sealant (3.14) between the mirror face and edge channel so that it completely fills that area. Prepare a process control sample to determine when the silicone sealant is cured per paragraph (5.1.2.6).

5.4.2.5 When the silicone is cured, not less than three days, the assembly is ready for final leak and contour checks if required.

6.0 REPLICATE TENSILE SAMPLE

6.1 Assemble a 4" x 4" section of a mirror module by using a piece of honeycomb core 4" x 4" (3.9) sandwiched between a 4" x 4" piece of mirror and a 4" x 4" piece of pan material, with a 4" x 4" piece of scrim (3.12) between the mirror and the core per Figure 1. Use same cleaning methods as Production Parts (5.0), if cleaned.

6.2 Place this assembly in an oven with a static load equivalent to 6" of Hg vacuum, 3 psi or 48 lb total.

6.3 Heat this per the Fabrication Specifications cure cycle for the comparable mirror module to bond the replicate assembly.

6.4 When the replicate assembly is cooled bond a 4" x 4" piece of doubler material, properly painted per engineering drawings, to the pan side of the assembly with Versilok 204/TS3108-37 (3.6 and 3.7) mixed per (5.1.2.2) ref. Figure 1. Use a properly ventilated area (8.8).

6.5 Aluminum pull blocks 4" x 4" x 1" with a drilled and tapped 1/2 - 13 UNC hole in the center will be bonded to this assembly.

6.6 Use Scotch Weld 2216 A&B (3.19) or Alternate (see paragraph 6.7).

6.6.1 Mix this 7 parts by weight "A" to 5 parts by weight "B" and mix thoroughly until the mixture is a uniform grey color. Use a properly ventilated area (8.8).

6.6.2 A minimum batch shall contain 28 grams of resin (Part A) and 20 grams hardener (Part B).

6.6.3 Pot life of mixed adhesive is 1 hour.

6.7 Alternate adhesive may be Versilok 204/TS3108-37 (3.6 and 3.7) mixed per (5.1.2.2). Adhesive mixing will be accomplished in a properly ventilated area (8.8).

6.8 Prior to bonding all parts will be cleaned with alcohol (3.18) per (5.1.1). Cleaning will be performed in a properly ventilated area (8.8)..

6.8.1 Special care shall be taken to assure properly cleaned glass surface on mirror.

6.9 Allow cleaned parts to set 5 to 15 minutes prior to bonding.

6.10 Assure that adhesive doesn't contaminate the threads in the pull blocks, fill the threaded holes with tissue paper if necessary.

6.11 Use alignment and clamping fixture (4.22) when bonding the pull blocks to the sample to assure proper alignment of the holes in the blocks.

6.11.1 Apply mold release agent (3.20) to the fixture prior to use to avoid possible bonding of the blocks to the fixture.

6.11.2 Clamp with just enough pressure to assure squeeze out around the periphery of the block.

6.11.3 After 2 to 5 minutes check alignment of sample with blocks, readjust if necessary.

6.12 If using adhesive 3.19 allow to cure for 16 hours at room temperature (65°F to 100°F) before removing from fixture. Full cure is achieved in 48 hours, or when the adhesive exhibits a minimum Shore D hardness of 50.

6.13 If using adhesive (3.6 and 3.7) allow to cure per 5.1.2.2.2. Full strength is achieved in 1 hour.

6.14 Perform bond tension test at a crosshead speed of ≤ 0.050"/minute. Minimum strength shall be 57 psi.

6.15 Removal of Pull Blocks.

6.15.1 Heat the pulled samples with pull blocks to approximately 350°F. At this temperature the operator should be able to remove the sample from the pull block by peeling or with the aid of a spatula to pry with.

6.15.2 While the blocks are still hot scrape the excess adhesive from the blocks with a spatula, or other scraper.

WARNING: Use heat resistant gloves (4.12.2) and take care to avoid burns from hot items.

7.0 QUALITY REQUIREMENTS

7.1 Quality shall ensure compliance with this process by performing inspection functions at the "Produce Quality Verification Required" (PQVR) points as required by the authorizing documents. Quality shall observe and verify additional in-process operations when required.

7.2 Finished product requirements shall be determined by visual inspection with the unaided eye under normal light intensity, except that a bulb at a distance not greater than 24 inches may be used.

7.3 Quality shall verify that process controls and contour dimensions meet the requirements of this process and the engineering drawings.

7.4 One 4"x4" replicate assembly shall be processed with each lot of material released for production. The flat wise tensile strength shall be 57 psi minimum at a crosshead speed of ≤ 0.050 inches per minute (6.0). See Figure 1.

7.5 Quality shall approve the work station instructions, panel test results, tool qualification, and first article fabrication data prior to production processing.

7.6 Ultrasonic, radiographic or other nondestructive test methods may be used by Quality to ensure conformance to the requirements of this process.

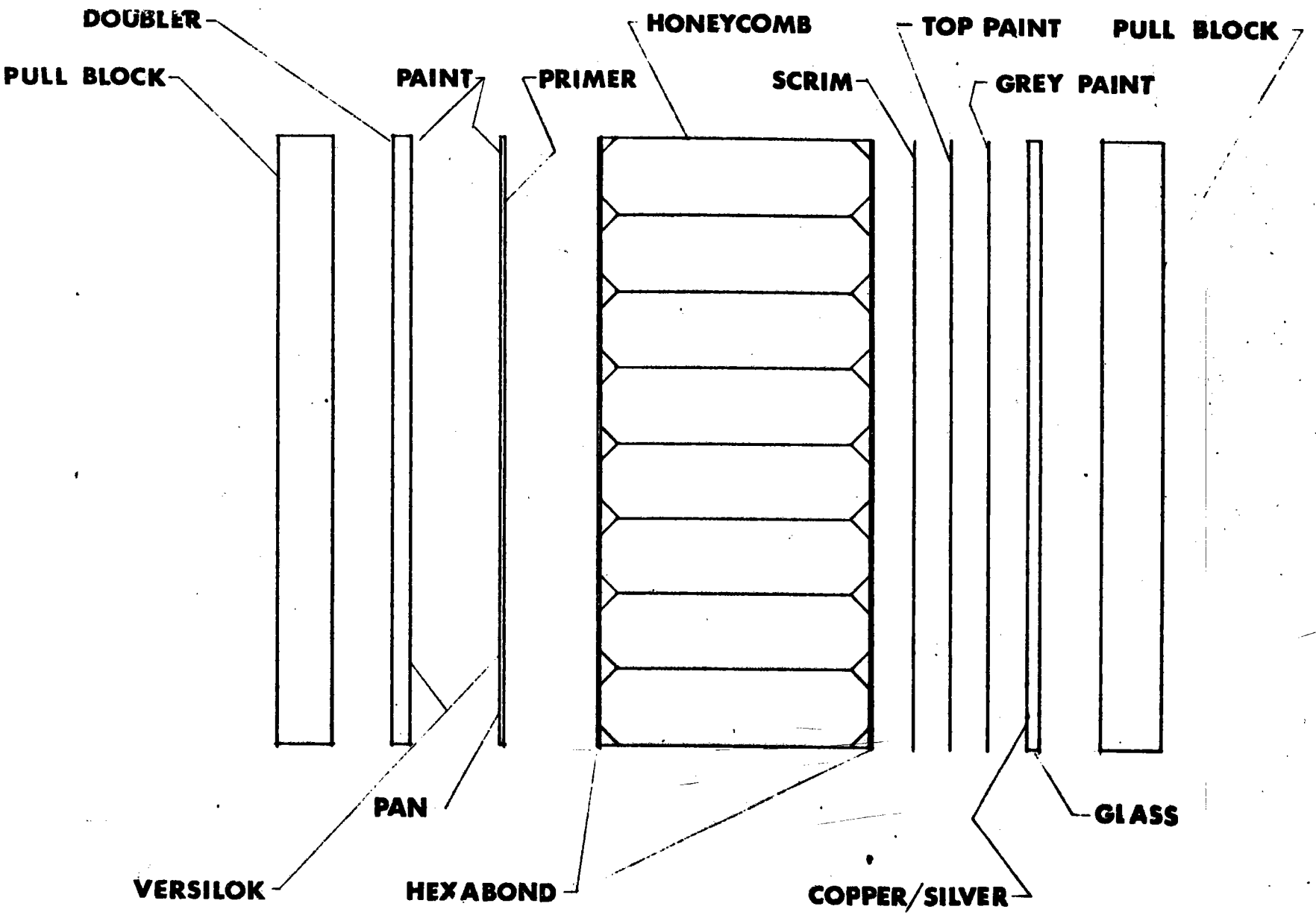
7.7 INSPECTION CRITERIA for surface defects in glass in finished mirror module assembly.

7.7.1 Disregard scratches in glass not visible beyond 10 feet. Any scratch visible beyond 10 feet is a dig.

7.7.2 Accept digs up to .25 in wide or long, reject all glass with digs in excess of .25 in.

7.7.3 Accept edge chips that are free of stress risers (cracks regardless of dimension) and do not preclude sealing. Total chip area must be covered with PIB.

FIGURE 1
TENSILE SAMPLE – 4 x 4 in.



7.7.4 Stains and spots are not cause for rejection.

8.0 SAFETY

8.1 Safety shall approve the work station instruction, procedure and revisions.

8.2 Materials used in this process can cause skin irritations if prolonged contact is experienced. Wear gloves (4.12.1) depending on material handled. If skin contact occurs, wash affected area thoroughly with soap and water.

8.3 No smoking or open flame shall be permitted in the area while working with the hazardous materials noted in the Materials Section 3.

8.4 All solvents shall be dispensed from a safety plunger can or plastic squeeze bottle.

8.5 Wearing contact lenses when working with solvents, chemicals, and adhesives is prohibited.

8.6 Parts and test panels will be hot upon removal from the oven or tool. Wear heat resistant gloves (4.12.2) when handling these.

8.7 When handling glass wear safety equipment (4.11).

8.8 Solvents (3.1) (3.2) (3.10) (3.11) (3.18) adhesives (3.6) (3.7) and paints (3.15) (3.16) shall be used in an area with a mechanical exhaust ventilation hood (4.18) or in other areas only when specifically approved by Personnel Safety.

8.9 Wear goggles (4.12.3) gloves (4.12.1) and apron (4.12.4) when handling materials (3.1) (3.2) (3.6) (3.7) (3.10) and (3.11).

9.0 GENERAL NOTES

9.1 When revising this document, the requirements of documents 40M5005132719, 832AH130200, and 40M5001132799 shall also be reviewed for compatibility.

REVISIONS

REV	SH	DESCRIPTION	DATE	APPROVED
0		INITIAL RELEASE RR 9168-001 RELEASE FOR PRODUCTION RR-9108-002	10-24-8 1/8/80	MMB
1		REVISED PARAGRAPHS 3.2.1.2, 3.2.1.3, 3.2.1.4, 3.2.1.5 DELETED PARAGRAPH 3.2.3.6 RW9124-001	1/8/80	
2		REVISED PARAGRAPH 3.2.5.3 RW9148-001	5/6/81	D PHIPPEN

DRAWING NO.

																			REV
																			SH
											0	2	1	0	2	REV	REV STATUS OF SHEETS		
											5	4	3	2	1	SH			

DRAWN BY	DEPT	DATE
M Prahst	0490	10-21-80
CHECKER D PHIPPEN	0485	10-22-80
GR ENGR L Eulenberg	0485	10-24-80
PROJECT M Reinhardt	0490	10-21-80
A R Henderson		10-24-80
[illegible] N. Bull		10-24-80

MARTIN MARIETTA CORPORATION

DENVER DIVISION, POST OFFICE BOX 179, DENVER, COLORADO 80201

FABRICATION SPECIFICATIONS FOR 10 MWe MIRROR MODULE

SIZE	FSCM NO.	DWG NO	REV
A	04236	40M 500 1132799	2

CONTRACT NO.	SCALE	PAGE	SHEET
		1 of 5	

E-503D(5-78)

Fabrication of Heliostat Mirror Module

1.0 SCOPE

1.1 This specification defines the requirements to be followed during fabrication of the heliostat mirror assembly, consisting of a reflecting mirror, aluminum honeycomb, and steel pan housing.

1.1.1 Work Station instructions will be used in conjunction with this document.

1.2 Equivalent Government Specifications - There are no equivalent government specifications to this process.

1.3 Validation - This process will be validated on the first article built.

2.0 APPLICABLE DOCUMENTS - The following documents form a part of the specification to the extent specified herein:

2.1 Pueblo Quality Control Document;

2.2 Engineering Drawings - 40M5005132719, 832AH130200, and 40M5005132718;

2.3 Material Control Specifications 40M5001132798.

3.0 REQUIREMENTS

3.1 LOADING OF BOND TOOL

3.1.1 The pan shall be supported in a fixture while bonding the inside corner clips such that the contour of the assembly will match the bond tool with minimum distortion and bending. The bonding adhesive shall be applied in a predetermined pattern such that no leak paths exist in the adhesive.

3.1.2 The foaming adhesive will be installed so as to have at least 1" clearance from each corner and at least 1" clearance from the centerline on the end with the two mounting points.

3.1.3 The honeycomb core with adhesive previously applied shall be inserted into the pan with the core in contact with the pan edge the entire perimeter.

3.1.4 The scrim shall be laid on the honeycomb in such a way that it does not lay on the pan lip but must be no more than 3/4 inch from the edge of the honeycomb.

3.2 BOND CYCLE

3.2.1 Loading and Ramp-up

3.2.1.1 The mirror shall be placed on the bond tool face down. It shall be centered on the tool so that the pan is centered over the mirror within .06". A vacuum shall then be applied to hold mirror down on the bond tool.

3.2.1.2 The tool shall be at $185^{\circ}F \begin{smallmatrix} +0^{\circ}F \\ -20 \end{smallmatrix}$ idle temperature prior to placement of a mirror on the tool.

3.2.1.3 After initial placement of the mirror on the tool, it will be held to the tool with $6 \pm .50$ inches of Hg. vacuum.

3.2.1.4 After the pan assembly has been installed and the lid closed, apply hold-down vacuum of $6 \pm .50$ inches of Hg on the entire assembly.

3.2.1.5 Ramp-up from $185^{\circ}F$ to bond temperature shall be accomplished in the minimum time, but keeping the differential temperature of the glass less than $50^{\circ}F$. The maximum ramp-up time shall be $\leq$ 25 minutes.

3.2.1.6 The four zones of the tool shall be held to within $32^{\circ}F$ of each other.

3.2.2 Bond Cycle

3.2.2.1 Cure time will be for one hour at the bond temperature.

3.2.2.2 This hour shall begin when all four zones have reached bond temperature $\pm 16^{\circ}F$.

3.2.2.3 The first 15 minutes of bond cycle shall be at the selected bond temperature $\pm 16^{\circ}F$.

3.2.2.4 The last 45 minutes shall be at the selected bond temperature $\pm 8^{\circ}F$.

3.2.2.5 Bond temperature may be varied as necessary by engineering to control mirror contour. Bond temperature shall be between $235^{\circ}F$ and $275^{\circ}F$.

3.2.3 Ramp-Down

3.2.3.1 Maximum differential mirror assembly tempera res shall be held to $20^{\circ}F$ or less.

3.2.3.2 When all zones of the tool are at or below 185°F, but not lower than 165°F, the hold-down vacuum on the mirror face will be released.

3.2.3.3 After complete release of the mirror face hold-down vacuum, the hold-down vacuum on the entire assembly will be released.

3.2.3.4 Each vacuum shall be released in no less than two minutes.

3.2.3.5 After the vacuum has been released, the mirror assembly shall be removed from the tool. After vacuum has been released, cut core to receive rivnut and install spacer tape.

3.2.3.6 Deleted

3.2.3.7 The tool may be reloaded at this time.

3.2.4 Primary Sealant (Polyisobutylene)

3.2.4.1 The primary sealant shall be applied in accordance with the drawings, making certain to fill the area between the entire edge of the mirror and the lip of the pan, providing a leak-tight seal.

3.2.4.2 Sealant temperature shall be no more than 260°F.

3.2.5 Doubler Installation

3.2.5.1 A .025" diameter bead of adhesive will be applied around the rivnut under the lip prior to installation of the rivnut in the doubler.

3.2.5.2 The rivnut shall be upset so that the shoulder of rivnut is flush with the back of the doubler.

3.2.5.3 Attach the doubler to the mirror assembly with adhesive so that 85% of the area, excluding the 2" x 2" spacer tape, is bonded. Voids are not allowed closer than 3/4" to the doubler edge. Edges may be sealed. Adhesive flow onto the spacer tape is acceptable. No adhesive is to enter the mirror assembly through the doubler hole.

3.2.6 Edge Channels

3.2.6.1 Edge channels will be attached to the pan using adhesive so that the bond line extends to cover the entire contact surface between the pan and the edge channel; and no voi_ gaps, or leak paths shall exist in this bond line

3.2.6.2 Edge channels will be centered lengthwise on the pan edge.

3.2.7 Outside Corner Clips - Outside corner clips shall be attached with adhesive so that the bond line covers the entire contact surface between corner clip, pan, and edge channel, and no leak paths exist in this bond area.

3.2.8 Secondary Sealant (Silicone)

3.2.8.1 The secondary sealant will completely fill the area between the mirror and the edge channel not already filled with primary sealant. In addition, it will extend on the mirror surface for .06" beyond the edge channel. The secondary sealant will be cured with high humidity to a minimum Shore A hardness of 25.

3.2.8.2 Leak test may be performed when the silicone is cured for a minimum of three days.

3.2.9 Breather Tube

3.2.9.1 The capillary tube shall be inserted into the hole in pan and held in position while the adhesive is applied. A 1/16" diameter by 1/4" long bead of adhesive shall be applied on both sides of the tube/pan interface nearest the open end. Also, a bead shall be applied around the pan hole/tube interface.

3.2.9.2 The hole shall be sealed and leak-tight. Capillary tube must permit free flow of air.

3.2.9.3 The cap shall be positioned over the open end of the capillary tube with the open side to the pan.

4.0 QUALITY REQUIREMENTS

The quality requirements shall be as specified in Material Control Specification 40M5001132798.

5.0 SAFETY REQUIREMENTS

The safety requirements shall be as specified in Material Control Specification 40M5001132798.