

K1DM3 – Technical Note

Maintenance Manual

1 Introduction

This document is intended to cover the unique nature of the custom assemblies and parts of the K1DM3 module. Although attempting to cover all aspects it is not a substitute for common sense and standard maintenance practices and observations of conditions that require close review or immediate attention.

2 Critical Spares List

The spares list can be found in Reference 1. A view of the spreadsheet is shown in Figure 1.

3 Tool list

872-LM8343 Level Pad Spanner Tool – This tool is used to adjust the piston, tip, and tilt of the mirror assembly. The mirror assembly is locked to the groove plate thru kinematic couplings. The groove plate is supported on the swing arm by three leveling pads. The Spanner Tool is used to both loosen the lock nut and to also adjust the leveling pad.

4 General

Maintenance procedures and schedules can be found in Table 1.

Consumable parts - Swing-arm hinge pin o-rings. Duty cycle and load are benign on these components. It is unlikely that they will be subjected to any wear for the life of the instrument

Expected life – The items listed in the spares table are those components that may not have an infinite life. Mean time to failure (MTTF) is unknown for these components. For those with long lead times spares should be maintained on hand. Components with only a couple weeks or less will not have spares due to their quick turnaround.

5 Mechanical

5.1 Actuators – lubricate planetary lead screw as needed and replace seals as per manufacturer's recommendations, Reference 10. Check shaft and pins yearly for wear.

5.2 Clamps – check, wipe down and grease M2 steel contact surfaces yearly.

5.3 Hinge – check yearly for excessive or unusual compliance.

5.4 Bearing – due to environment and duty cycle the manufacturer claims no maintenance will be required. Inspect yearly. Grease only if the seals or grease is contaminated. Monitor drive and rotation motors for changes in current loads.

5.5 Inner drum rotation

Oil – Some machine and cutting oils used in fabrication and assembly leaked onto surfaces between the inner and outer drums. Check periodically and clean up all traces. Use KimWipes or other absorbent tissues or cloths. Do not spray any cleaning fluids or grease cutters on drum surfaces. Apply fluids directly to tissues first before wiping. After cleaning surface areas wipe dry with a tissue or cloth.

5.6 Docking system

Inspect the tang and the clevis entry edges at the scheduled maintenance intervals. Check for surface wear, scratches, and any deformations. Note and document any conditions new since the last inspection. Check attachment hardware of the tang to the swing-arm. Make sure the sub-assembly is tight and rigid.

5.7 Ring gear inner drum positioner, V-blocks, and engagement wheel.

Check v-blocks and wheel for cleanliness. Wipe down with alcohol wipes if needed.

Check limit switches on the air cylinder. Check strain relief on wiring. Check retracting spring for deformation, wear or damage.

5.8 Kinematic & defining points inspection/maintenance

- 5.8.1 Instrument Module defining points – Inspect the defining points whenever the module is removed from the tower and parked on the handling cart. Add grease at fitting and at the acme screws. Clean defining point interfaces (cone, groove, flat) and apply a thin coat of grease to them.
- 5.8.2 Deployment kinematics – wipe down interface surfaces prior to installation - then grease contact surfaces yearly as in Section 5.8.1.
- 5.8.3 Mirror assembly kinematics
Inspect canoe spheres and v-blocks when mirror is removed for recoating. Check all kinematic surfaces for wear and deformation. Note and document any conditions new since the last inspection. Clean and grease the contact surfaces as above. An infinite lifetime is expected due to the extended coating frequency.
- 5.9 Axial and lateral pucks – check pucks and glue bonds yearly for chipping and discoloration.
- 5.10 Flex blocks
Inspect flex blocks, Figure 1, for cracks, deformations, or unusual appearance in the flexure or at the ends in the filets. If there is anything out of the ordinary or changes from the previous inspection the module should be removed from service for a more thorough review and inspection.
- 5.11 Mirror support flexures
On a yearly basis check all flexures for looseness or rattling. Check rod centricity with the outer flexure housings (Figure 6).
- 5.12 Earthquake clips – check yearly for binding or contact with mirror.
- 5.13 Clamps & air cylinders
Check contact surfaces for cleanliness. Wipe down with alcohol wipes if necessary and apply a thin coat of grease. Check limit switches on the air cylinders. Check strain relief on wiring along with signs of wear or abrasion.
- 5.14 Outer drum plumbing - Check tubing and fittings for scratches and wear. Note azimuthal location so that clearance thru the tower can be reviewed and inspected.
- 5.15 Hardware tightness – Reference 13 covers all the HW securing procedures. Check for loose HW and re-apply Loctite if necessary.

6 Electrical

- 6.1 Overview and troubleshooting – For general K1DM3 electronics information see the electronics overview (872-LE0001) and the top level schematic (872-LE0000).
- 6.2 Monthly maintenance
 - 6.2.1 Fan, 48V power supply (M1eBox) - verify proper rotation of fan
 - 6.2.2 Fan, heat exchanger (M1eBox) – verify proper rotation of fan
 - 6.2.3 Heat exchanger coolant (M1eBox) – verify proper flow of coolant, check for leaks
 - 6.2.4 Heat exchange fins – check for dust, clean as needed
- 6.3 Quarterly maintenance – monitor and record motor voltages and currents, report any significant changes
- 6.4 Annual maintenance (or at mirror re-coating)
 - 6.4.1 Brush contacts – Clean contact blocks. Inspect contacts and brushes for excessive wear.
 - 6.4.2 External cables - inspect for damage
 - 6.4.3 Drum wiring – inspect for loose cable strapping
 - 6.4.4 LEDs – inspect light coverings on inner drum Galil RIO (PLC) and Galil DMC (motor controller) LEDs. Replace as needed.

- 6.5 Rewiring events – For cables and wiring connected to moving components check for proper and unrestrained motion of the moving component. Make sure there is no rubbing or abrasion of the wiring. For lines that are static make certain that they are free and clear of any moving or rotating parts.

7 Optical

7.1 Surface quality

- 7.1.1 cleanliness – Check mirror quarterly for accumulated debris and particulate matter on the surface. Blow off particulate matter with compressed N2 or filtered dry air. Do not use canned air, which can spit propellant residue.
- 7.1.2 Inspect the surface quality, looking for scratches, dings, water spots, blemishes or other signs of degradation in the coating. Note and record any significant changes or cracks since the last inspection. Document locations and take photographs.
- 7.1.3 Cleaning of K1DM3 should be performed on a yearly basis. The module should be removed from the tower and parked on the handling cart. See Reference 15 for cleaning instructions.

7.2 Axial & lateral puck bonds

The epoxy bonds will not be visible due to their size relative to the pucks. Inspect the gap at the edge of the puck; look for any material or debris in the area. With a gloved hand or suitable mechanical probe check the rigidity of each puck. It should be solid to and with the mirror.

Inspect the each flex rod and make sure the center node is symmetric with the housing, see Figure 6.

- 7.3 Handling - Never touch the mirror with bare hands. Wear gloves specified for this purpose. Procedures and practices when working with and around the mirror should follow the same rules and requirements as applied to all primary mirrors and other optics. Specific handling of the mirror assembly which includes removal for re-coating is covered in Reference 11.
- 7.4 Coating – See Reference 2 for requirements and documentation

8 Glycol cooling

- 8.1 M1 Box coolant flow – The recommended flow rate is 1.75 to 2.00 liters/min. Figure 7 shows the location of the valve in the M1 Box. When facing the enclosure it is in the lower right corner of the box.
- 8.2 Temperature – The temperature difference between inlet and outlet is less than 1°C during full scale steady state electronic operation.
- 8.3 Pressure – line pressure should not exceed 150 psi, which is the rating for the heat exchanger in the M1 Box. Check monthly.
- 8.4 Flowmeter – Refer to the user manual, Reference 3
- 8.5 Heat-exchanger
- Check fan for excessive noise or imbalance. Check exchanger air intake for dust and debris build up; remove and clean as needed.
- 8.6 Plumbing – check for leaks among the fittings and abnormal noises in the lines. Check on a monthly basis.

9 Pneumatic

9.1 Flow

Air flow on all clamp systems is adjusted and controlled by needle valves on each line. Adjust as needed for proper operation without excessive noise or violent action.

9.2 Pressure

Air pressure on all lines should be within 100 and 120 psi.

9.3 Air cylinders

Check limit switches on cylinders. Make sure the sensors are snug and do not move when wires are tugged. Check strain relief on wiring. Make sure any snagging cannot effect switches.

9.4 Fittings

Check fittings for noise and leaks.

9.5 Inner drum air delivery – clean the sealing surface on the inner drum. Wipe down quarterly. Check and inspect the (Viton) O-ring on the outer drum; replace annually.

10 Special operations and considerations

10.1 Come-along operation and other manual control – If there is a loss of power or any other reason the swing-arm cannot be operated by the actuators, see Reference 11 for manual operation.

10.2 Responses and actions due to earthquake – Remove K1DM3 from the tower and secure it to the handling cart. Perform all maintenance tasks listed in Table 1.

Item	Description	MFR	Model	SSN	Category	Spares		Cart \$	Lead time	Reference	Comments	
						Avail- ed	Qty on hand					
1	Actuator	Euler	GSS40-0691-CA-GA1-1B3-04-RB-AS-L3		mechanics	1	0	10,000	4mo			
2	Rotary Air Motor	Ingersoll Rand	M007RWR27BR6		mechanics	1	1	2,450	3mo			
3	Air motor coupling	American Gear	200F / 100C		mechanics	1	1	300	1mo		coupling	
4	Inner drum rotation servomotor	Mosmotor	O33-H-800E	T20210115	mechanics	1	1	800				
5	Inner drum rotation speed reducer	Harmonic Drive	ISR01106491CGP-SP-42X5		mechanics	1	1	2,300				
6	Pinion Gear	UCO	872-LM3120		mechanics	1	1	1,000			fab'd in house	
7	Suinq arm motor controller	Gall	DMO-4040 (14in,JSCHTL,M0,TRES4) C022-1000-D740-SRH90		Electronics	1	1	3,770	2-3 wks		check spare with rotation controller	
8	Suinq arm safety PLC	Gall	RIO-4712-16in-BISS		Electronics	1	1	520	2-3 wks		RIO-4712-16in-BISS can be used for either detector safety PLC spare supported in April 2019; status at removal unit unknown	
9	Tauxer decking PLC	Gall	RIO-4712-16in-BISS or RIO-47142-16in		Electronics	1	1	520	2-3 wks		RIO-4712-16in-BISS can be used for either detector safety PLC	
10	Rotation motor controller	Gall	DMO-4040 (14in,JSCHTL,M0,TRES4) C022-1000-D740-SRH90		Electronics	1	1	3,770	2-3 wks		check spare with suinq arm controller	
11	Kinematic coupler	Bal-Tec	2000-CS / VB2000-CPM		mechanics	3	0	1,500	1mo		deployment system; cano sphere, V-black	
12	Kinematic coupler	Bal-Tec	CS-1125-CPM / VB-750-CPM modified		mechanics	3	0	220	2 wks	872-LM4522	Mirror Assy; cano sphere, V-black	
13	Display clamor	Daraca	8007 EHL		mechanics	4	4	1	311		no manual available, only spec sheet	
14	Decking Clamp	Daraca	803		mechanics	1	?	0	200	1wk	872-LM5100 872-LM6009	decking system; no manual available, only spec sheet
15	Solenoid Valve	BBBA/MDF	H49230C-0624VDC		mechanics	1	0	132	1mo	872-LM5100	decking system, could serve as replacement for S22, Check	
16	Solenoid Valve	Bimba/Pneumadyne	S22U40-DS-14-0		mechanics	5	4	1	112		deployment clamp, may be discontinued, check	
17	Hall Effect Sensor	Cherry	WN101501		Electronics	1	?	0	10	1wk	872-LM6009	decking system
18	Compressed Air delivery actuator	Bimba	FOD-040.30-1HY		mechanics	1	1	1	100	1mo		
19	Fluometer	Ha-Dand	H6045-002		mechanics	1	?	0	600	5 wks	872-LM5101 872-LM5201	M1Bax glycol system, have manual
20	Flau Control Valve	Parco	F-820-SS		mechanics	1	?	0	300	5 wks	872-LM5101 872-LM5201	M1Bax glycol system
21	Detent Valve Solenoid	Ingersoll Rand	1N210-39		mechanics	1	0	0	29	3 wks		
22	Display FOB (on exit board)	UCO/courtam	872-LE0420-DisplayFOB_r01		Electronics	1	1					
23	Rotation FOB	UCO/courtam	872-LE0120-RotationFOB_r00		Electronics	1	1					verify mod
24	Safety FOB	UCO/courtam	872-LE0440-SafetyFOB_r01		Electronics	1	1					zpro @UCSC tabo shippe if ok 2019
25	Power protection board	UCO/courtam	872-LE0140-TauxerPrat_r00B		Electronics	1	1					zpro @UCSC tabo shippe if ok 2019
26	Air FOB	UCO/courtam	872-LE0460-AirFOB_r00a		Electronics	1	1					
27	Actuator encoder (magnetic trip)	Renishaw	LA11		Electronics	2	1					Actuator travel, absolute encoder - connected to Safety PLC
28	48V power supply	TDI-Lemda	HWS150040		Electronics	1	0	1,645		872-LM5200		motor power for rotation and deploy / retract
29	24V power supply	TDI-Lemda	LS150-24		Electronics	1	0	40		872-LM5200		logic power for rotation and deploy / retract
30	25A @ 120VAC SSR	Cryfem	CWA2425		Electronics	2	0	50				wired to central 120VAC to 24V and 48V supplies
31	40A @ 100VDC SSR (4-32VDC input)	Cryfem	DC100D40C		Electronics	2	0	105				wired to central 41VDC to Rotation and deploy motor controllers
32	10A @ 60VDC SSR (3-32VDC input)	Cryfem	GH14D17750		Electronics	1	0	55				electrical isolation for "Module Inlet-to-4" signal
33	10A @ 24-24V SSR (120VAC input)	Oman	G3NA-D210BAC100-240		Electronics	1	0	65				isolation and voltage drop for "K1ESTOP"
34	5A @ 60VDC (3-32VDC input)	Cryfem	DC6055		Electronics	1	0	35				wired to central 24VDC to inner drum
35	12 ohm 300W resistor	Wahay-Huntington	FVE030020EER0KE		Electronics	2	1	20				load dump for power protection board
36	Drum encoder (magnetic trip)	Renishaw	LM1D		Electronics	1	?					load encoder for drum rotation
37	Ethernet transceiver	Ubiquiti	EdgeRouter X SFP		Electronics	1	1	84		872-LM5200		
38	contact block	courtam	?		Electronics	lot	full lot					fab'd in house
39	contact spring	courtam	?		Electronics	lot	full lot					full lot plus...
40	MS connector	various	various		Electronics	lot	lot					10 each of crimp cable connectors (not panel connectors)
41	Renishaw absolute encoder	Renishaw	LA11DOA13B1E10DF00									

Figure 1 - Spares list. Example print out from the Spares tab in the project spreadsheet.

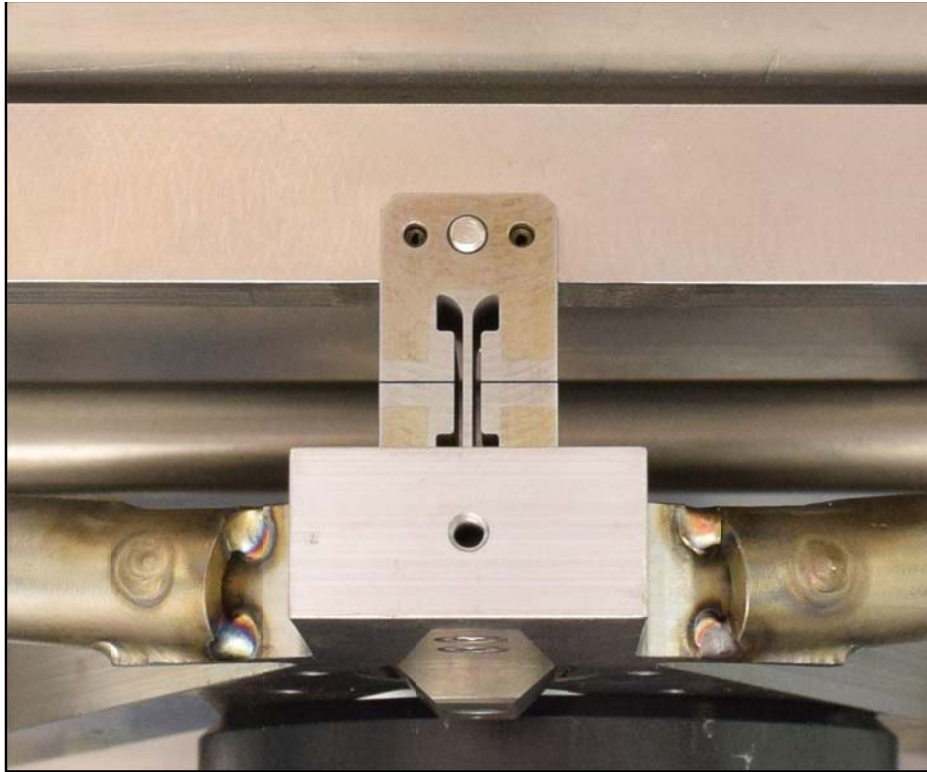


Figure 2 - Flex block, one of three, one for each whiffle tree.

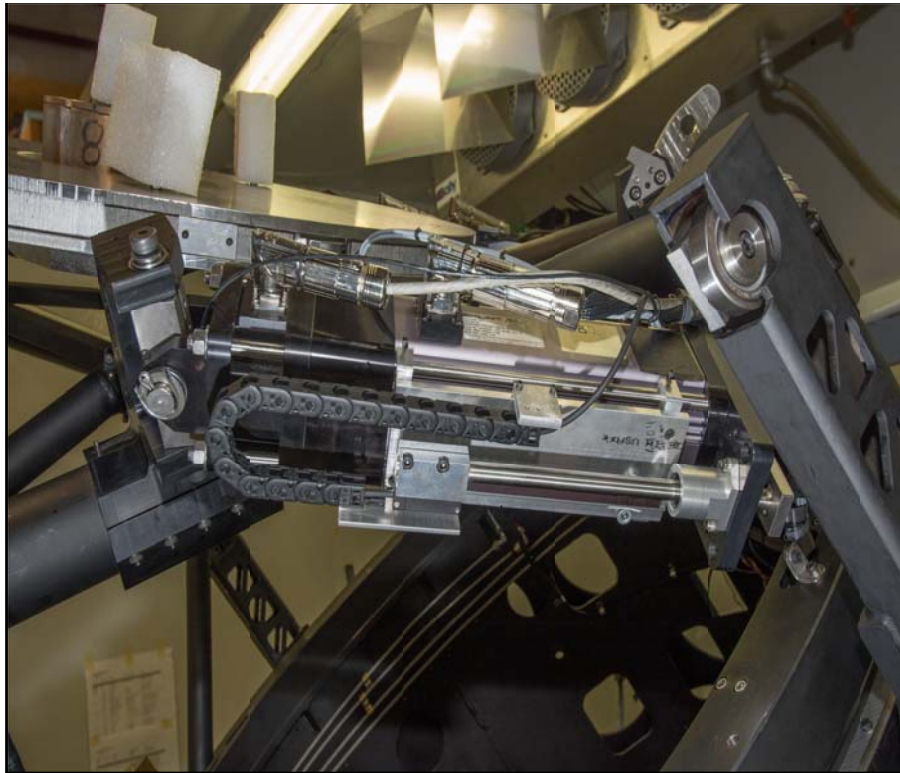


Figure 3 - Actuator with incorporated encoder.



Figure 4 - Clamp/Air Cylinder at one of the two bipod locations

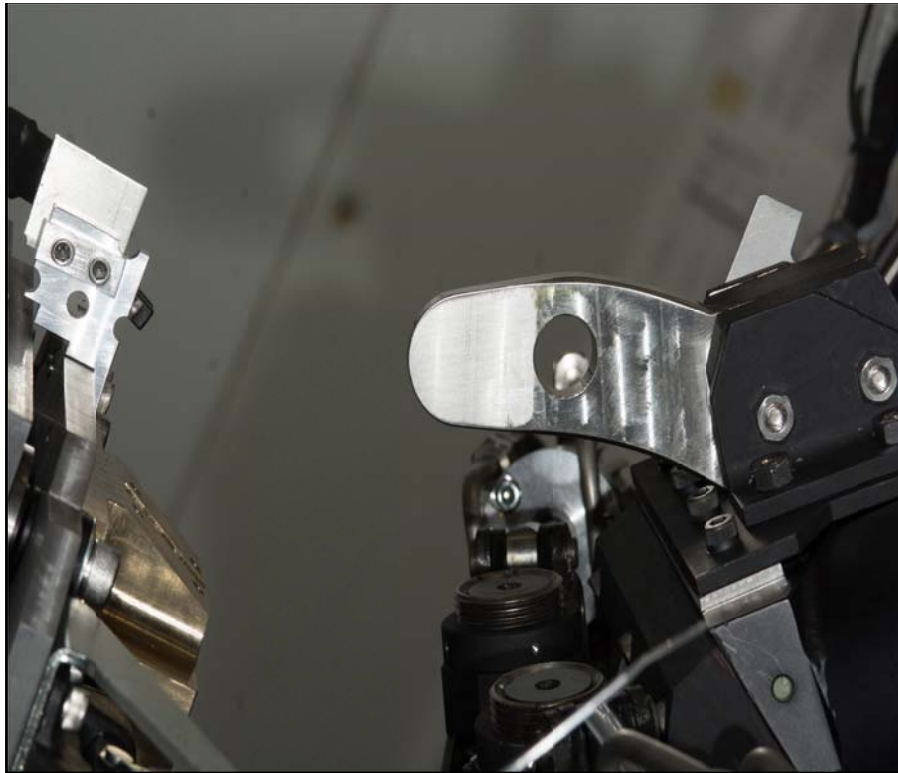


Figure 5 - Docking system

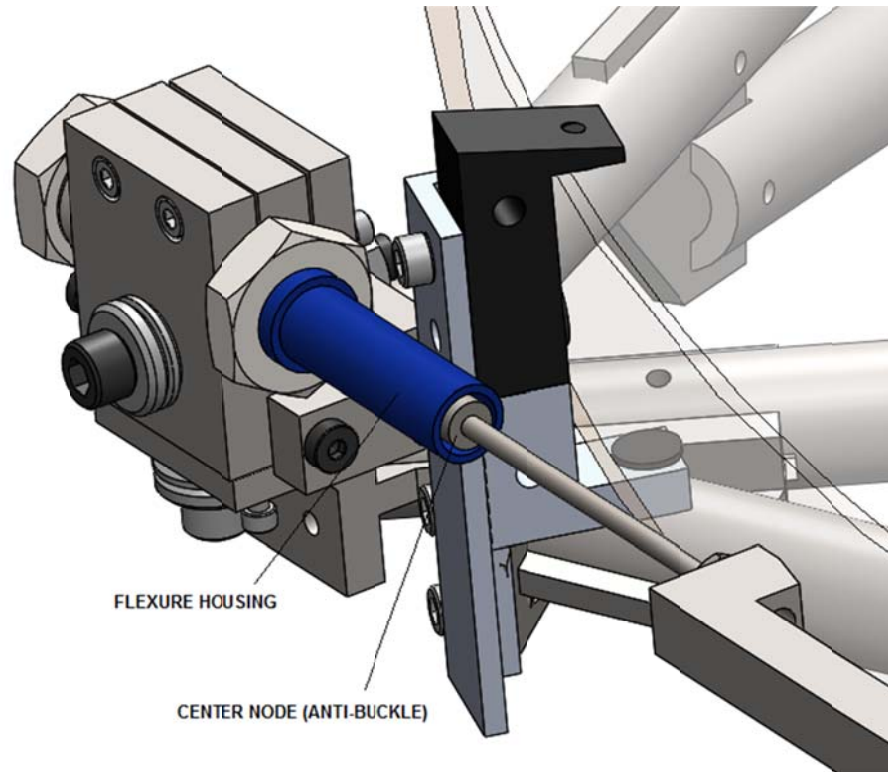


Figure 6 - Flex rod showing centration between the flexure housing and the center node on the flex rod.

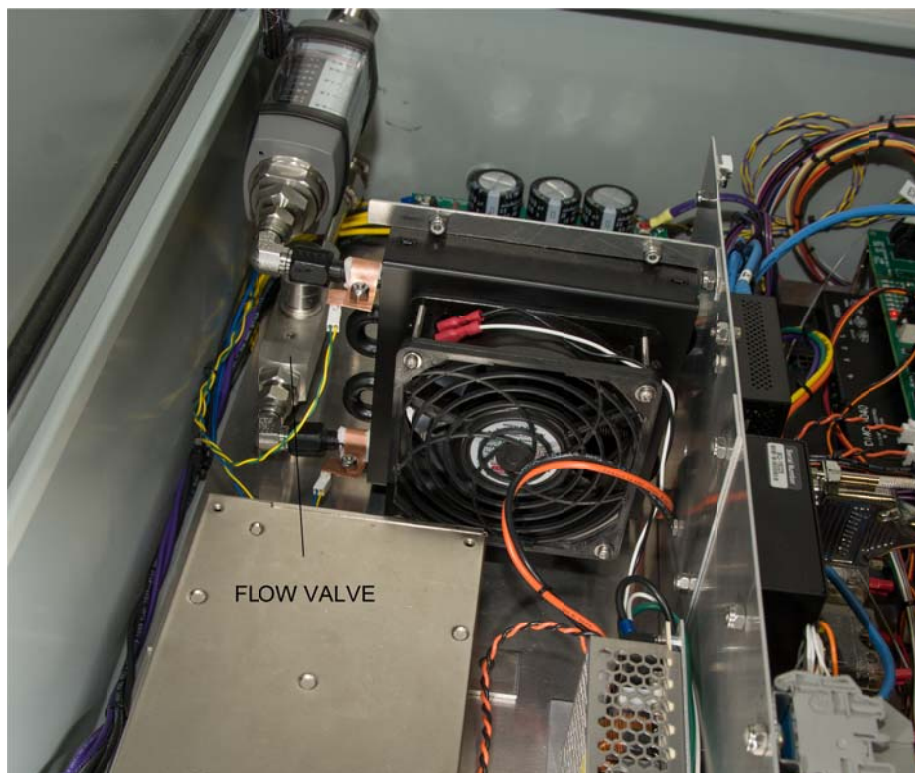


Figure 7 - Flow control valve for the coolant in the M1 Box, located in the lower right hand corner of the enclosure.

Table 1 - Maintenance Schedule

Item	Section	Description	Frequency	Action	Comments
1	5.1	swing arm actuators	yearly	lubrication and seal inspection	manufacturer's recommendations; Reference 10
2	5.2	clamps	yearly	clean & grease contact surfaces	
3	5.3	swing-arm hinge	yearly	check compliance of hinge	
4	5.7	detent motor	yearly	check for proper operation of clamps	check pressure
5	5.8	kinematics & defining points	yearly	check surface wear and for birnelling; clean & re-grease surfaces	Note 3
6	5.8.1	acme nut	Note 3	grease fittings and screw	
7	5.8.3	mirror lock-down HW	re-coating	check for loose HW and proper torqueing	
8	5.9	axial & lateral pucks	re-coating	inspect bond line and surrounding area for cracks	Note 1
9	5.10	flex blocks	yearly	inspect for cracks/deformations	
10	5.11	flexure rods	yearly	inspect	
11	5.12	clip clearance	yearly	adjust clip to remove interference	earthquake clip clearance
12	5.15	loose hardware	yearly	adjust and tighten to assembly specs and torque document	Reference 13
13	6.3	motors	yearly	note and record current loads	
14	6.3.1	brush contacts	re-coating	check contacts for corrosion and wear	
15	6.3.2 6.3.3	wiring	yearly	check strain reliefs and wear on wiring	
16	6.5	restraint of natural movements	yearly	check wiring interference with motion	
17	7	mirror cleanliness	yearly	inspect and clean as needed	mirror quality related to dust, debris, & oil deposits
18	7	mirror quality	yearly	Note 2	degradation of reflective surface
19	7	mirror cracks	re-coating	inspect mirror for scratches and cracks	Note 1
20	8	M1 box plumbing	yearly	check box plumbing, all fittings for leaks	

Item	Section	Description	Frequency	Action	Comments
21	9	air lines	yearly	check or air lines for proper operation	check pressure
22	9	clamps	yearly	check for proper operation of clamps	check pressure
23	9.5	air connect	quarterly	clean surfaces and check o-ring	Note 4

Notes

1. Perform first PM after a year, then at every re-coating thereafter
2. Refer to existing M3 PM practices regarding mirror coating and cleaning
3. Refer to existing M3 PM practices for defining points, perform yearly
4. Replace o-ring yearly

References

1. Spares List, project main Excel spreadsheet, K1DM3.xlsx, Tab – Spares List, copy also at <http://k1dm3.ucolick.org>, under documentation.
2. Technical Note 925, Deployable Tertiary Mirror Removal & Installation Procedure, WMKO
3. User Manual, Hedland Variable Area Flow Meters, VAM-UM-00551-EN-04, September 2014, Badger Meter
4. Level Pad Spanner Tool, 872-LM8343
5. Mirror Assembly, 872-LM4200
6. Mirror & Swing-Arm Assembly, 872-LM4700
7. Compressed Air Clamps Schematic, 872-LM2237
8. Air Motor and Detent Compressed Air Plumbing Schematic, 872-LM3136
9. Clamping System Pneumatics, 872-LM6100
10. GSX and GS Series Linear Actuator Installation and Service Manual, GS/X Manual.doc, PN 10278, Revision KK, 02/17/14, Exlar Corporation, 952-500-6200
11. K1DM3 Coating Procedure, Keck document
12. MULTI-VANE Air Motors, M007 Series, Operation and Maintenance Information, Form P6877, Edition 6, June 2016 CCN: 03536968, Ingersoll Rand
13. Technical Note 872-LTN2003, Hardware Lockdown Specifications, Procedure, Screw Tightening and Loctite Application Slides, PowerPoint file
14. Technical Note 872-LTN2004, Come-along Procedure
15. Technical Note 872-LTN2005, Mirror Cleaning Procedure

Revisions

- | | | |
|---|---------|---|
| A | Dec18 | Initial release |
| B | 29Jan19 | Electronics section updated, Figure 7 added, Reference 1 updated. |
| C | 4Feb19 | Optical cleaning, schedule table updated, Reference 15 |