SATEC *Materials Testing Equipment*

SATEC Systems, Inc.
900 Liberty Street
Grove City, PA 16127-9005
Phone: 412-458-9610
1-800-726-8378
Fax: 412-458-7857

Calibration Report

CUSTOMER:	MMA LABORATORIES, 15062 BOLSA CHICA, HUNTINGTON BEACH, CA 92649		
INSTRUMENT:	LOAD RATE DISPLAY	TEST DATE:	8/15/97
SIZE-RANGE:	VARIOUS	RECALL DATE:	2/15/98
MFG.-MODEL:	MII 100UD	PER SPECIFICATION:	ISO10012-1, ANSI/NCSL Z540-1
SERIAL NUMBER:	1107 P075R	TECHNICIAN:	DANIEL V. FALKENSTEIN
RATED ACCY.	+/- 10%		

ELEMENTS VERIFIED	VALUES	STANDARDS USED	VERIFIED BY	DATE
10%	MIN:SEC:100TH			
10000 LBS/MIN.	01:01:02	1	SATEC	8/15/97
20%				
20000 LBS/MIN.	00:59:43	1	SATEC	8/15/97
40%				
40000 LBS/MIN.	01:01:41	1	SATEC	8/15/97
70%				
70000 LBS/MIN.	01:02:09	1	SATEC	8/15/97
100%				
100000 LBS/MIN.	01:02:16	1	SATEC	8/15/97

STANDARD REF. TEST NO.

1. STOPWATCH, ALPHA 410, SERIAL #5001, CAL DATE: 7/19/97, DUE DATE: 7/19/98

REMARKS

THIS IS TO CERTIFY THAT THE DESCRIBED TIMING STANDARD USED FOR THIS VERIFICATION HAS BEEN CHECKED USING SOUND TONES BROADCAST BY THE NATIONAL BUREAU OF STANDARDS, FORT COLLINS, CO VIA CENSIUM BEAM CLOCKS TRANSMITTED ON WWV, AND ACCESSED BY TELEPHONE IN BOULDER, CO AT (303) 499-7111 TO ESTABLISH THAT THE ERROR OF CALIBRATION DOES NOT EXCEED +/- 3 SECONDS.

[redacted]

Calibration Technician

MMA 1

8/22/97

Results:

Sample ID	Determination	Test Values	Observations
Exemplar Pallet Lock Assembly Sample No. 1	Load Test Fully Locked Position	12,400 lbf	Breakage of lock base at the shear pin was observed (Figure 4).
Exemplar Pallet Lock Assembly Sample No. 2	Load Test Partially Locked Position	4,800 lbf	Deformation of the backside of the forward locking pawl was observed (Figure 7).
Exemplar Pallet Lock Assembly Sample No. 1	Compressive Load Test Inverted Position	4,000 lbf	No disengagement or shearing of the locking pawls was observed.

Summary Observations:

Load testing was performed to determine if the locking pawls could be sheared or disengaged by a vertical downward load. Testing was performed with the release pawl in the fully locked position and partially locked position. In the fully locked position, the assembly was able to withstand a load of approximately 12,400 lbf with no disengagement or shearing of the locking pawls occurring. During this test, breakage of the lock base occurred with usage of the pallet lock assembly pawls still possible. In the partially locked position, the pallet locking assembly was able to withstand a load of approximately 4,800 lbf. No disengagement or shearing of the locking pawl was observed. Compressive loading was performed to determine if disengagement of the pawls would occur and it did not. MMA was unable to cause in any of the three tests performed pawl disengagement.

Fractographic Analysis of Evidentiary Pawl

A fractographic analysis was performed on the evidentiary locking assembly's failed locking pawl. The analysis was performed visually and with the use of a scanning electron microscope. The visual and scanning electron microscopic evaluations indicate that the pawl failed due to an impact or overload event. Neither of the fractured surfaces examined exhibited macroscopic features that would be consistent with a fatigue type failure in aluminum. No thumbnails were observed that would suggest a fatigue crack origin(s). No ratchet marks were observed on either of the fractured surfaces. The fractographic features indicate that the failure initiated on the side opposite the witness marks or impact marks identified with arrows in Figure 9a. Figure 10a is made up of two close-up photographs showing the pawl fracture surfaces after disassembly from the unit. Figure 10b is a schematic drawing showing the interpretation of the fractographic features. The radial lines emanating from the pawl corners indicate the general location of the failure origin and direction of crack propagation. Scanning electron microscopy of the fracture surfaces revealed a textured, overload type fracture morphology. The textured or stepped appearance of the fracture surface is attributed to the aluminum microstructure. Figures 11, 12 and 13 are laser reproduced, enlarged scanning electron microscopic micrographs showing the fractographic features observed on the left hand side sample in Figure 5a. The right hand side exhibited similar fractographic features. Metallographic examinations of the failed pawls would be required to verify the directional nature of the grain structure. The fracture surface did not exhibit features that would indicate a fatigue crack mechanism was active.

Respectfully submitted,
MMA Laboratories,

Hector Ray Hernandez, B. S. M. E.
Manager
Product Evaluation Laboratory

Respectfully submitted,
MMA Laboratories,

Hugo A. Menendez, M.S.
Senior Metallurgist
Failure Analysis Director

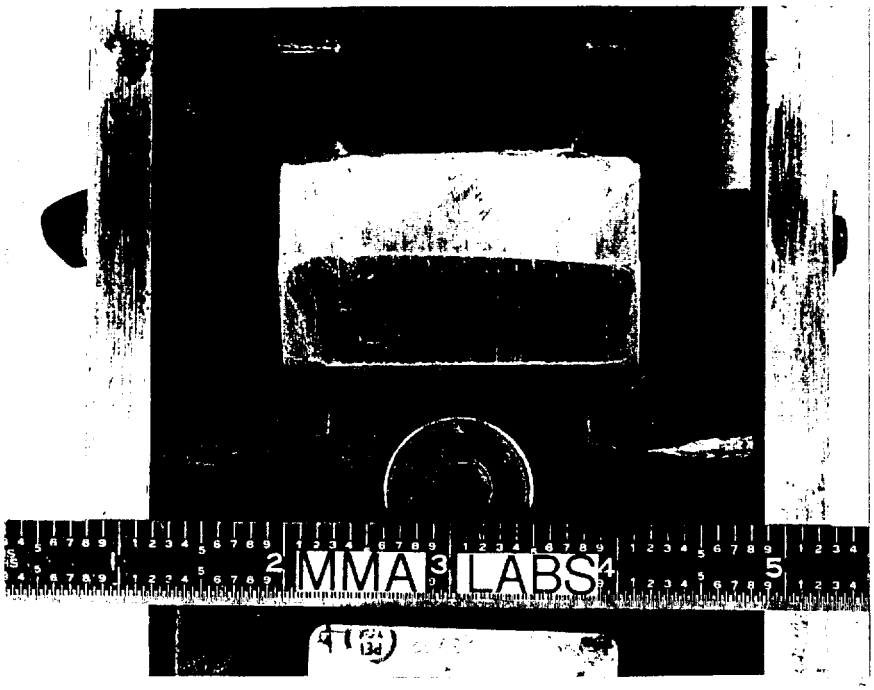

Figure 9a: Color Photograph Showing Impact Marks (Identified with Arrows) That were present in the Failed Pawl

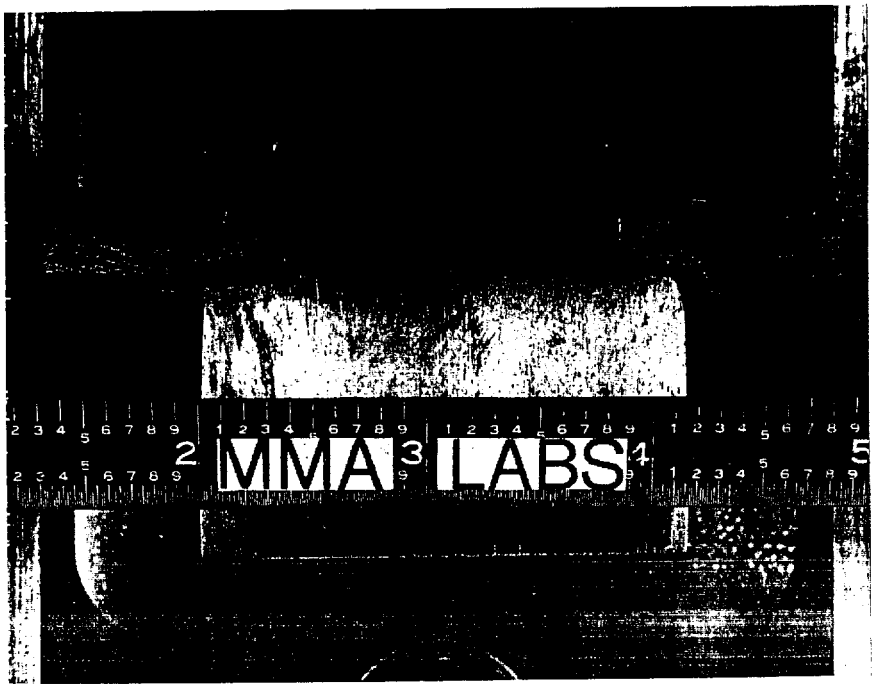

Figure 9b: Color Photograph Showing the Fractured Pawl Prior to Disassembly

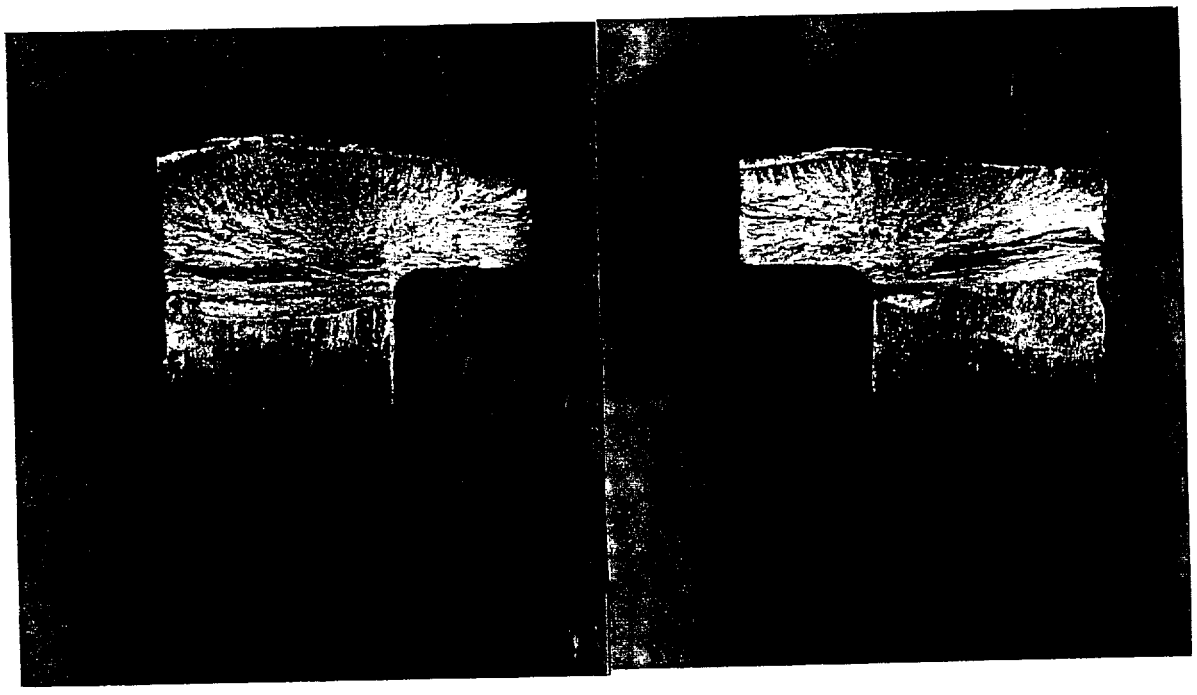

Figure 10a: Macro Photographs Showing the Fracture Surfaces from Failed Pawl

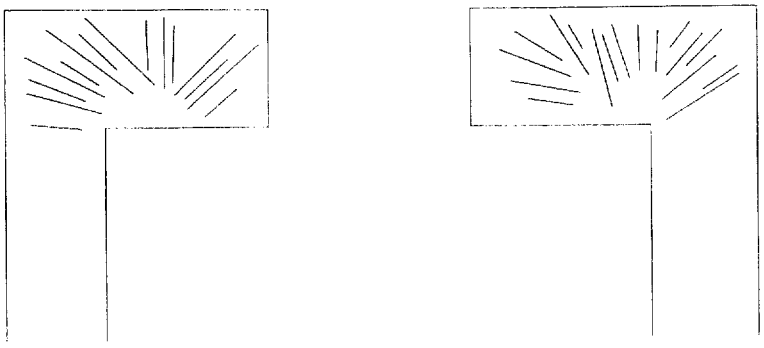

Figure 10b: Schematic Drawing Showing the Fractographic Features
Observed in the Failed Pawl.
The Radial Lines Point Back Toward the Crack Origin.

C:\HAM\GML4406A.PCI

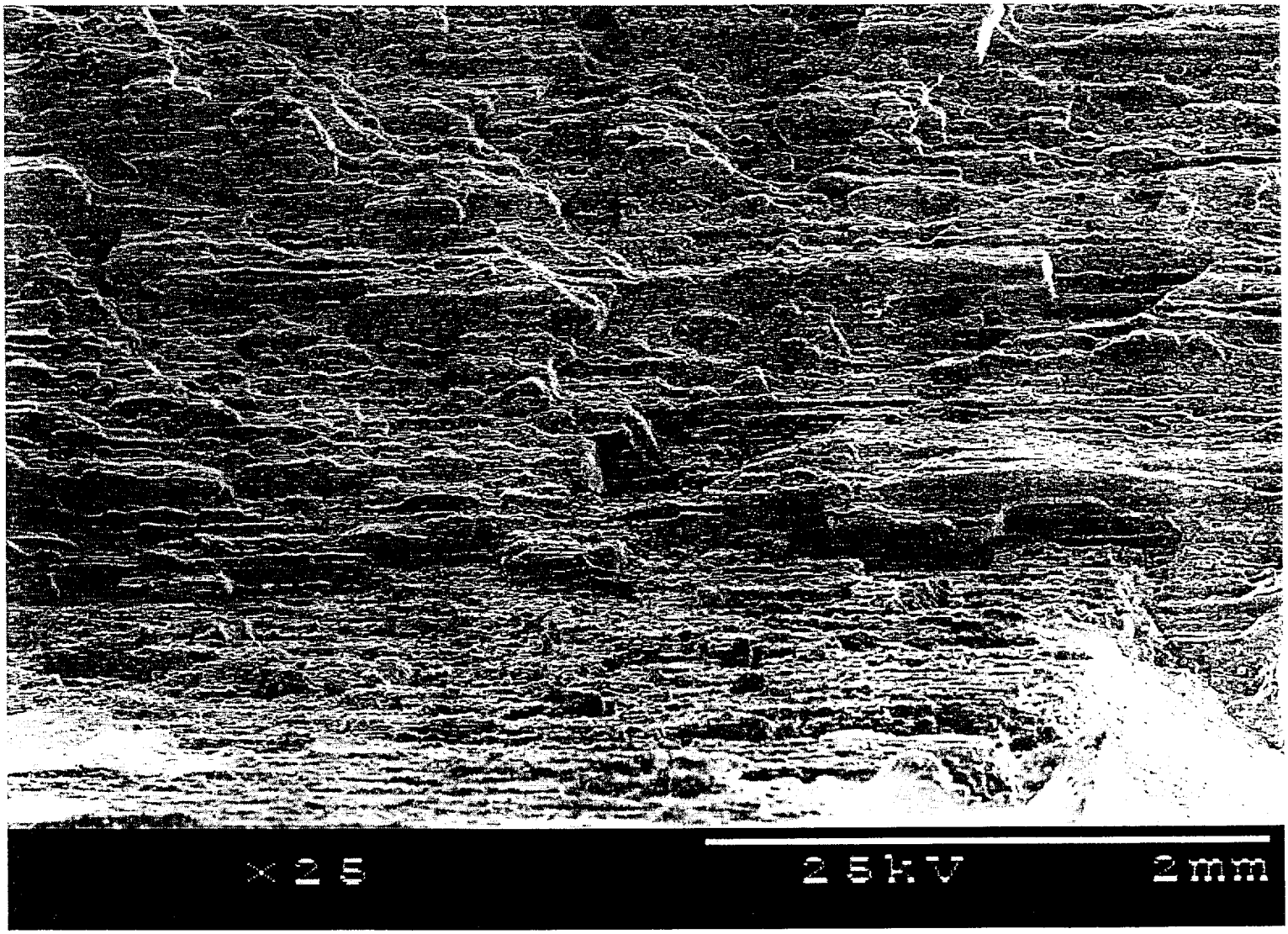

Figure 11: Low Magnification (25X) Laser Reproduced, Enlarged SEM Micrograph Showing the General Vicinity of Fracture Origin

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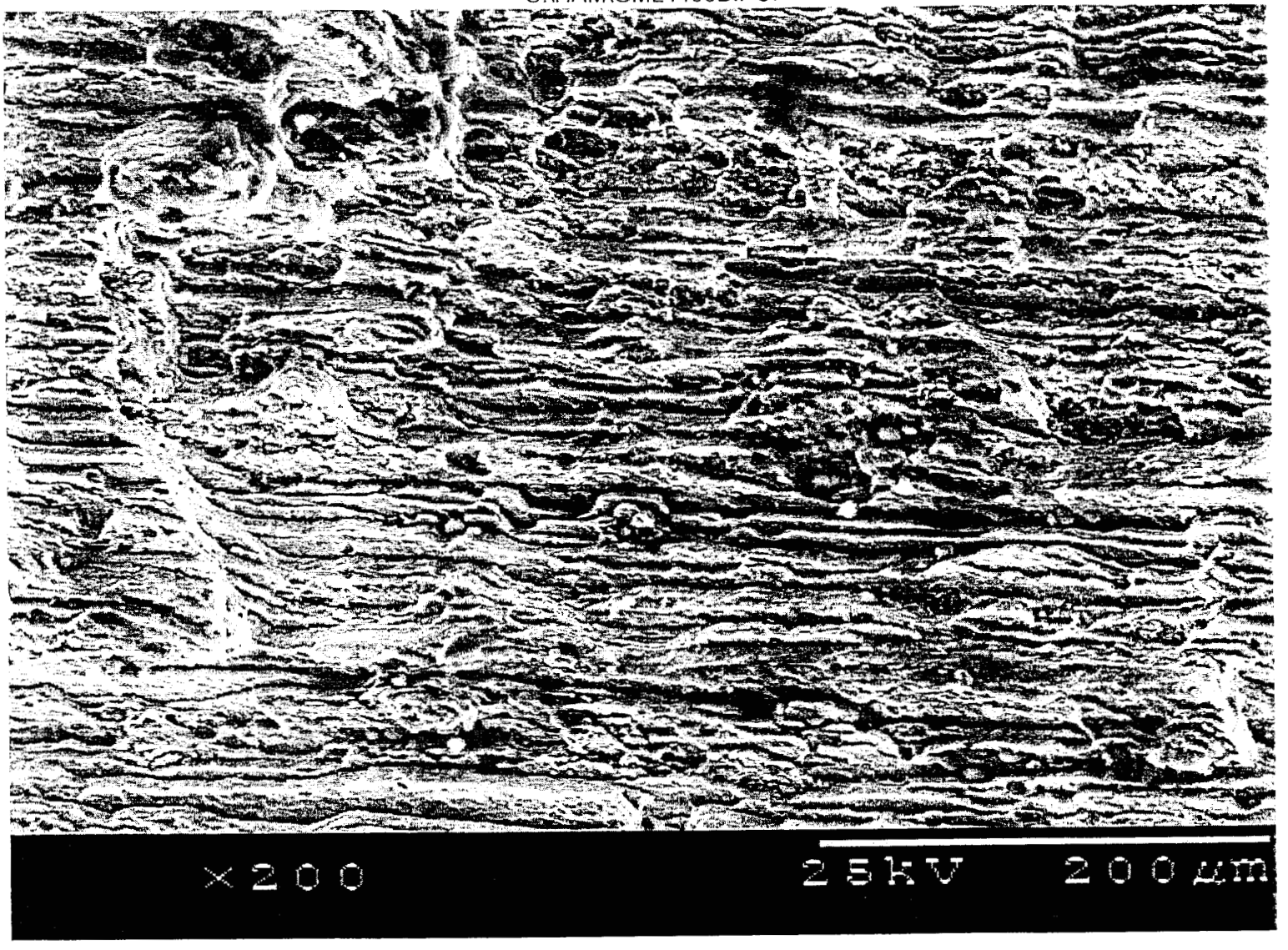

Figure 12: Higher Magnification (200X) Laser Reproduced, Enlarged SEM Micrograph Showing Impact or Overload Fracture Morphology

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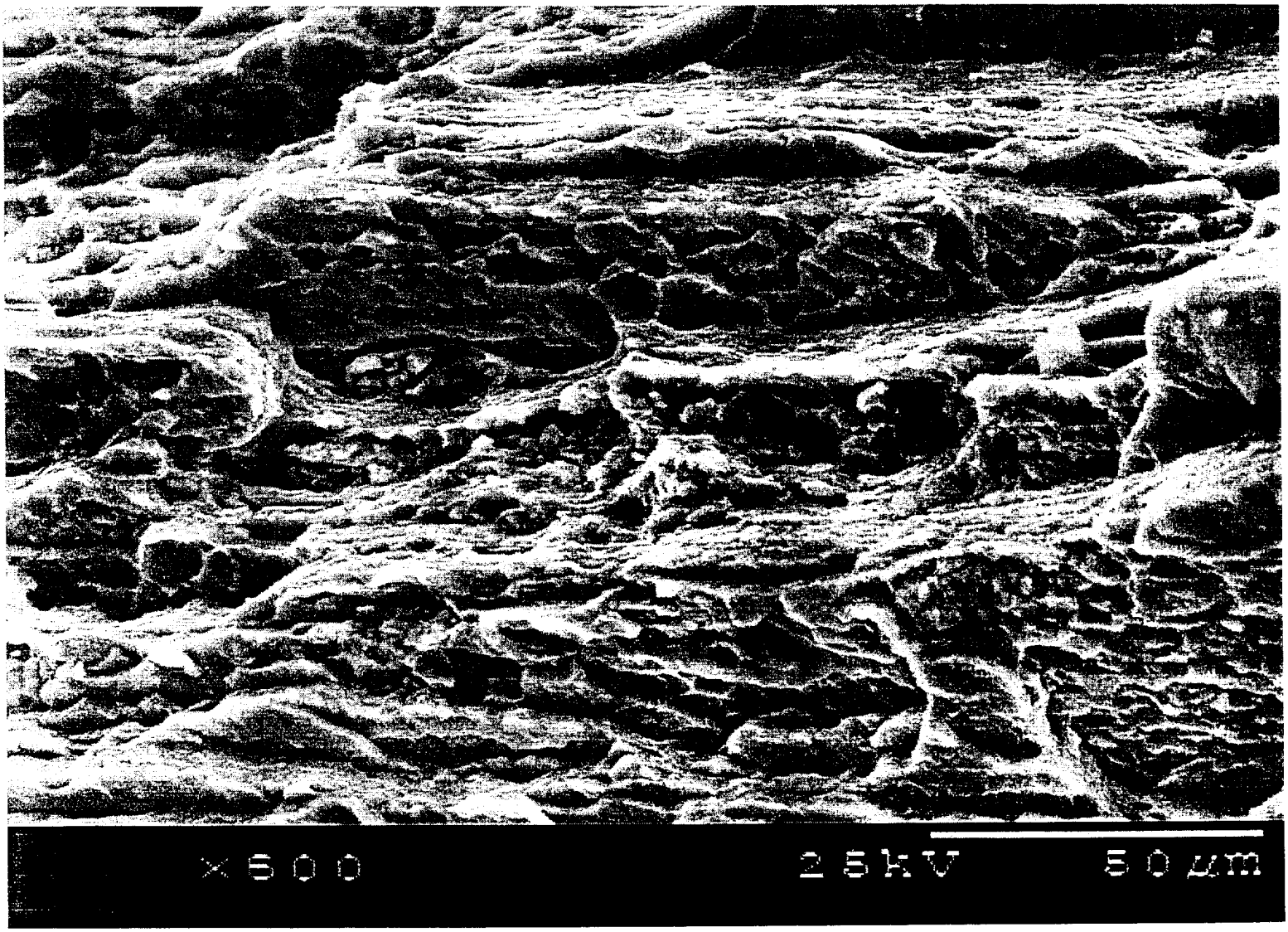


Figure 13: Higher Magnification (600X) Laser Reproduced, Enlarged SEM Micrograph Showing Impact or Overload Fracture Morphology.

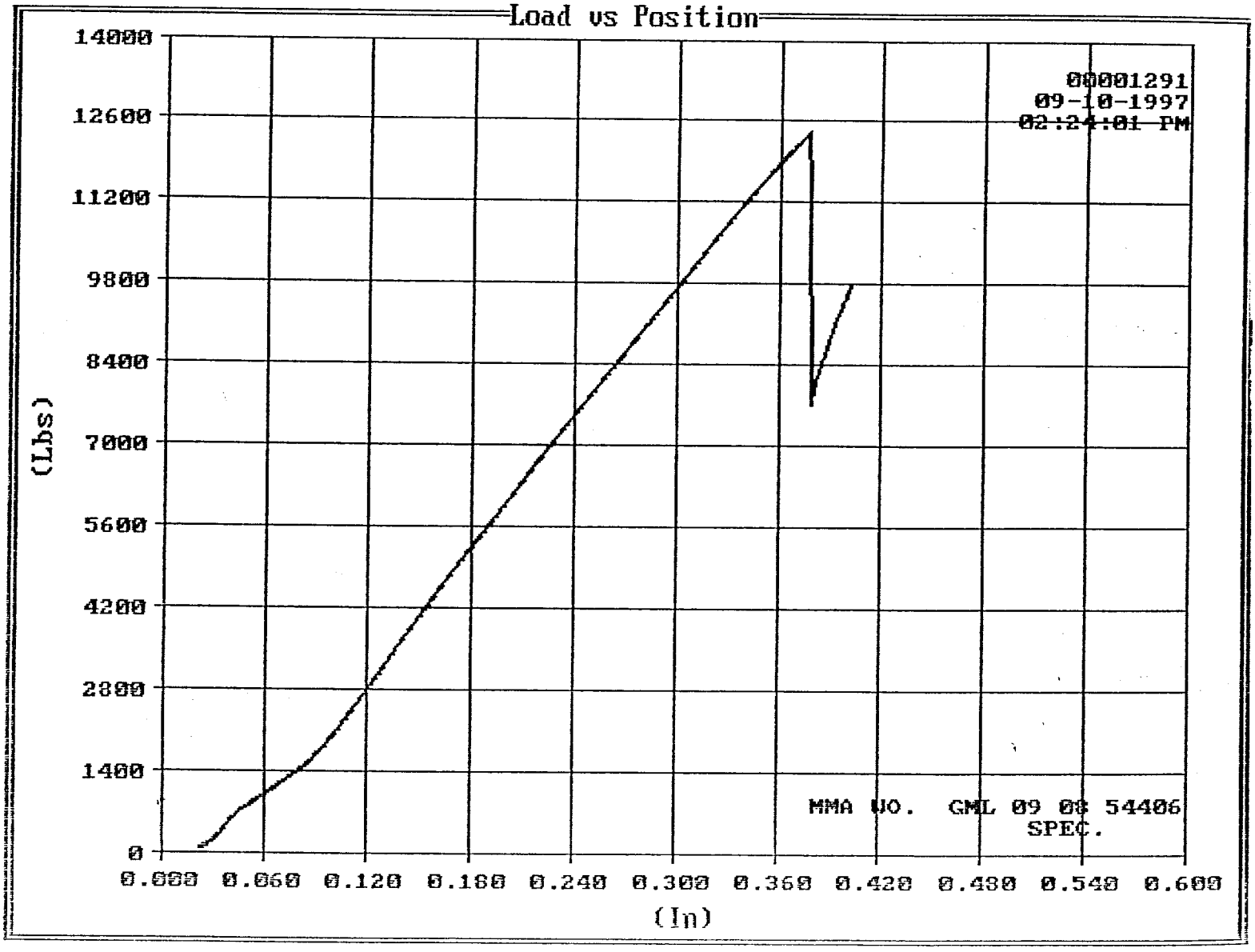
Appendix A

Test Maintain Test
Procedure NUT P.L.

Test Date	09-10-1997	Tested By	MMA LABS
Test Time	02:24:01 PM	Test Counter	00001291
Elapsed Time	00:03:48	Area	0.5000 In²
Maintain Level	30000.0 Lbs	Maintain Time	00:00:00

---------- Peaks ----------

Position	0.40330 In	Load	12415.0 Lbs
Stress	24830.0 PSI		



Fully Locked Position Load Test Graph

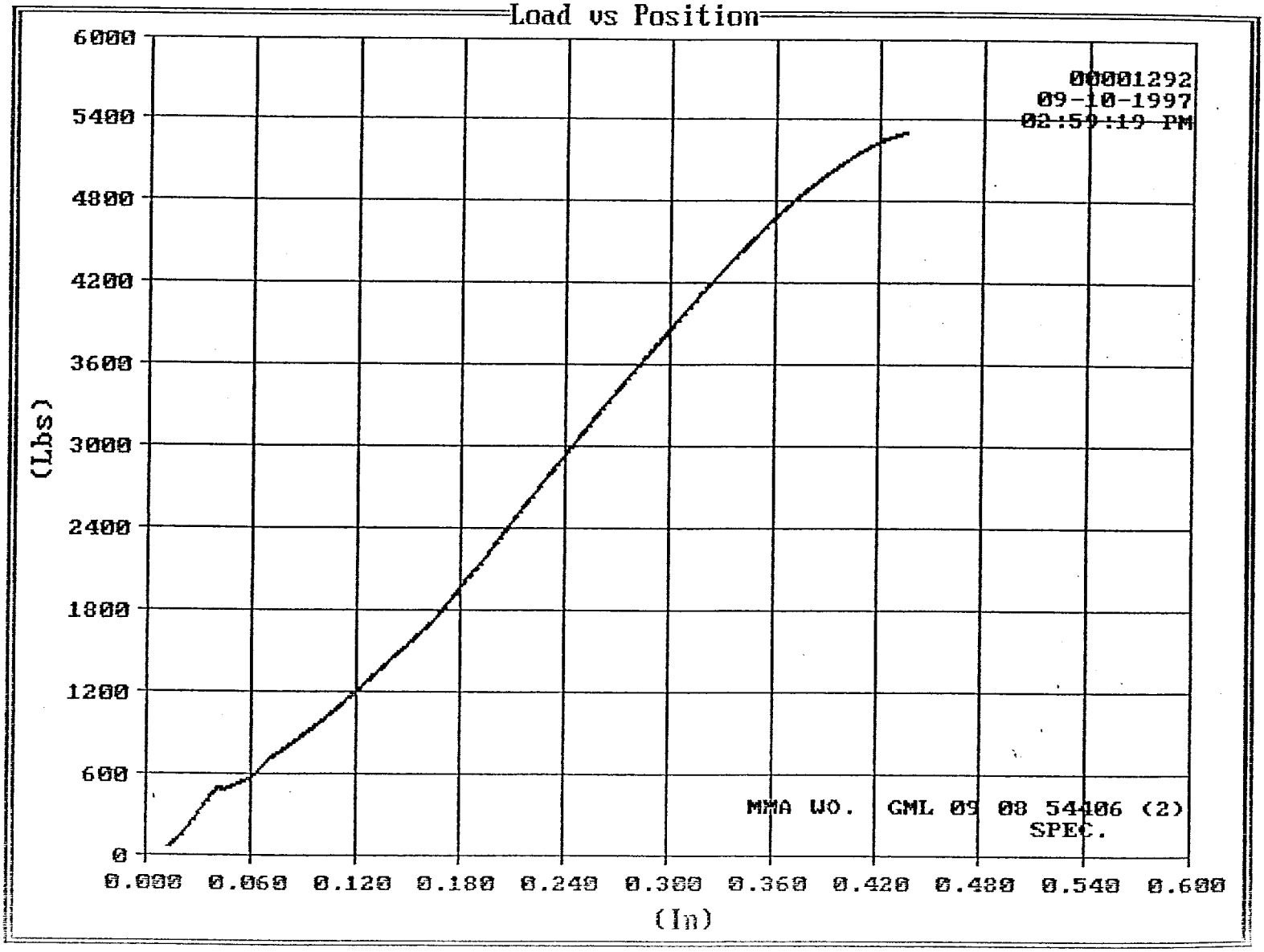
The stress results were based upon an arbitrary area inputted into the computer system in order to run the program

Test Maintain Test
Procedure NUT P.L.

Test Date	09-10-1997	Tested By	MMA LABS
Test Time	02:59:19 PM	Test Counter	00001292
Elapsed Time	00:04:13	Area	0.5000 In²
Maintain Level	30000.0 Lbs	Maintain Time	00:00:00

---------- Peaks ----------

Position	0.43650 In	Load	5302.5 Lbs
Stress	10605.0 PSI		



Partially Locked Position Load Test Graph

The stress results were based upon an arbitrary area inputted into the computer system in order to run the program

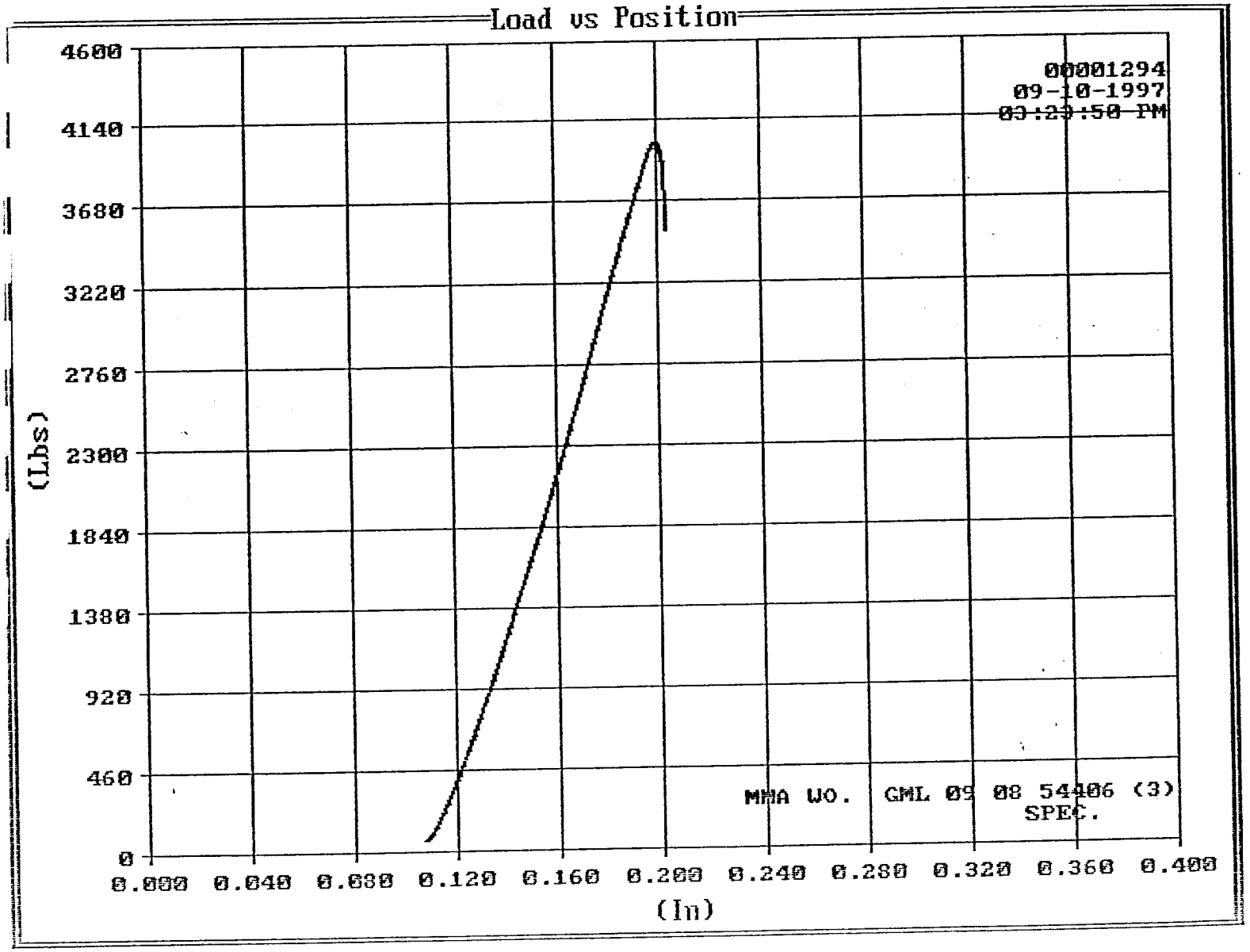
PEC.

st Maintain Test
rocedure NUT P.L.

st Date	09-10-1997	Tested By	MMA LABS
est Time	03:23:50 PM	Test Counter	00001294
lapsed Time	00:00:58	Area	0.5000 In²
aintain Level	30000.0 Lbs	Maintain Time	00:00:00

---------- Peaks ----------

ition	0.20430 In	Load	4004.9 Lbs
ress	8009.8 PSI		



Inverted Compression Load Test Graph

The stress results were based upon an arbitrary area inputted into the computer system in order to run the program

MMA Laboratories, Inc.
15909 Producer Circle, Huntington Beach, CA 92649 Ph: (714) 892-1961 Fx: (714) 892-8159 • 2 Pheasant Run, Newtown, PA 18940 Ph: (215) 579-7800 Fx: (215) 579-7991

Machine: SATEC
Model: MII 100UD

Ser. No: 1107 (P075)
Device Verified: CRT DISPLAY

Machine Range Verified: to Resolution: LBS.

Machine Reading		Force	Device Reading		Run 1 Machine Err.		Run 2 Machine Err.		Repeat-	CD
Run One	Run Two	% Diff.	Run One	Run Two	1st. Err.	%	2nd. Err.	%	ability	Code
		Return to Zero								

LOAD VALUES CORRECTED FOR A TEMPERATURE OF 74 DEGREES FAHRENHEIT.

VERFICATION METHOD USED:
XX Follow-the-Force Method
____ Set-the-Force Method
____ Dead weights

SATEC MEASURING DEVICE INFORMATION

C.D. Code	Serial Number	Manufacture	Verification High Value	Date Last Calibrated	Due Date	Range Class A	Traceable to NIST Lab No.
1	960122A	STRAINSENSE	600	03/03/97	03/03/99	41.72	SJT.01/106707
2	970220B	STRAINSENSE	6,000	03/03/97	03/03/98	368.80	SJT.01/106707
3	891027C	STRAINSENSE	20,000	03/03/97	03/03/99	1,496.00	SJT.01/106707
4	891027D	STRAINSENSE	120,000	02/16/96	02/16/98	3,160.00	SJT.01/106368
5	3192	TROEMNER	51	11/07/95	11/07/00	0.00	822/250904
6							
7							

Elastic verificatioin devices calibrated by National Standards Testing Laboratory in accordance with ASTM E74. Dead Weights certified by RICE LAKE in accordance with ASTM E4, paragraph (12.1).

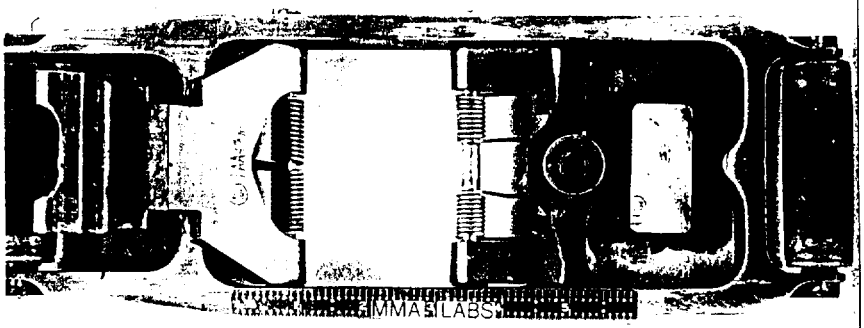
Comments:

SCALE NUMBER (5) 93.65, 93.65, 93.65, 93.65

To reschedule, please call 1-800-RAN-TEST (726-8378)

We sincerely appreciate your business and thank you for selecting SATEC Systems, Inc.

EXTRA



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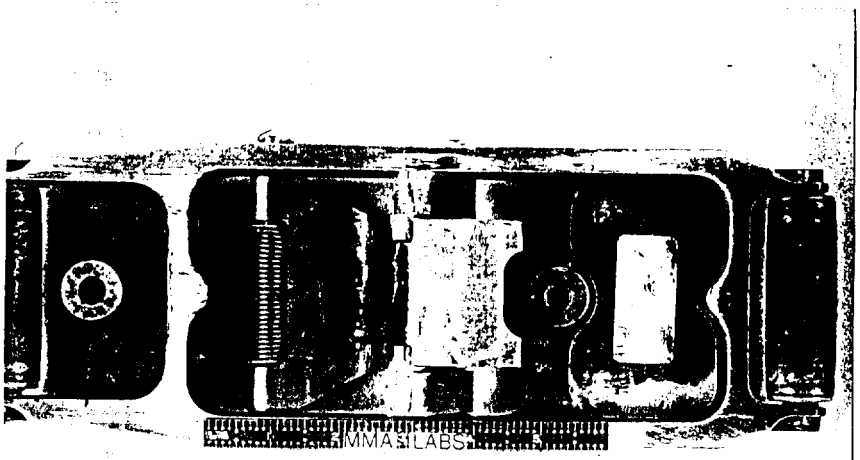

→ F

IMMA Laboratories, Inc.
15062 Bolsa Chica, Huntington Beach, CA 92649 **Ph:** (714) 892-1961 **Fx:** (714) 892-8159 • 2 Pheasant Run, Newtown, PA 18940 Ph: (215) 579-7500 Fx: (215) 579-7501

APPENDIX D

NTSB FACTUAL REPORT OF FLAP ACTUATOR EXAMINATION

BOEING'S COMMENT ON NTSBREPORT "FACTUAL REPORT OF FLAP ACTUATOR EXAMINATION"

NTSB TECHNICIANS FACTUAL REPORT

NO. 97-145

NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

September 23, 1997

FACTUAL REPORT OF FLAP ACTUATOR EXAMINATION

DCA-97-MA-059

A. ACCIDENT

Location:	Miami, Florida
Date:	August 7, 1997
Time:	1234 Eastern Standard Time
Aircraft:	Douglas DC-8-61, N27UA

B. COMPONENTS EXAMINED

The six flap actuators (inboard, midwing, and outboard for the left and right wings) from the accident airplane.

C. DETAILS OF THE EXAMINATION

The actuators were examined at the Safety Board's Materials Laboratory. The cylinder body ("barrel") of each actuator was cut open to examine for impact marks on the inner wall. Melted or burned residue from the seals between the piston and barrel wall was also documented.

Prior to any destructive work on the actuators, the piston rod extensions were measured.[1] The measurements were taken from the centerline of the actuator's wing-side attach point to the centerline of the piston's flap-side rod end. The extensions were correlated with approximate stroke measurements and flap positions using the information provided by Boeing (see attached diagram).

Actuator Position	Extension	Stroke	Flap Position
LW Outboard	12.25"	1.5"	approximately 9°

- External fire/heat damage to actuator

[1] A breach in the extend or retract hydraulic lines connected to each flap actuator will allow the loss of hydraulic fluid and movement of the flap actuator pistons under force.

- Heat discoloration on barrel inner wall except in an approximate ¾" band forward of aft piston stop (i.e., consistent with full-extended position)
  - several very light, longitudinal scrapes in discolored area of inner wall
- No thermal damage to piston seal

RW Outboard 12.8" 2.0" approximately 14°

(note: since piston had broken off near the end of the barrel, it was mated with fracture surface to obtain proper measurement)

- External and internal fire/heat damage to actuator
- burned piston seal residue observed at the as-found location of piston

LW Midwing 13.5" 0.5" near retracted

(note: barrel outside diameter at flap end is approx. 4.8" [consistent with specfication per drawing 3774158])

- External fire/heat damage
- No thermal damage to piston seal

RW Midwing (rod end was missing)

(note: barrel outside diameter at flap end is approx. 4.1" [not consistent with specfication per drawing 3774158])

- External and internal fire/heat damage to actuator
- burned piston seal residue observed at the as-found location of piston
- piston was intact, but rod end was not attached. If the same rod end as found on LW Midwing actuator was used, extension would be 15.75 inches; this corresponds to a flap position of approximately 17°.
- no damage was observed on the threaded portion of piston end; continuous sooting/grease was observed across threads

LW Inboard: 17.5" -0.2" retracted

- External and internal fire/heat damage to actuator
- burned piston seal residue observed at the as-found location of piston

RW Inboard: 17.5" -0.2" retracted

- No fire damage to actuator or piston seal
- although barrel inner wall retained a lubricated, polished appearance, two small marks were observed on approximately half of the inner wall circumference at

locations approximately 3 ½" 4 3/8" from wing end of barrel; distance between these marks is roughly the same as the piston width (unbeveled portion). Assuming these marks were made by the piston would provide a stroke of approximately 3.5 inches, which equates to a flap setting of approximately 15°.

The barrel of each actuator was cut open to provide good access to the inner wall. Other than on the right-inboard and left-outboard flap actuators, no marks were observed on the inner wall of the barrels other than at the as-found location of the piston. No evidence of burned piston seal was observed except at the as-found locations of the pistons.

[redacted]

Frank Hilldrup
Aerospace Engineer

9/26/97

Douglas Products Division
3855 Lakewood Boulevard, Long Beach, California 90846-0001

C1-L70-SRL-97-F080r1
24 September, 1997

Mr. Carrol A. (Corky) Smith
Air Safety Investigator
Southeast Regional Office
National Transportation Safety Board
8405 N. W. 53rd St.
Suite B-103
Miami, Florida 33166

Subject: NTSB Report "Factual Report of Flap Actuator Examination"

Reference: Fine Air DC-8 Accident, Miami, Florida, 8/7/97

Dear Sir:

The Douglas Products Division (DPD) has reviewed the subject report, and the following comments are provided per your verbal request:

Absent definitive witness marks, other mechanical damage, or flap lockout cylinders, the initial impact flap setting may be difficult or impossible to confirm. As you know, the flaps are hydraulically actuated and positioned. Any breach of the hydraulic lines to or from the otherwise undamaged actuators would allow the loss of hydraulic fluid from the system and actuators, which in turn would allow actuator pistons to travel to any position within their full range of motion, given the application of relatively minimal force. Under such conditions the "as found" flap actuator piston extension would probably not accurately reflect the actual position of the piston (and therefore flap setting) at initial ground impact.

Sincerely,

William C. Steelhammer
Senior Accident Investigation Coordinator
Flight Operations (MC D094-0025)

NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594

August 27, 1997

TECHNICIAN'S FACTUAL REPORT Report No. 97-145

A. ACCIDENT

Place	: Miami, Florida
Date	: August 7, 1997
Vehicle	: DC-8-61, N27UA
NTSB No.	: DCA97-M-A059
Investigator	: Corky Smith

B. COMPONENTS EXAMINED

Vertical Air Speed Indicator and Airspeed Indicator

C. DETAILS OF THE EXAMINATION

The two indicators were received without their glass lenses present, and with their dial indicator plates heavily covered with soot. Visual examination of the dial plate before and after cleaning with soap and warm water revealed no evidence of transfer marks from the needle indicators.

Detail examination of the vertical speed indicator after cleaning revealed that the needle for this indicator was found midway between the numbers 2 and 3 down position as shown in figure 1. The units for this dial plate were not clear because of heavy sooting deposits. The needle could be easily rotated by hand and the soot pattern under the indicator needle was similar in appearance to near by areas.

Visual examination of the air speed indicator in figure 2 revealed the max. allowable airspeed indicator needle was pointing to approximately the 330 knots position and the air speed indicator needle was pointing to approximately the 107 knots position. Neither of these indicator needles could be moved easily by hand. Due to the sooting deposits, the mach scale was not legible.

[redacted]
Spencer Phillips
Physical Science Technician

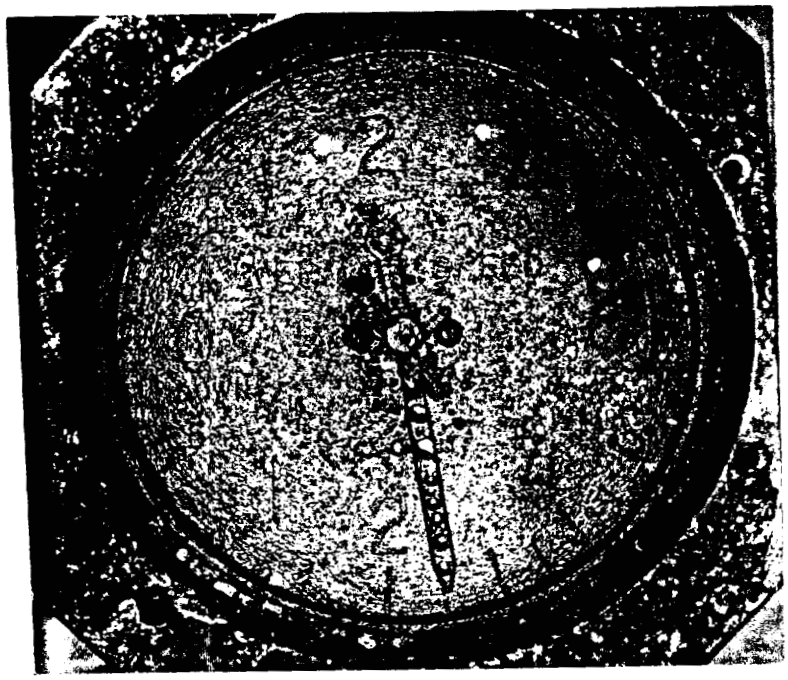

Figure 1 View of vertical speed indicator showing needle position.

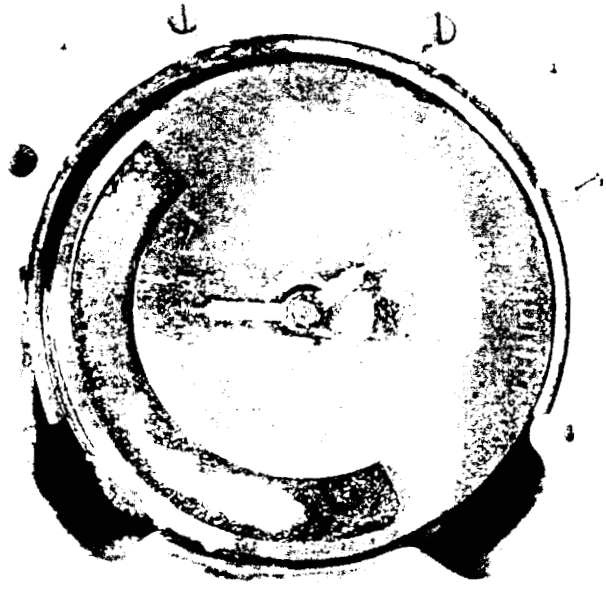

Figure 2 View of the airspeed indicator showing the needle position.

APPENDIX E

METRO DADE LABORATORY ANALYSIS REPORT NO. 394036T

METRO DADE POLICE DEPARTMENT

9105 N.W. 25TH STREET
MIAMI, FLORIDA 33172

CRIME LABORATORY BUREAU

LABORATORY ANALYSIS REPORT

Date: 08/29/97

TO: INVESTIGATOR CARROL SMITH
NATIONAL TRANSPORTATION SAFETY BOARD

DISTRICT 99

M.D.P.D. Case # 394036T
Other Agency Case # 97059
Defendant: *NOT LISTED
COURT CASE #
ASST STATE ATT
JUDGE NAME :

The below listed evidence was receipted for by this laboratory

on 08/21/97

THE PROPERTY RECEIPT REFLECTS THE SUBMITTING OFFICER IS INVESTIGATOR CARROL SMITH, NTSB

ITEM 27: Description: 1 DC-8-61 TAIL SKID

ITEM 28: Description: 1 PAINT SAMPLE FROM RUNWAY 27R CENTER

A comparison of the paint from the tail skid, item #27, and the standard paint from the runway, item #28, revealed that the paint samples were different and did not share a common origin.

RESPECTFULLY SUBMITTED,

[redacted]

GEORGE A BORGHI, ID# 302472
CRIMINALIST II, CRIME LABORATORY

DISTRIBUTION: White to Addressee; White to Case-file; Canary to Prosecuting Attorney; Blue to MDPD Records; Gold to Analyst.

APPENDIX F

BOEING MEMORANDUM

SEPTEMBER 9, 1997

09 September, 1997

TO: Steven R. Lund, (D094-0025)

FROM: William R. Saksa, C1-BM5 (C052-0018)

SUBJECT: CONTROL INSTAL - TAIL SECTION FLIGHT LONGITUDINAL TRIM DRIVE MECHANISM, P/N 5647880 (Ref Drawing # 3717263)

COPIES TO: Carrol A. Smith N T S B; Fred M. vonZabern, C1-L33 (D035-0035)

P/N	Name	S/N
MS30-3913-257-S656-5	Hydraulic Motor (Vickers)	MX158489
4372-501	Gear Box (Schrillo)	1-397
402197	Electric Motor (Western Gear)	268A
3771240-5501A	Brake Assy	EBA-017

Functional Test Was Performed in Accordance with DC-8 Overhaul Manual 27-11-1 Test Number 3

A) With 3000 PSI applied to port D and the control valve lever and shutoff valve lever in position 1 the torque shaft rotation is counter- clockwise viewing shaft end.

B) With 3000 PSI applied to port D and the control valve lever and shutoff valve lever in position 3 the torque shaft rotation is clockwise viewing shaft end.

Assembly passes the functional test requirement of overhaul manual. Tests were witnessed by Carrol A. Smith, National Transportation Safety Board, Air Safety Investigator and Fred M. vonZabern, Customer Technical Engineering Product Support.

Test Inspectors: Bob Johnson C326649
Howard Mauer C301495

[redacted]

Bill Saksa, Manager
Mechanical Laboratories
Oxygen / Hydraulics / Pneumatics