TWR-64983, Volume II, Revision N/C
Appendix

SPACE SHUTTLE
Solid Rocket Motors
Thiokol Corporation

FLEX BEARING UUEC
FINAL REPORT
VOLUME II - Appendix

1 September 1993

Prepared for:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GEORGE C. MARSHALL SPACE FLIGHT CENTER
MARSHALL SPACE FLIGHT CENTER, ALABAMA 35812

Contract No. **NAS8-38100**

DR No. **3-5**

WBS. No. **4C102 10 05**

Thiokol **CORPORATION**
SPACE OPERATIONS

P. O. Box 707, Brigham City, UT 84302-0707 (801) 863-3511

FORM TC 4677 (REV 1-88)

(NASA-CR-193900) FLEX BEARING UUEC. VOLUME 2: APPENDIX, REVISION N/C Final Report (Thiokol Corp.) 293 p

N94-71524

Unclas

Z9/37 0206791

Thiokol CORPORATION
SPACE OPERATIONS

Robert E. Lindstrom
Senior Vice President and General Manager

26 January 1993
A100-FY93-072

TO: Space Distribution A and B
UUEC Team Members
RSRM Program Managers

FROM: R. E. Lindstrom

SUBJECT: UUEC - Flex Bearing Unbond Investigation

In accordance with Procedure 75-01-03, *Incident Reporting and Investigation,* Morley Cox has been assigned to chair the subject UUEC. The board will conduct its investigation in accordance with the requirements of TWR-61870, Rev A, *Significant Incident Reporting and Investigation.* The membership to support the chairperson fulltime is as follows.

M. Berhold	Project Engineer
M. Clapper	Work Center Product Design
R. Didericksen	Nozzle Design
D. Hougaard	Quality
G. Lierd	RSRM Program Management
D. Mikesell	Reliability
A. Olsen	Manufacturing Engineering
L. Paulsen	Materials and Processes
C. Jackson	NASA/RMO

Mishap Investigation Guide, Publication No. 921526, may be used as a guide in the investigation. Weekly progress reports are required.

R. E. Lindstrom

P.O. Box 707, Brigham City, UT 84302-0707 (801) 863-3511

FSM #3 UUEC DISSECTION PHOTOGRAPHS:

BEARING NO. 20: 132035-1 THRU -13, PHOTOGRAPHED 02/16/93

BEARING NO. 22: 132002-25 THRU -33, PHOTOGRAPHED 01/30/93

BEARING NO. 27: 131910-1, -2, -22 THRU -28, PHOTOGRAPHED 01/29/93
132088-1 THRU -4, PHOTOGRAPHED 02/05/93

BEARING NO. 29: 132002-1 THRU -3, -34 THRU -40, -43

BEARING NO. 35: 131910-9 THRU -12, -21, PHOTOGRAPHED 01/29/93

BEARING NO. 39: 132002-16 THRU -24

BEARING NO. 53: 131910-3 THRU -7, -14, PHOTOGRAPHED 01/29/93

BEARING NO. 68: 132002-4 THRU -15, -41, -44

BEARING NO. 70: 131910-15, -16, -29 THRU -37, -39, PHOTO. 01/29/93

BEARING NO. 24: 132025-6 THRU -9, -13 THRU -16, PHOTO. 02/15/93

UUEC FLEX BEARING UNBONDS

TENTATIVE FLIGHT RATIONALE

RSRM-30 (STS-55)

5 February 1993

D. Morley Cox
E630-FY93-023
5 February 1993

FLIGHT RATIONALE (R30A, R30B, TEM-10)

- FSM-3 unbonds caused by excessive heat input from Zone 8 butterfly heaters
  - Lab test data
  - Vendor input
  - Cure cycle correlations
  - Forward end ring pitting on bearing build immediately after FSM-3
- Unbond at TC 4 (low temp) on FSM-3 is understood
  - TC data pre-81 correlates with temps in unbond areas (1, 2, 4 and 11 similar)
  - Thermal analyses indicates TC 4 reading is average of others and mold wall
  - Concluded that after 81, TC 4 was shorted - giving erroneous readings

D. Morley Cox
E630-FY93-023
5 February 1993

FLIGHT RATIONALE (R30A, R30B, TEM-10)

- Unbonds in FSM-3 occur in quadrant of highest temperature
  - Mold tool survey
  - Double cure bearing rusted in same quadrant
  - Pitted bearing end ring damage is in same quadrant
  - Zone 4 failure bearing exhibits rust in same quadrant
- Thermal mold tool correlations with 'selected' bearings from FSM-3 population indicates R30A, R30B and TEM-10 cures are below critical temperatures
  - Rust formation threshold
  - Bearing which was dissected - no rust found
  - Below non-rust areas in FSM-3
  - Below non-pitted areas in FSM-3 plus 1 bearing

D. Morley Cox
E630-FY93-023
5 February 1993

FLIGHT RATIONALE (R30A, R30B, TEM-10)

- No process variations identified in materials or mold preparation activities
- Bearings passed all acceptance tests, DRs reviewed and accepted for use
- R30A, R30B and TEM-10 bearings are acceptable for use

D. Morley Cox
E630-FY93-023
5 February 1993

UUEC - FSM#3 FLEX BEARING UNBONDS

STATUS & TENTATIVE FLIGHT RATIONALE

PRESENTED IN SUPPORT OF

RSRM 30A/B TIR

5 FEB 1993

HISTORICAL OVERVIEW

FLEX BEARING HISTORICAL OVERVIEW

* SUBSCALE 10 & 2 SHIM BEARINGS USED TO EVALUATE DESIGN & PROCESSING.
* ELECTRICALLY HEATED MOLD TOOL DESIGN SELECTED (FIGURE 1)
* THREE PROTOTYPE BEARINGS FABRICATED WITH 205/220/H-TYCEMENT/TR3005
* TYCEMENT FORMULATION CHANGED BASED UPON C-1 SUCCESS WITH NON-HYCAR FORMULATION.
* EIGHT PRODUCTION BEARINGS FABRICATED WITH 205/220/TYCEMENT/TR3005
    * #1 REJECT LEAKED
    * #2 ACCEPTABLE, 6 USES TO DATE
    * #3 ACCEPTABLE, 6 USES, DISSECTED FOR AGING STUDY IN 1992
    * #4 ACCEPTABLE, 8 USES TO DATE, ASSIGNED TO 33A
    * #5 REJECT
    * #6 ACCEPTABLE, 6 USES TO DATE
    * #7 REJECT
    * #8 REJECT
* TEAM BUILT BEARING (#9) WITH CHEMLOK 233 INSTEAD OF 220 - REJECT UNBONDS

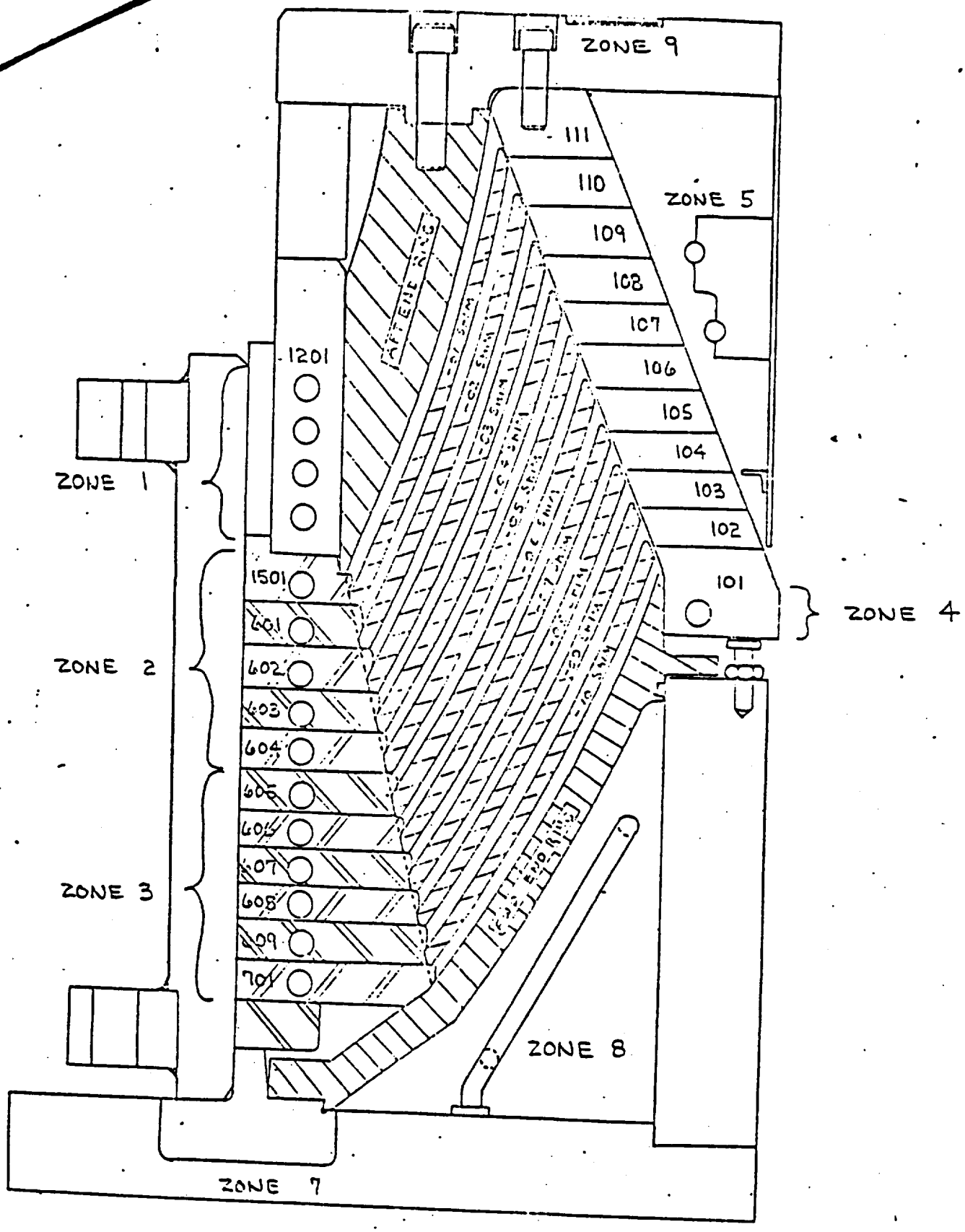
ZONE 9
111
110
109
108
107
106
105
104
103
102
101
ZONE 5
ZONE 4
1201
ZONE 1
1501
601
602
603
604
605
606
607
608
609
701
ZONE 2
ZONE 3
ZONE 8
ZONE 7

FIGURE 1

FLEX BEARING HISTORICAL OVERVIEW (CONT'D)

- TASK FORCE FORMED APRIL 1979
  - #10 FINISHED BUILDING LAST BEARING WITH NON-HYCAR TYCEMENT - REJECT MASSIVE UNBONDS.
  - CHANGED BACK TO NON-HYCAR TYCEMENT.
  - #11 BUILT WITH INTERNAL THERMOCOUPLES - NOTED THAT AREAS IN MOLD WERE 20° F. LOWER THAN EXPECTED. RAISED CURE TEMP AND EXTENDED TIME
    - GOOD BEARING, BUT SOFTER
    - USED 5 TIMES TO DATE
  - #12 REDUCED CURE TEMPERATURE 10° F. BEARING SIGNIFICANTLY UNBONDED IN TWO QUADRANTS (FIGURE 2).
  - 30 DEGREE PEEL TEST SHOWS GOOD/BAD BONDS

FLEX BEARING HISTORICAL OVERVIEW (CONT'D)

- #13 RAISED CURE TEMPERATURES UP 5° F.
    - GOOD BEARING
    - USED 5 TIMES TO DATE
- LAB DATA CONFIRMS CHEMLOK 220 CHANGE IN 1978 WHICH SHIFTED ADHESIVE CURE ACTIVATION THRESHOLD UPWARDS (FIGURE 3)
- LAB SPECIMENS SHOW CURES ABOVE 340° F. COULD PRODUCE RUST (FIGURE 4)
- MOLD STUDIES REVEALED CAL-ROD PIGTAIL COLD AREAS COINCIDE WITH UNBOND QUADRANTS FOR #12 BEARING - MOLD EXTENSIVELY MODIFIED
- #14 BUILT WITH ANOTHER 5° F. TEMPERATURE INCREASE AND IMPROVED ID HEATING
    - SOFT BEARING
    - USED ONCE - DISSECTED
- #15 LAST TASK FORCE BEARING BUILT - WELL BONDED OUT SOFT

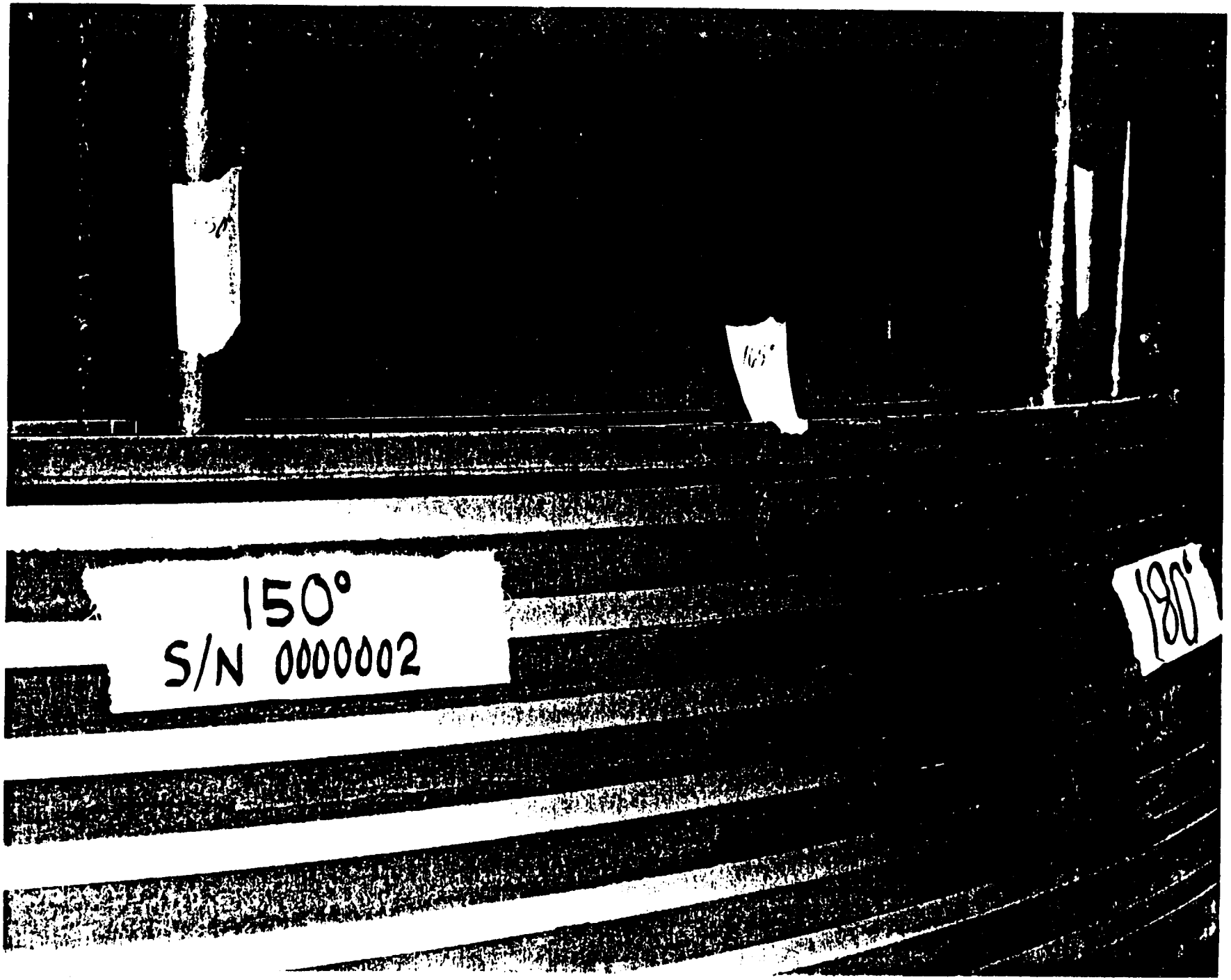

FIGURE 2a

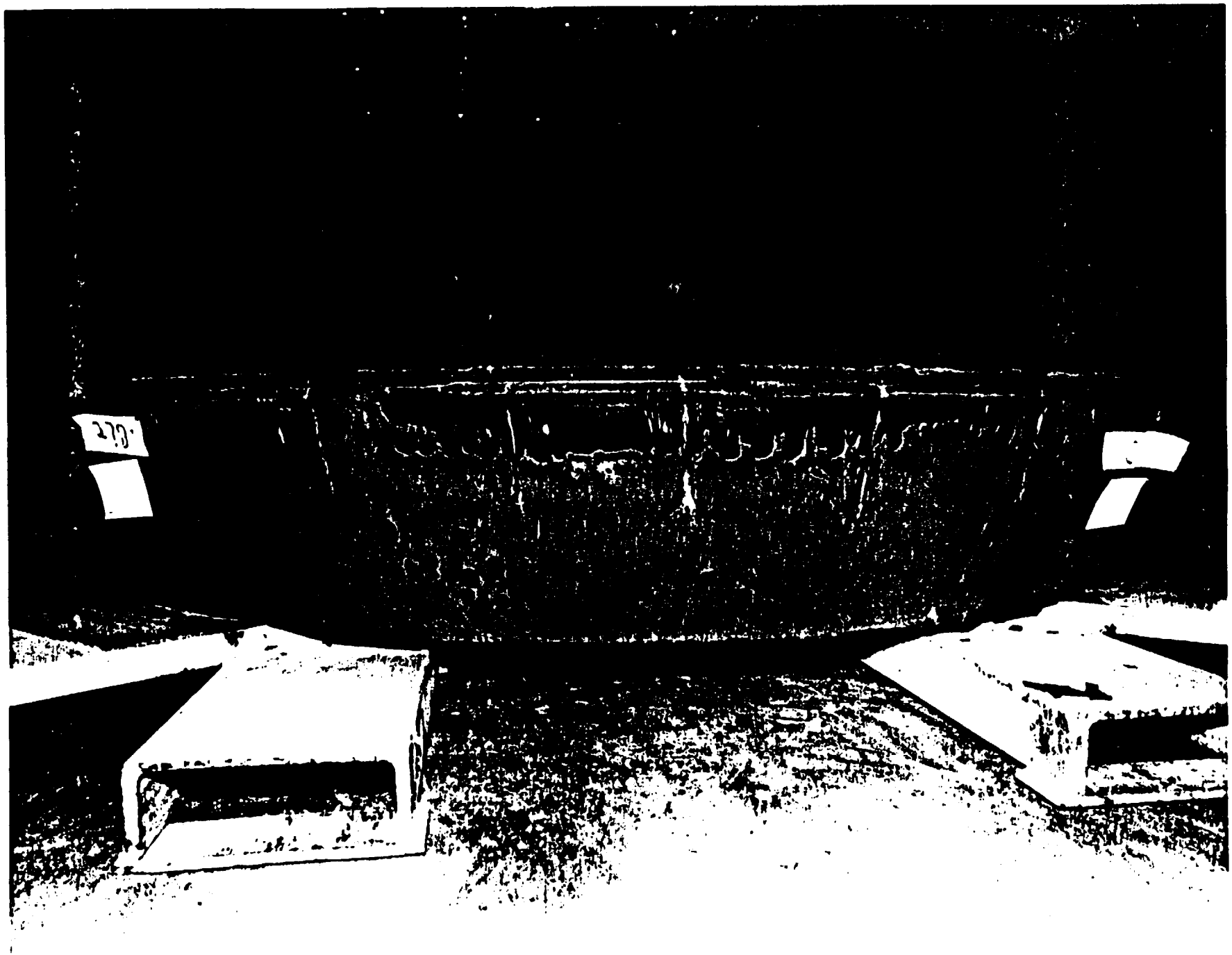

FIGURE 2b

FIGURE 3

CHEMLOK 220 EVALUATION

MFG DATE	HUGHSON STOCK NO	TYCEMENT TYPE	SPECIMEN RESULTS	BEARING USAGE
Sept 74	OIH	TBD	96% Acceptable	
Jan 75	PAA	TBD	93% Acceptable	
July 75	PGF	(w) HYCAR	100% Acceptable	
Dec 75	PKH	TBD	100% Acceptable	
Dec 75	PLE	(w) HYCAR	100% Acceptable	Prototype #1,2,3,4
Aug 76	RHC	NO HYCAR	89% Acceptable	Development #1,2
Sept 76	RIA	NO HYCAR	100% Acceptable	
Sept 76	RII	NO HYCAR	NONE	Development #3
April 77	SDA	NO HYCAR	90% Acceptable	
Aug 77	SHH	NO HYCAR	91% Acceptable	
Sept 77	SIC	NO HYCAR	65% Acceptable	
Dec 77	SLA	NO HYCAR	73% Acceptable	
April 78	TDF	NO HYCAR	NONE	Development #4,5
July 78	TGA	NO HYCAR	60% Acceptable	
Nov 78	TKB	NO HYCAR	84% Acceptable	Development #6,7
Dec 78	TLI	NO HYCAR	NONE	Development #8,10
Feb 79	WBE	NO HYCAR	NONE	

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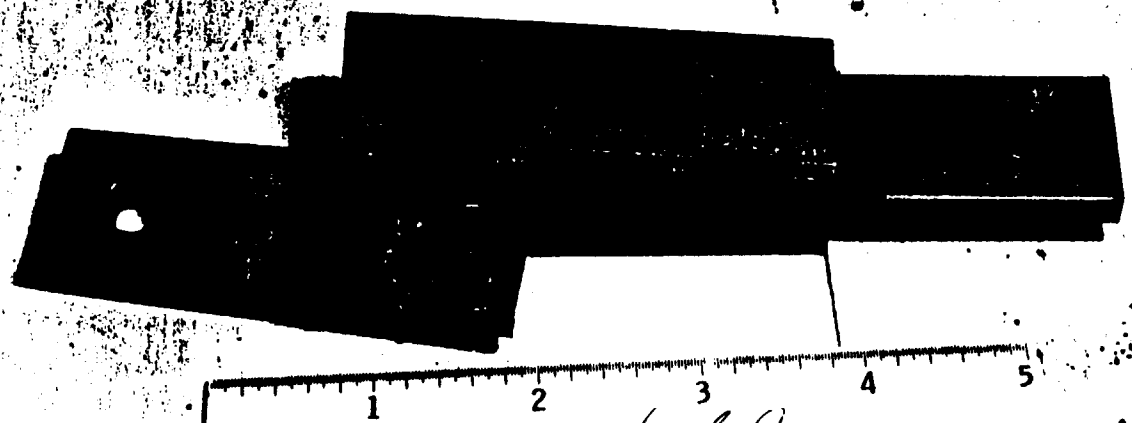
FIGURE 1



SUBJECT: QLS heated oven

DESCRIPTION: 340°F for 4 hr &
Stored. At 12-16 weeks,
Sample fell apart. Chemlok 205
(c) delaminated & stress cracked

PHOTOG: DHS

DATE: 1-21-93

Thiokol

FOLDOUT FRAME
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FLEX BEARING HISTORICAL OVERVIEW (CONT'D)

- PRODUCTION RESUMED JUNE 1980
  - MUST EXCEED MINIMUM THRESHOLD TO AVOID UNBONDS
  - MUST NOT CURE TOO HOT IN ORDER TO AVOID RUST
  - ACCEPTANCE CRITERIA USED TO SCREEN FOR DEFECTS

- BETWEEN 12/80 AND 11/85 TWENTY BEARINGS WERE BUILT WITH THE REVISED MANUALLY CONTROLLED HEATERS. THEY INCLUDED:
  - R30A BUILT 12/18/80 USED 5 TIMES
  - R31B BUILT 7/22/82 USED 6 TIMES
  - DISSECT BUILT 10/18/82 USED 4 TIMES NO RUST/UNBONDS
  - FSM#3 BUILT 2/12/83 USED 6 TIMES DISSECTED, RUST/UNBONDS (FIGURE 5)
  - R34B BUILT 4/22/83 USED 5 TIMES
  - TEM #10 BUILT 5/4/85 USED 4 TIMES

- AUTOMATIC CONTROLLERS WERE INTRODUCED IN 11/85
  - DISSECT BUILT 11/12/85 USED 1 TIME, NO RUST/UNBONDS
  - 33B BUILT 11/27/85 USED 1 TIME
  - 34A BUILT 12/13//85 USED 2 TIMES
  - DISSECT BUILT 4/11/86 CALROD CONTACT WITH FWD AND END RING

- PRODUCTION INTERRUPTED CHALLENGER ACCIDENT

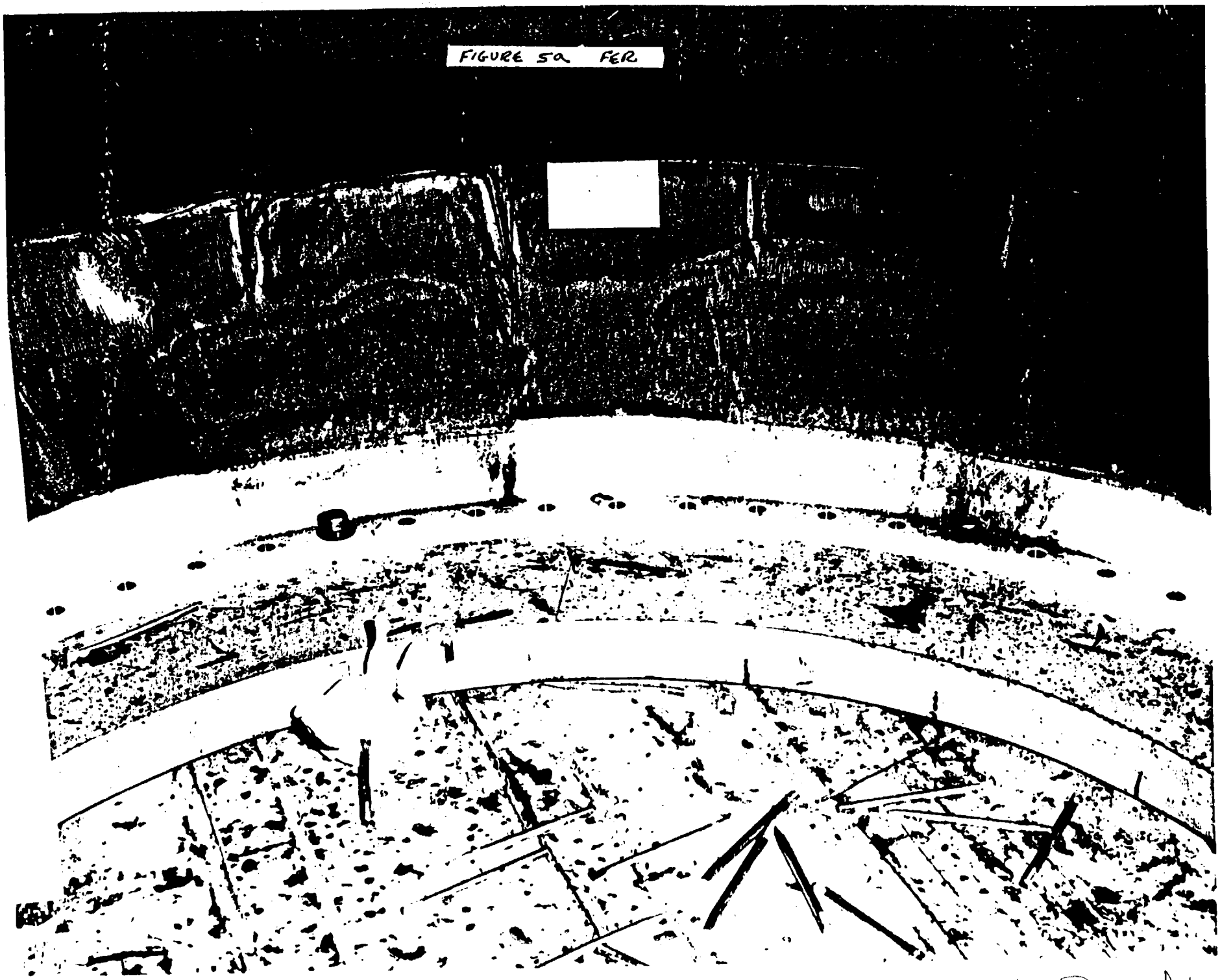


FIGURE 5a FER

FIGURE 5B SHIM

FLEX BEARING HISTORICAL OVERVIEW (CON'T)

- RSRM PRODUCTION CHECKOUT INITIATED 12/16/87
  - TWO CHECKOUTS - BOTH WITH CALROD CONTACT WITH FWD END RING
  - BECKSTRAND BUILT 06/18/88 ALSO HAD CALROD CONTACT
- BUTTERFLY HEATSHIELDS INSTALLED AND TC'S RELOCATED ONTO FWD END RING (FIGURE 6)
  - THIRTY BEARINGS BUILT
  - R31A BUILT 10/13/88 - USED 2 TIMES
  - DISSECT BUILT 11/03/89 - USED 2 TIMES
  - R32A BUILT 06/27/90 - USED 1 TIME
  - R32B BUILT 04/28/92 - NO PREVIOUS USE
  - DISSECT BUILT 06/15/92 - NO PREVIOUS USE, DOUBLE CURE, RUST (FIGURE 7)
  - DISSECT BUILT 08/19/92 - NO PREVIOUS USE, ZONE #4 MALFUNCTION RUST (FIGURE 8)

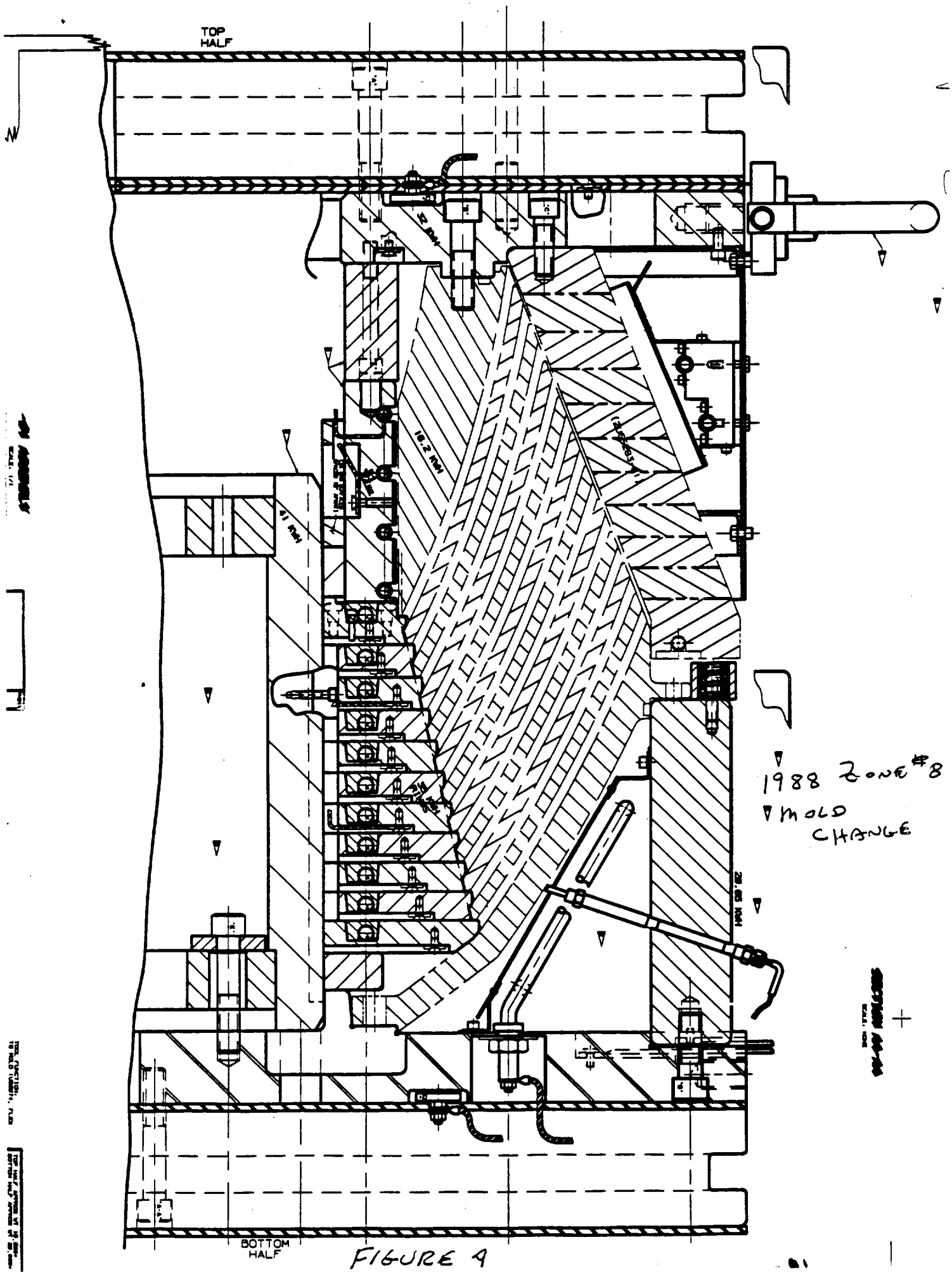
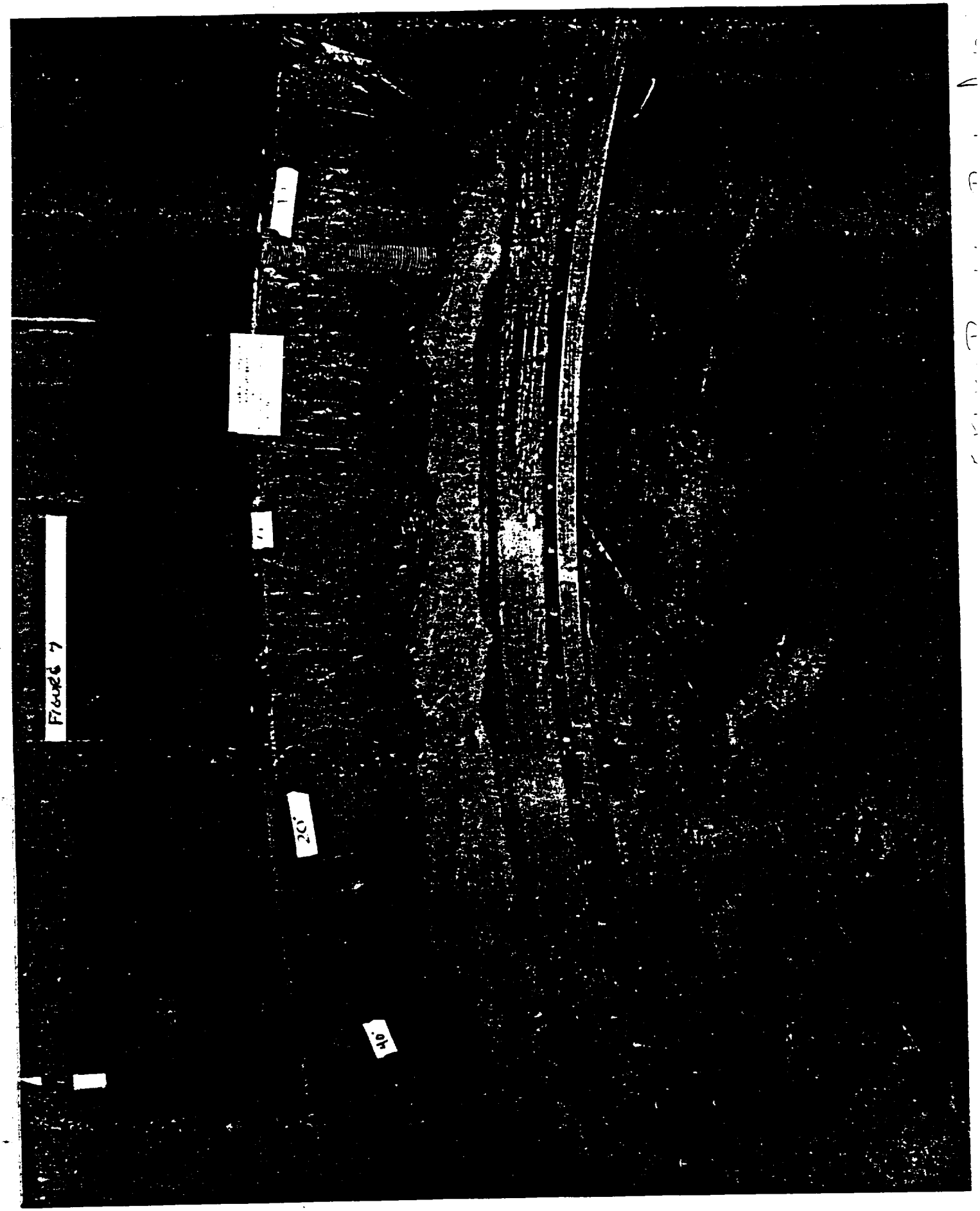


FIGURE 4



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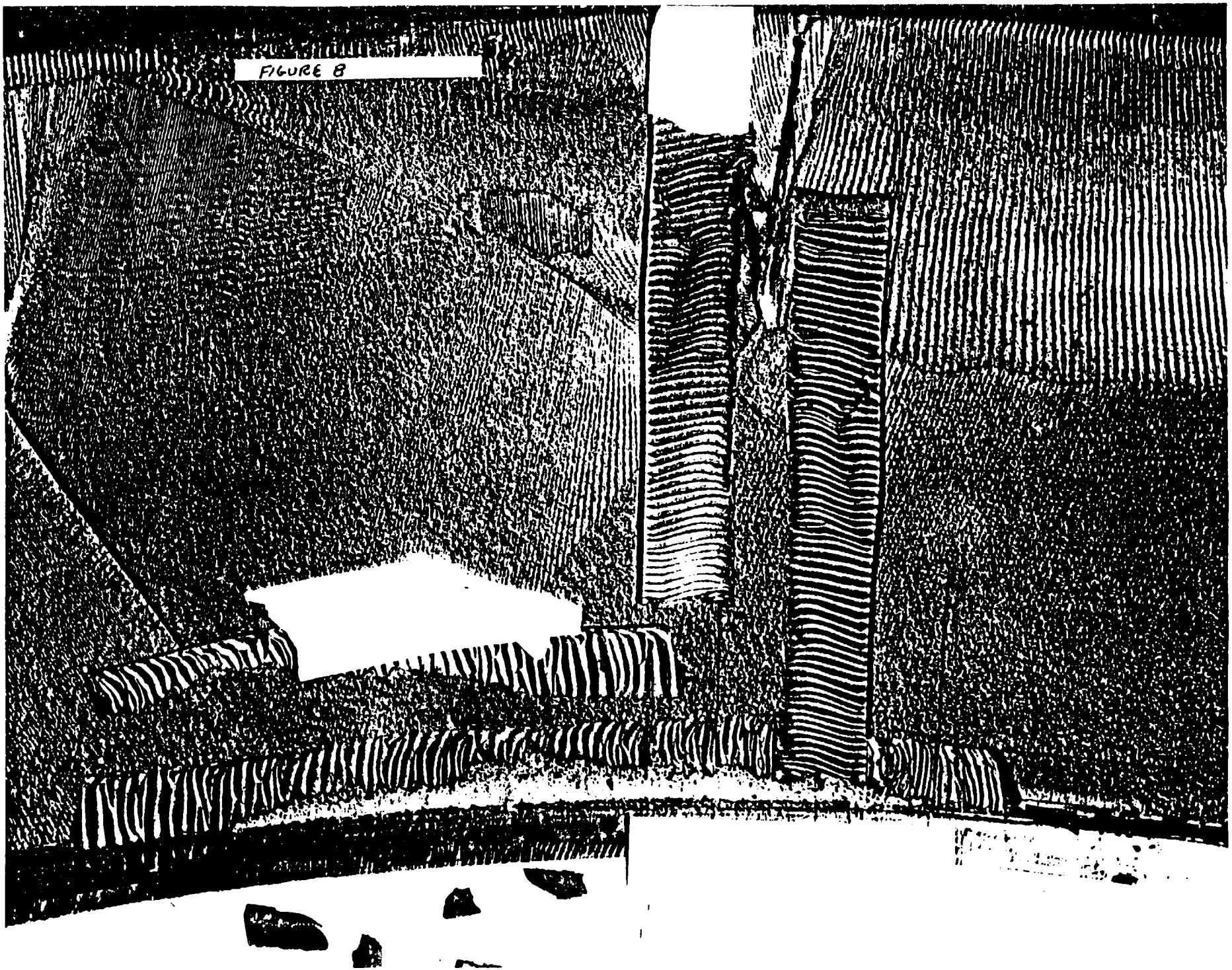
FIGURE 8

FSM #3 FLEX BEARING CONDITION

FSM#3 FLEX BEARING CONDITION

* FOUR MAJOR UNBOND AREAS ON FWD END RING (FIGURE 9)
    * THREE (TYPE 1) HEAVILY RUSTED
    * ONE (TYPE 2) LIGHTLY RUSTED

* ONE UNBOND ON #10 SHIM ADJACIENT TO FWD END RING OUTBOARD FROM FWD END RING UNBOND (FIGURE 10)
    * TYPE 2 LIGHT RUST
    * PAD DISECTION REVEALS HIDDEN RUST (FIGURE 11)

* REMOVAL OF STRIPS ADJACIENT TO FWD END RING RUST ZONES REVEALS GOOD BONDS (FIGURE 12 & 13)

* PAD # 11 HARDNESS - HIGHER THAN LAB SPECIMENS (FIGURE 14), NO OBVIOUS REVERSION (SEE SAMPLES)

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FER ID 1U76916-04 S/N 0000013 (R6)

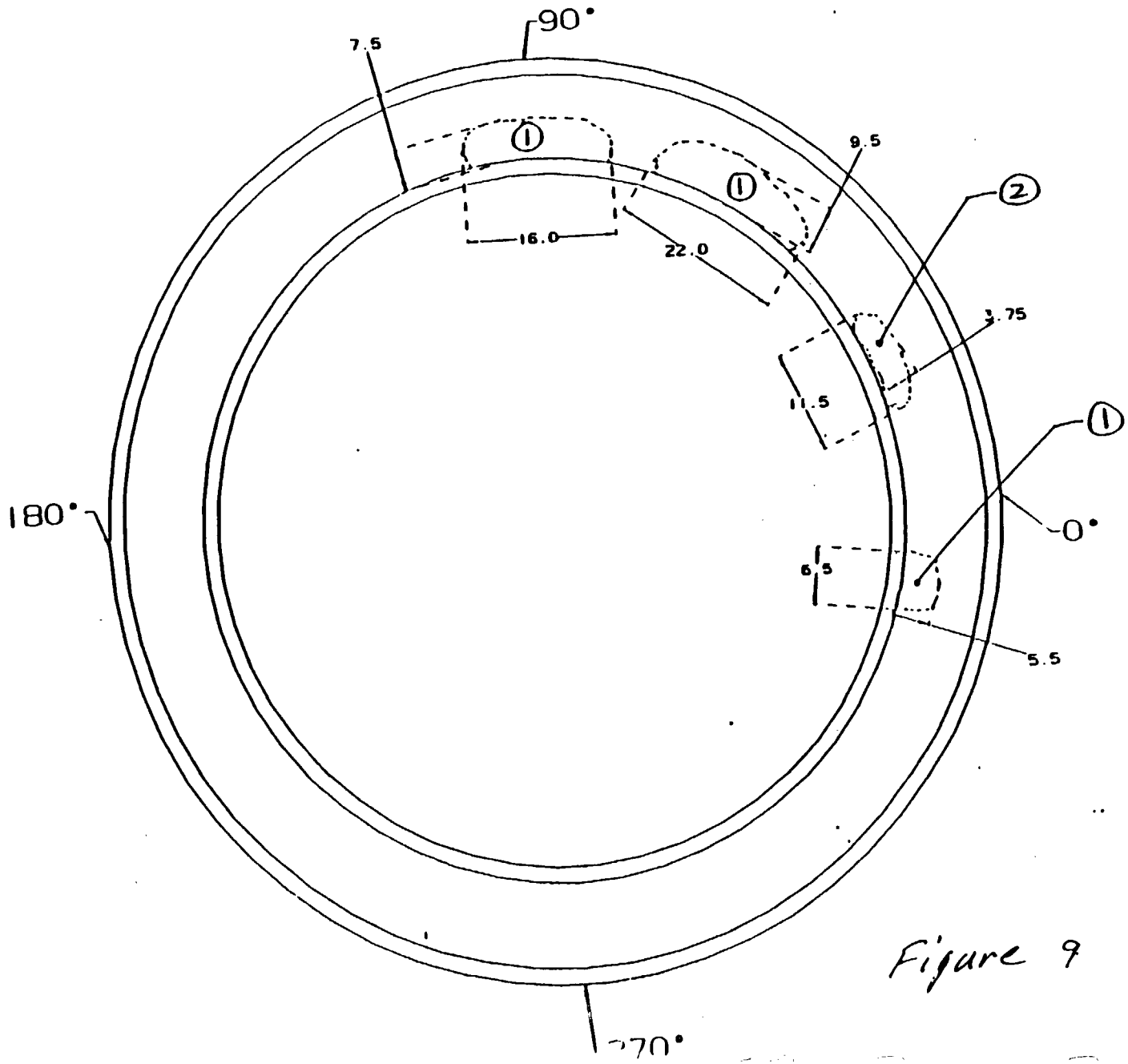

Figure 9

SHIM 10 OD 1U76916-04 S/N 0000013(R6)

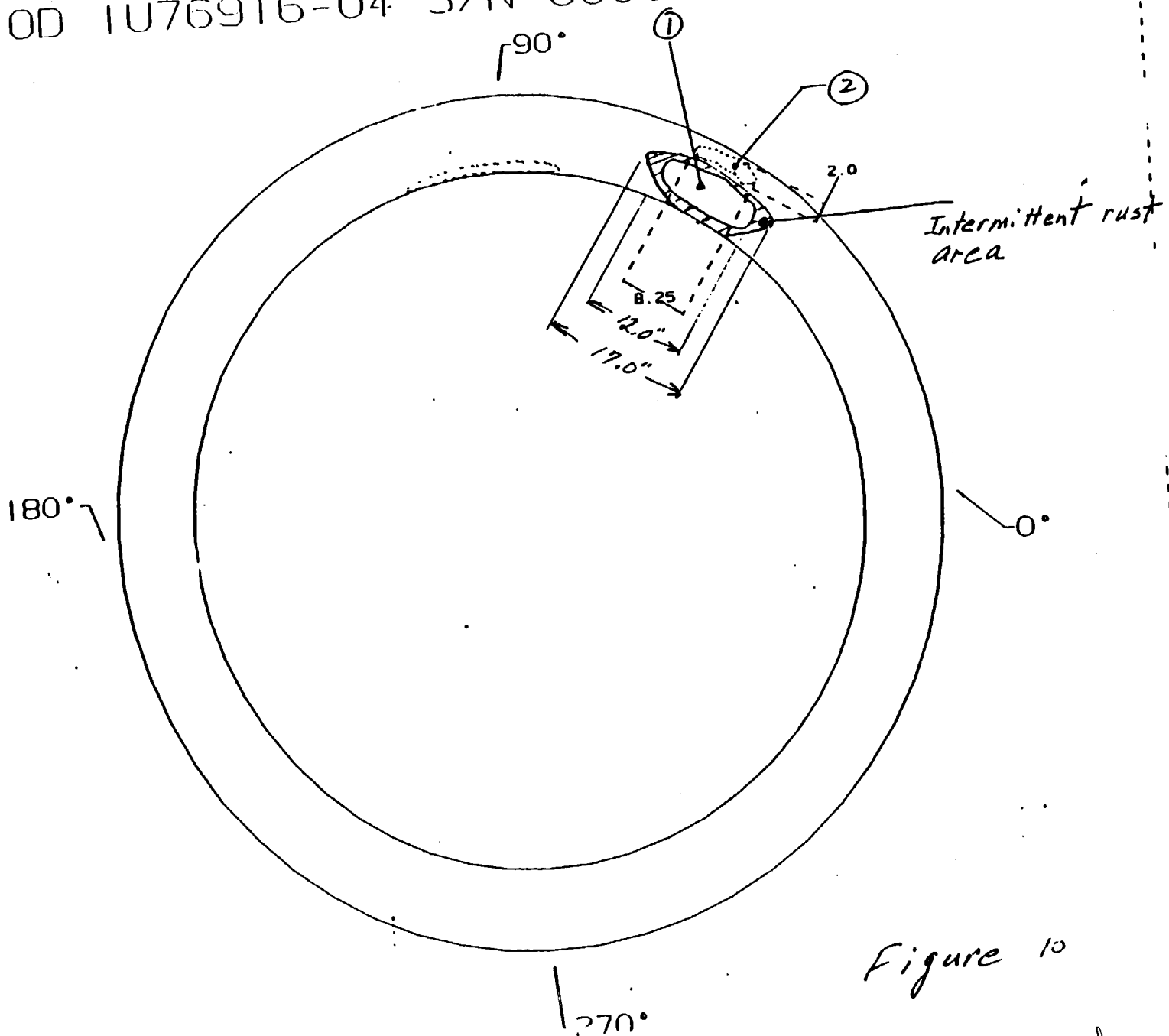

Figure 10

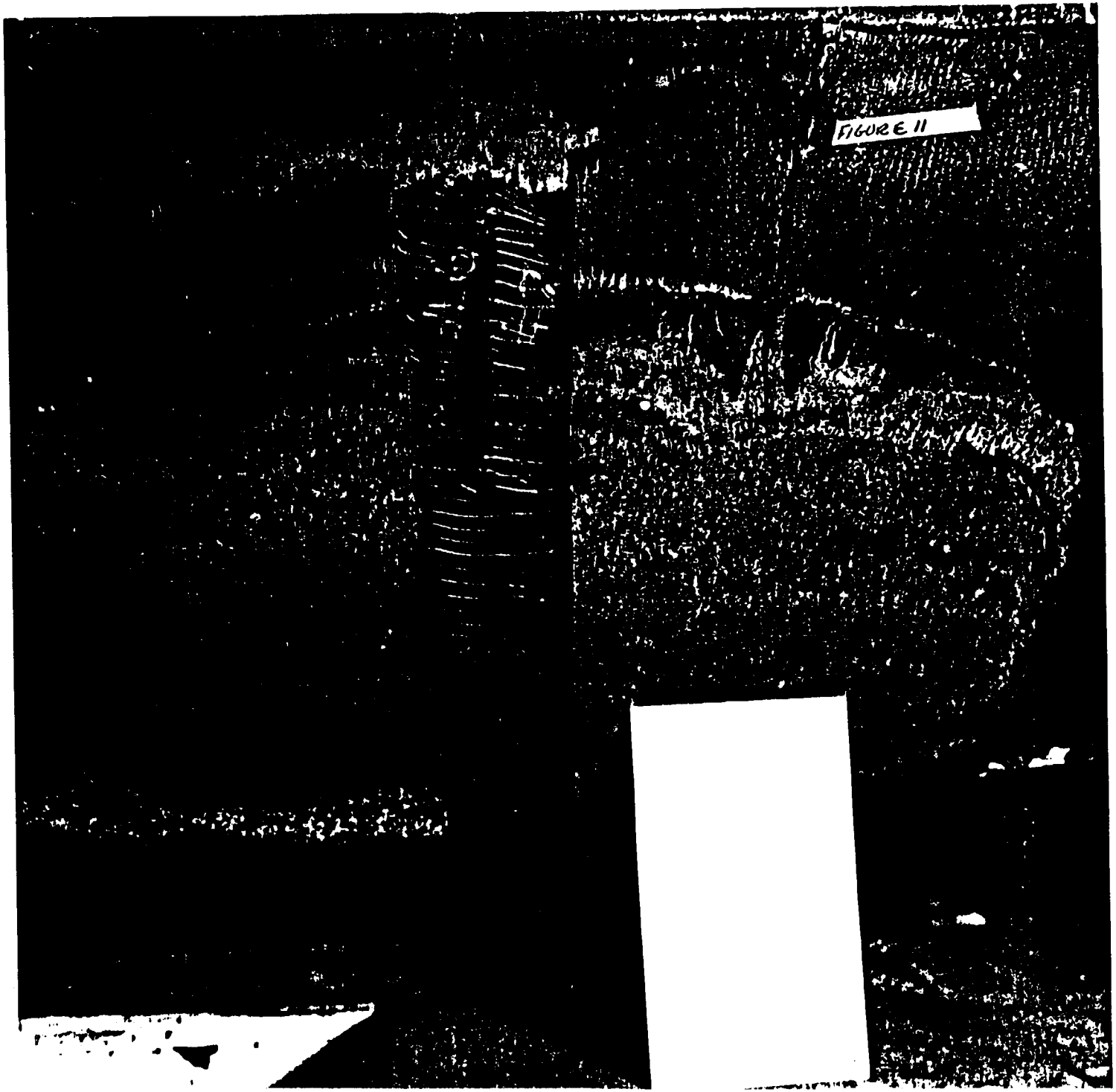
FIGURE 11

FER ID 1U76916-04 S/N 0000013

LEGEND:
SPOT 5--On opposite side of rubber
Peels:
#1-Tab broke at 13 lbs. load
#2-Tab broke at 13 lbs. load
#3-Tab broke at 16 lbs. load
#4-Tab broke at 16 lbs. load
#5-Tab broke at 13 lbs. load
Test Pulls:
*At 18 lbs load tab broke
20 lbs load tab broke
**At 18 lbs load tab broke
15 lbs load tab broke
27 lbs load tab broke
Pre-Test Shave Spot:
Spot No. 1
No. 2
No. 3
No. 4
No. 5

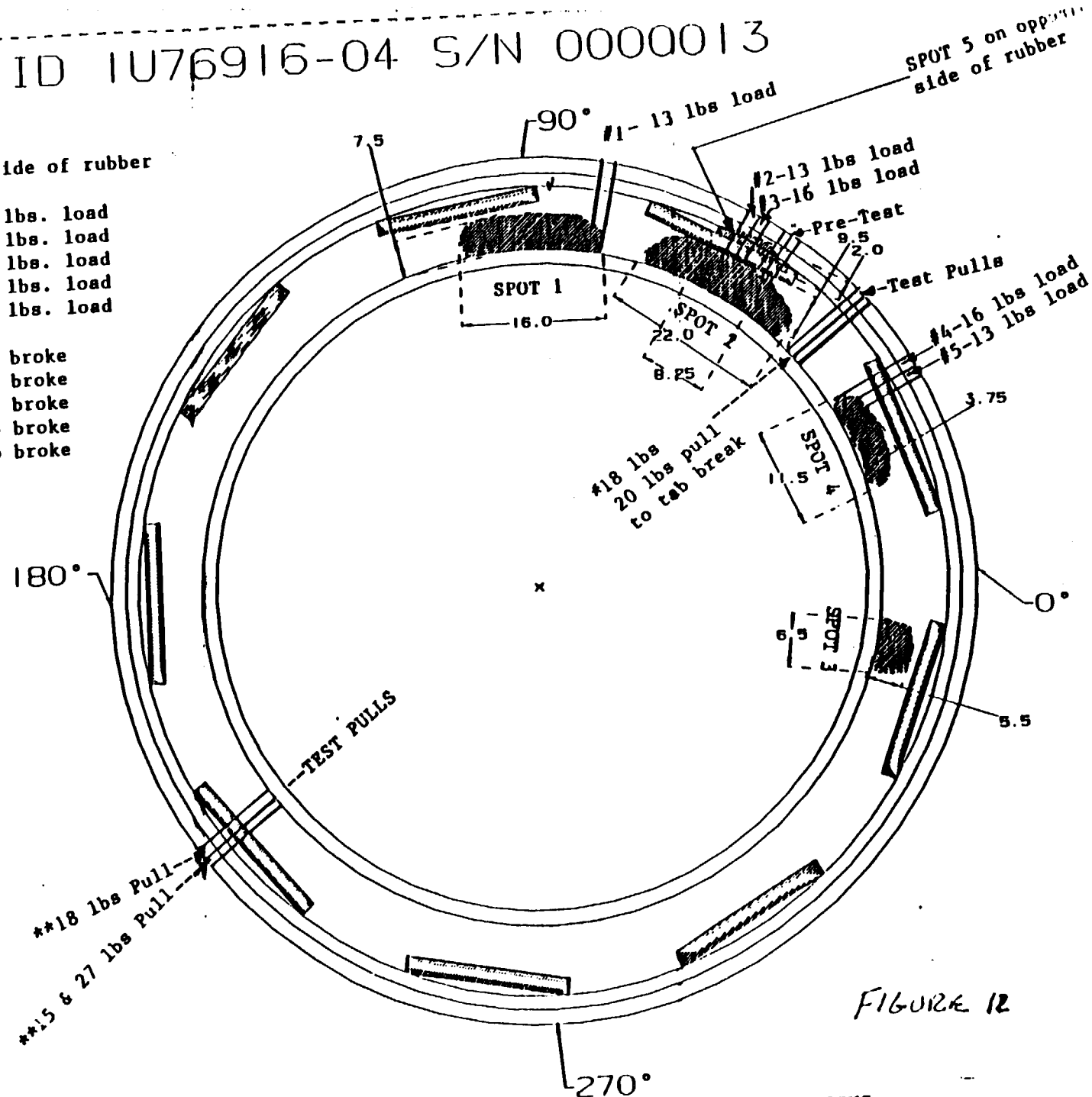

FIGURE 12

SKETCH #1. FORWARD END RING--LOCATION AND I.D. NO. OF SEPARATIONS

FIGURE 13

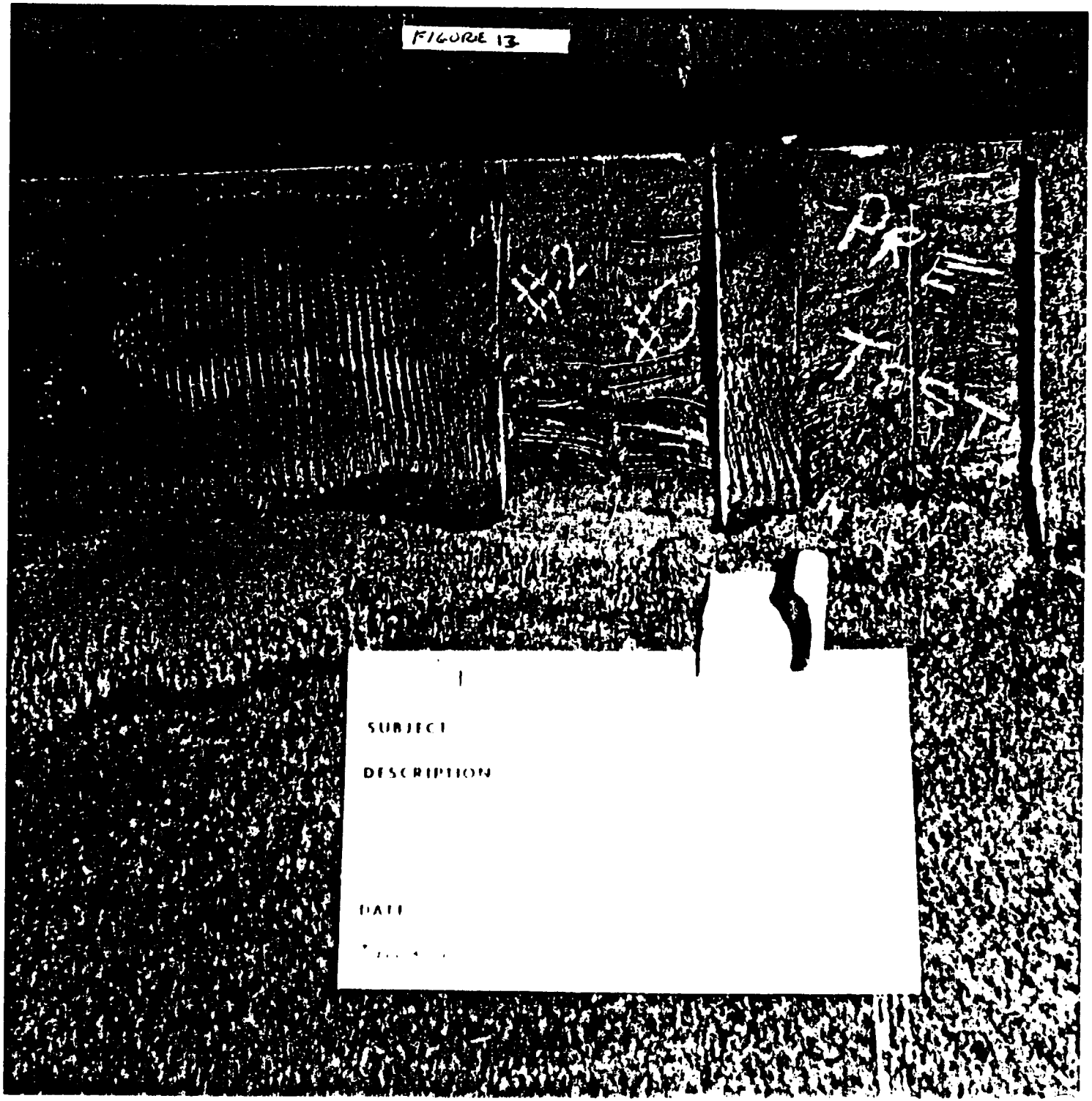

FIGURE 14

Shore A Hardness Samples taken on thick rubber on #10 shim opposite unbonds on FSM-3 flex bearing.

See attached chart for spot location.

Rust = hardness taken on rusty rubber

R/S = hardness taken on rusty rubber that was scraped free of rust

Black = hardness taken on black rubber immediately adjacent to rust spot

Spot #1 R = 25 Avg 9

R/S = 20.6 Avg 5

B = 19.7 Avg 10

Spot #2 R = 23.6 Avg 10

R/S = 20.2 Avg 5

B = 19.2 Avg 10

Spot #3 R = 25.0 Avg 5

R/S = 20.2 Avg 5

B = 20.0 Avg 10

SHORE A HARDNESS VS CURE TEMPERATURE OF FLEX BEARING RUBBER TR3005A
LAB SPECIMENS

Cure Time, Hrs Temp. °F	4	5	6
320	-	In Work	-
330	15	15	15
340	15	14	14
350	14	13	13
360	11	10	11*1
430			*
500			*

* = Rubber reverted
*1 = Some readings as low as 9

FSM#3 MOLD/CORE CYCLE ASSESSMENT

* BEARING BUILT IN MOLD TOOLING AFTER MT-19 PACK FORGE EFFORT
  * 21 BEARINGS BUILT
  * HEAT ZONES CONTROLLED MANUALLY
  * ZONE #8 NOT CONSIDERED CRITICAL TO PROCESS CONTROL

* UNBOND AREAS PREFERENTIALLY LOCATED 340° – 110° QUADRANT OF MOLD (FIGURE 17) AND APPEAR RELATED TO ZONE 7 & 8 HEATERS (FIGURE 15)
  * ZONE #8 TC'S ARE HIGHEST IN THIS QUADRANT, AND EXCEED RECORDER LIMIT OF 400°F. (FIGURE 16)
  * EXTRAPOLATION OF TC DATA INDICATES MAX TEMPERATURES OF 430°F (FIGURES 17-19.)
  * CORRECTION OF FIGURE 16 DATA INDICATES MAX INSTANTANEOUS TEMPERATURES OF APPROXIMATELY 424°F (FIGURE 20).
    * UNBONDS CORRELATE TO HIGH TEMPERATURES EXCEPT AT 110° LOCATION
    * TC READING NOT UNDERSTOOD
    * HIGHEST ZONE #8 TC MEASUREMENTS ARE IN 340°-60° QUADRANT OF MOLD

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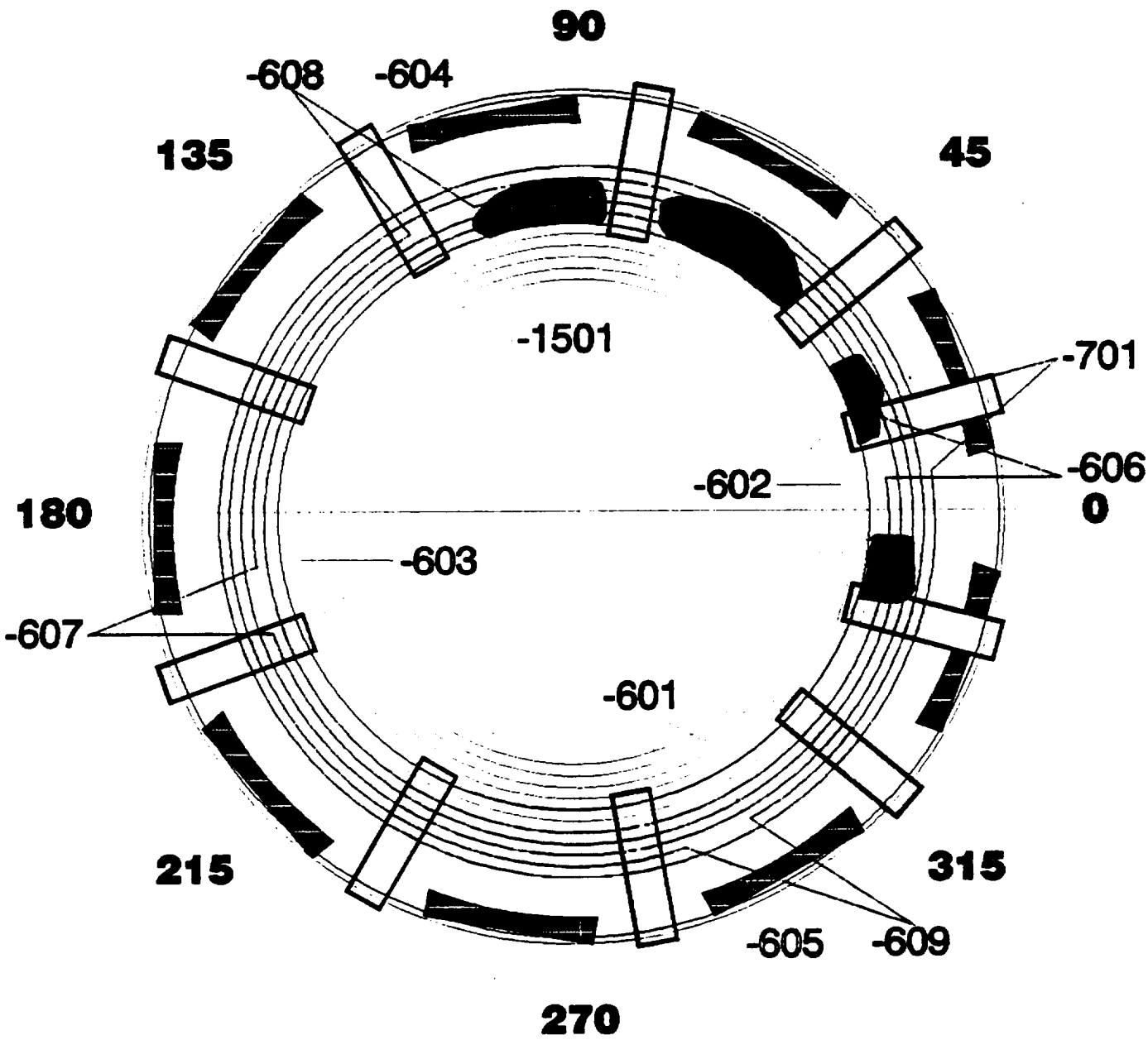


FIGURE 15 - ZONE 7 & 8 HEATERS
RELATIVE TO UNBONDS

Part # Serial # Date Cured

Recorder #

°C Degree												
Time	1	2	3	4	5	6	7	8	9	10	11	12

Notes:

FIGURE 16

Part # 1465060 Serial # 0000007 Date Cured 2/11/83

Recorder # 4 FSM-3

Time	801 20	802 60	81 85	803 100	804 140	805 180	806 220	807 260		808 300	809 340	82 275
12	1	2	3	4	5	6	7	8	9	10	11	12
:30	176	171	168	127	165	155	162	162	X	160	173	162
:00	154	149	168	129	143	140	148	148	X	146	158	163
30	184	179	172	141	172	164	170	173	X	170	184	163
:00	188	184	171	147	178	169	176	180	X	178	193	164
30	191	187	172	150	180	171	176	178	X	175	188	163
:00	174	173	172	150	165	160	163	167	X	164	175	163
30	340	327	254	183	312	280	300	296	X	326	382	236
:00	244	240	230	178	229	216	225	227	X	223	242	217
30	220	219	230	180	206	200	204	208	X	206	218	216
:00	216	214	230	187	202	197	200	208	X	203	220	218
:30	421 ~~400~~	421 ~~400~~	342	256	400	383	400	400	X	396	421 ~~400~~	326
:00	398	391	348	276	382	360	378	379	X	368	405 ~~400~~	323
:30	394	389	349	288	378	360	374	377	X	368	405 ~~400~~	323
:00	416 ~~400~~	416 ~~400~~	349	300	383	378	381	387	X	387	416 ~~400~~	328
:30	407 ~~400~~	407 ~~400~~	350	308	388	370	380	384	X	381	407 ~~400~~	327
:00	420 ~~400~~	420 ~~400~~	356	318	398	382	388	390	X	376	420 ~~400~~	323
:30	417 ~~400~~	417 ~~400~~	352	320	392	379	387	391	X	385	417 ~~400~~	327
1:00	419 ~~400~~	419 ~~400~~	358	324	399	381	385	384	X	378	419 ~~400~~	323
1:30	420 ~~400~~	420 ~~400~~	355	324	396	382	388	388	X	389	420 ~~400~~	326
2:00	415 ~~400~~	415 ~~400~~	359	324	395	377	380	380	X	370	415 ~~400~~	325
12:30	424 ~~400~~	424 ~~400~~	359	330	400	385	388	388	X	374	424 ~~400~~	324
3:00	308	322	310	300	304	300	290	290	X	278	290	272
3:30	278	288	288	279	273	271	261	262	X	255	262	253

Notes: Start cure @ 0156 2/11/83
Heat up to 220° @ 0518 2/11/83
Debulk @ 0706
2 hour 290° cure at 10:36
12:36 power off.

FIGURE 18

FSm #3 CURE CYCLE DATA EXTRAPOLATION
AT 20° LOCATION UNBOND AREA

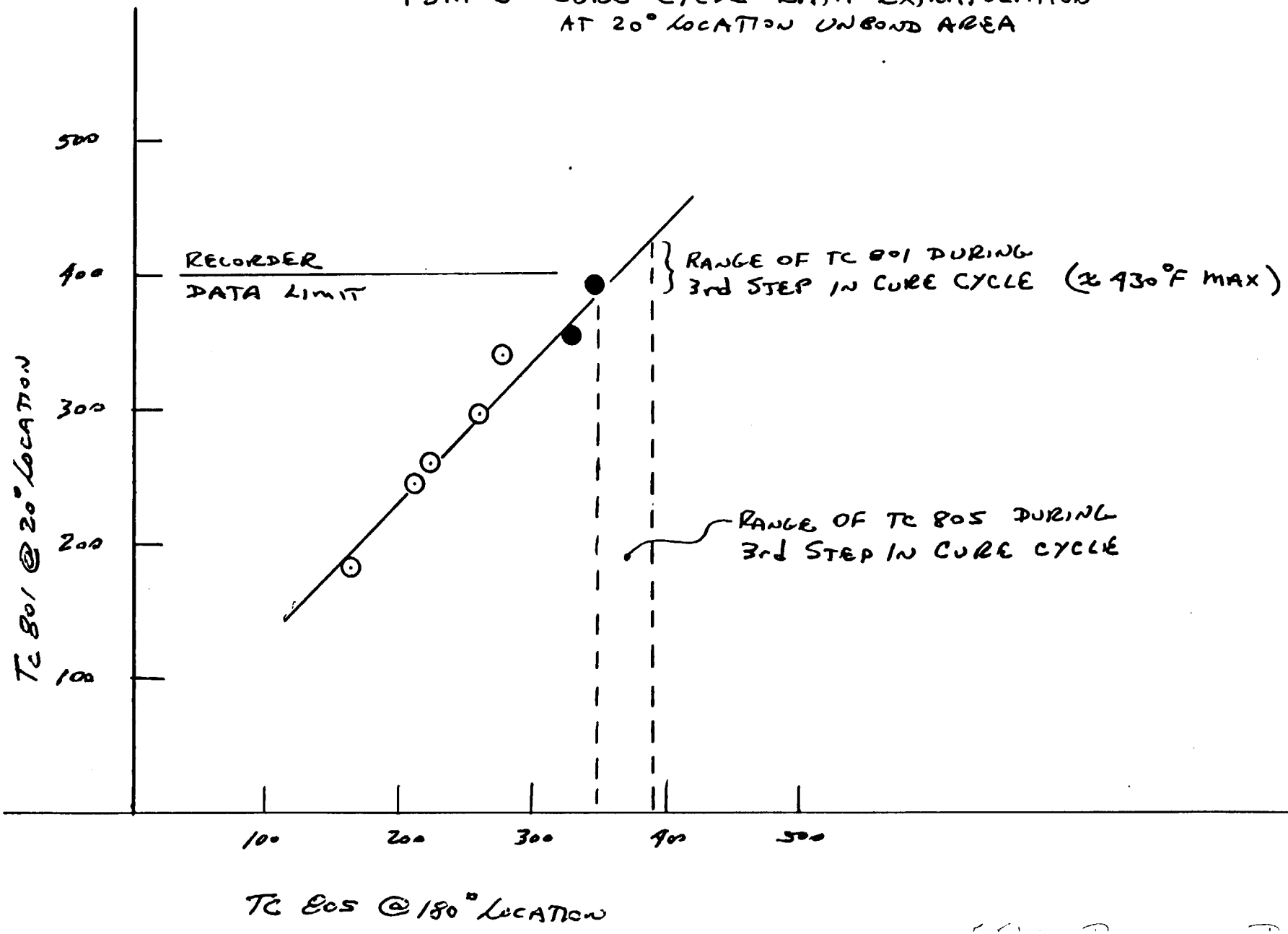


FIGURE 19

FSM #3 CURE CYCLE DATA EXTRAPOLATION
AT 60° LOCATION UNBOND AREA

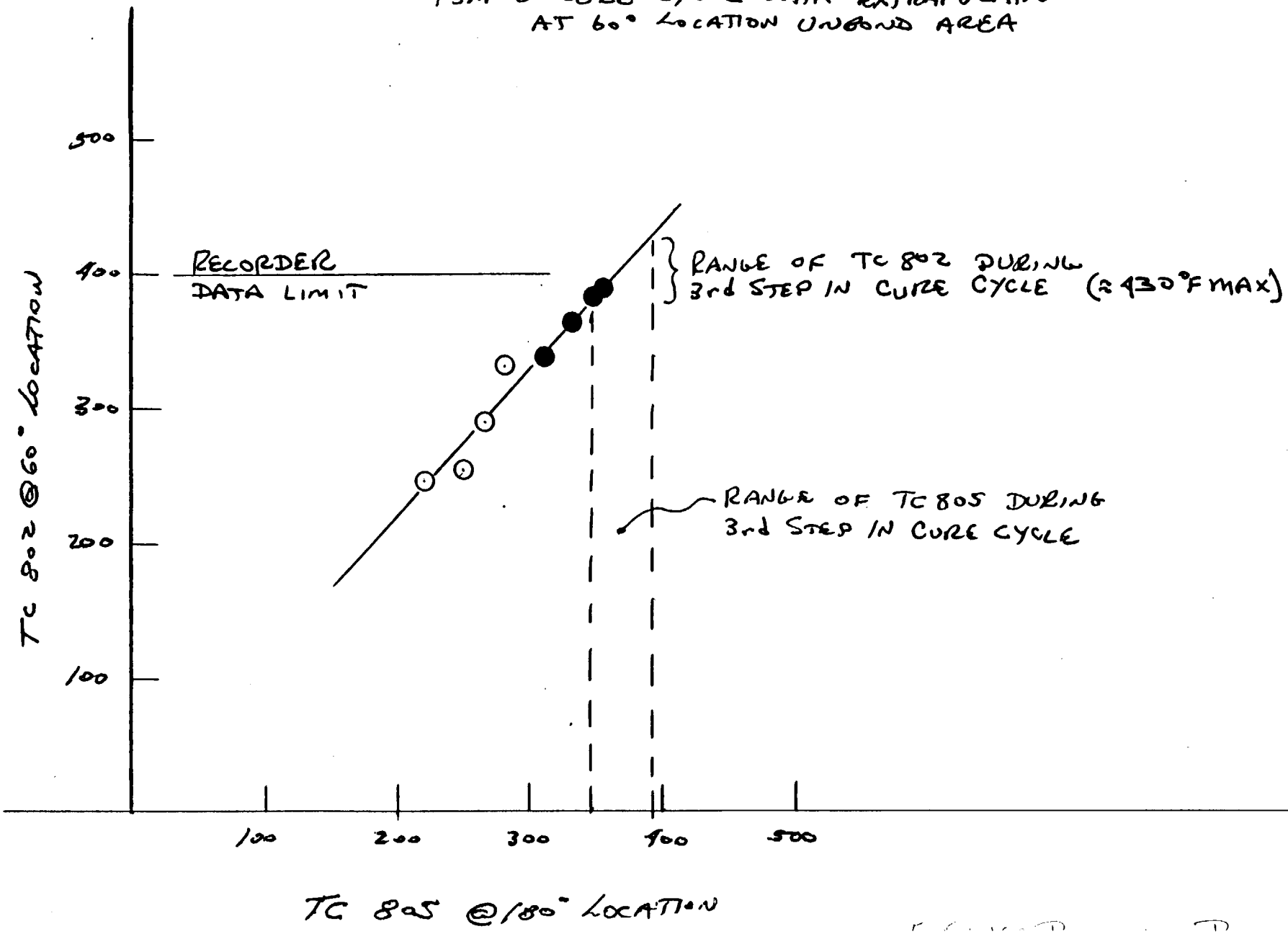
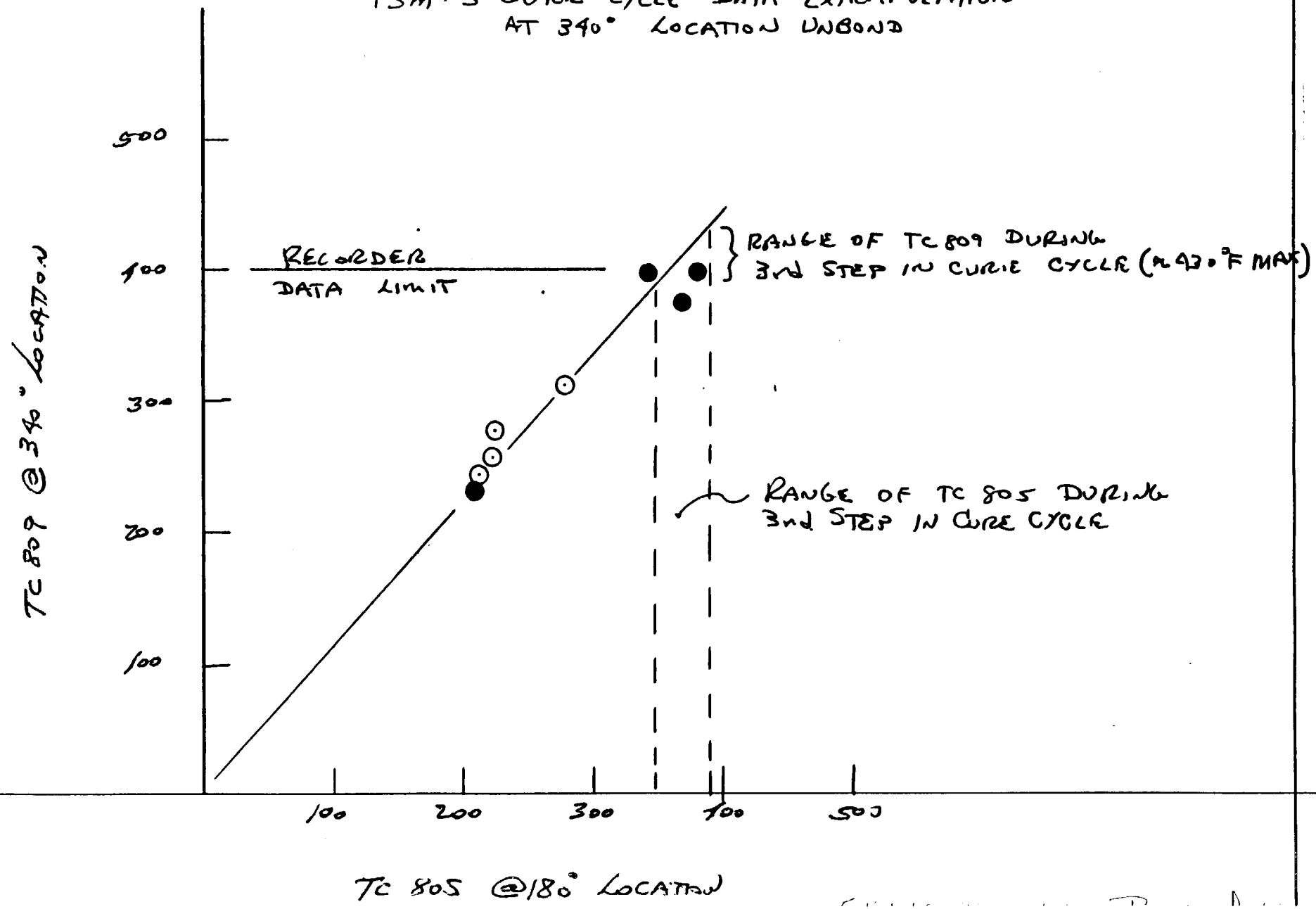


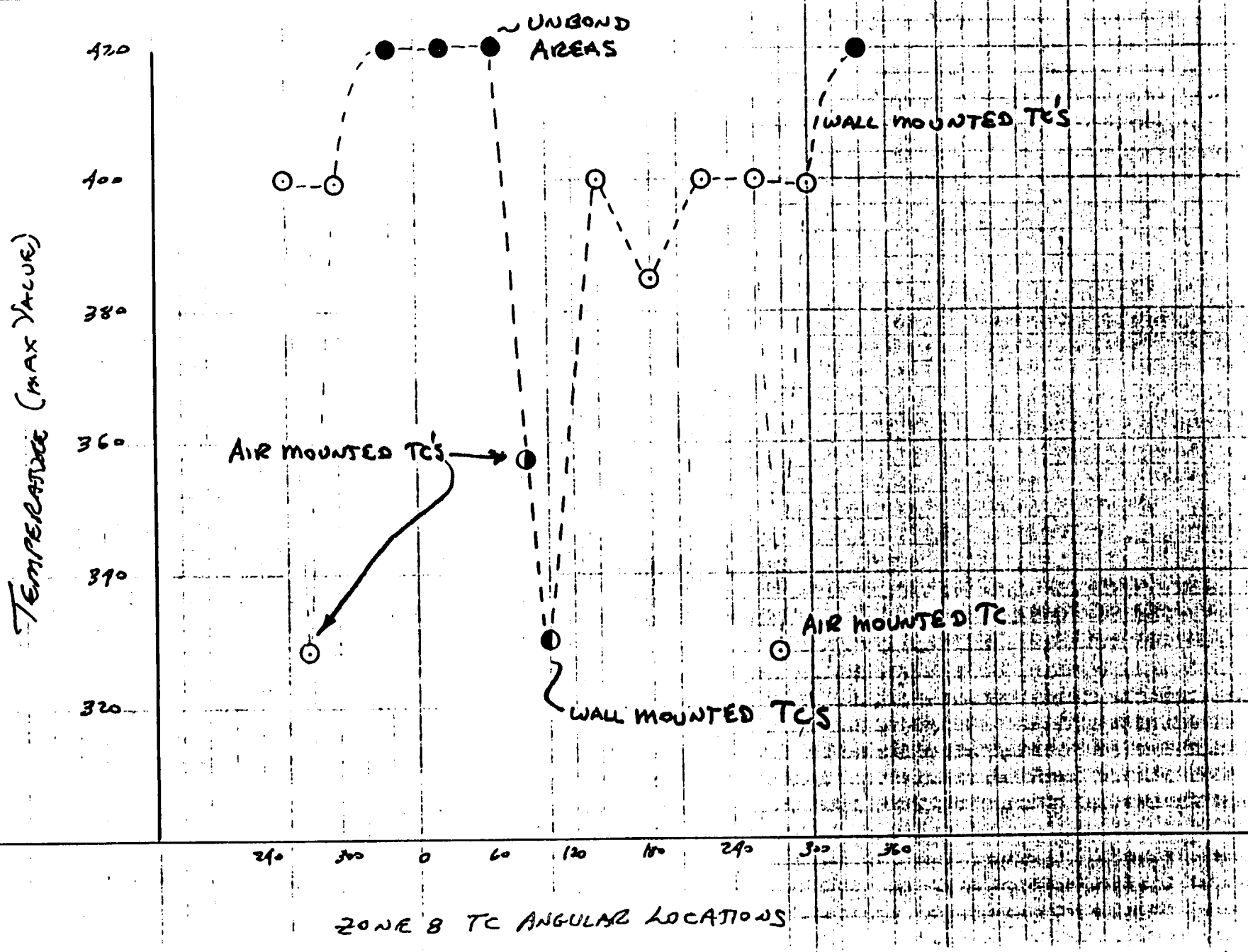
FIGURE 17

FSM #3 CURE CYCLE DATA EXTRAPOLATION
AT 340° LOCATION UNBOND



FSM #3 MAX ZONE 8 TC VALUES

FIGURE 20



FSM #3 ANOMALY SCENARIO

* BUILT WITH ACCEPTABLE MATERIALS — NO SIGNIFICANT DIFFERENCES / DR'S

* BUILT WITH MOLD USING MANUAL CONTROLS

  * ZONE #8 HEATING EXCEEDED RECORDER LIMITS IN UNBOND AREAS

  * ZONE #8 HEAT FLUX INTERACTIONS WITH ~~ZO~~ HEAT FLUX ~~WITH~~ FROM OTHER ZONES ELEVATED LOCAL AREAS ABOVE CRITICAL THRESHOLD (≈ 340+ °F)

    * CHEMLOK 220 BREAKDOWN ATTACKS CHEMLOK 205

    * BI PRODUCTS PRODUCED RUST AT SOMETIME DURING USE CYCLE

  * RUST EVENTUALLY DEGRADED BOND INTERNALLY, BUT EDGE BOND ON ID PREVENTED DETECTION

  * SMALL EDGE UNBOND AFTER FSM #3 STATIC TEST ALLOWED WATER TO ENTER DURING ~~LE~~ 7-17 LEAK TEST

  * INSPECTOR NOTICED RUST ON FWD END RING AT EDGE UNBOND AND UPON PROBING IDENTIFIED 9 INCH INTERNAL UNBOND.

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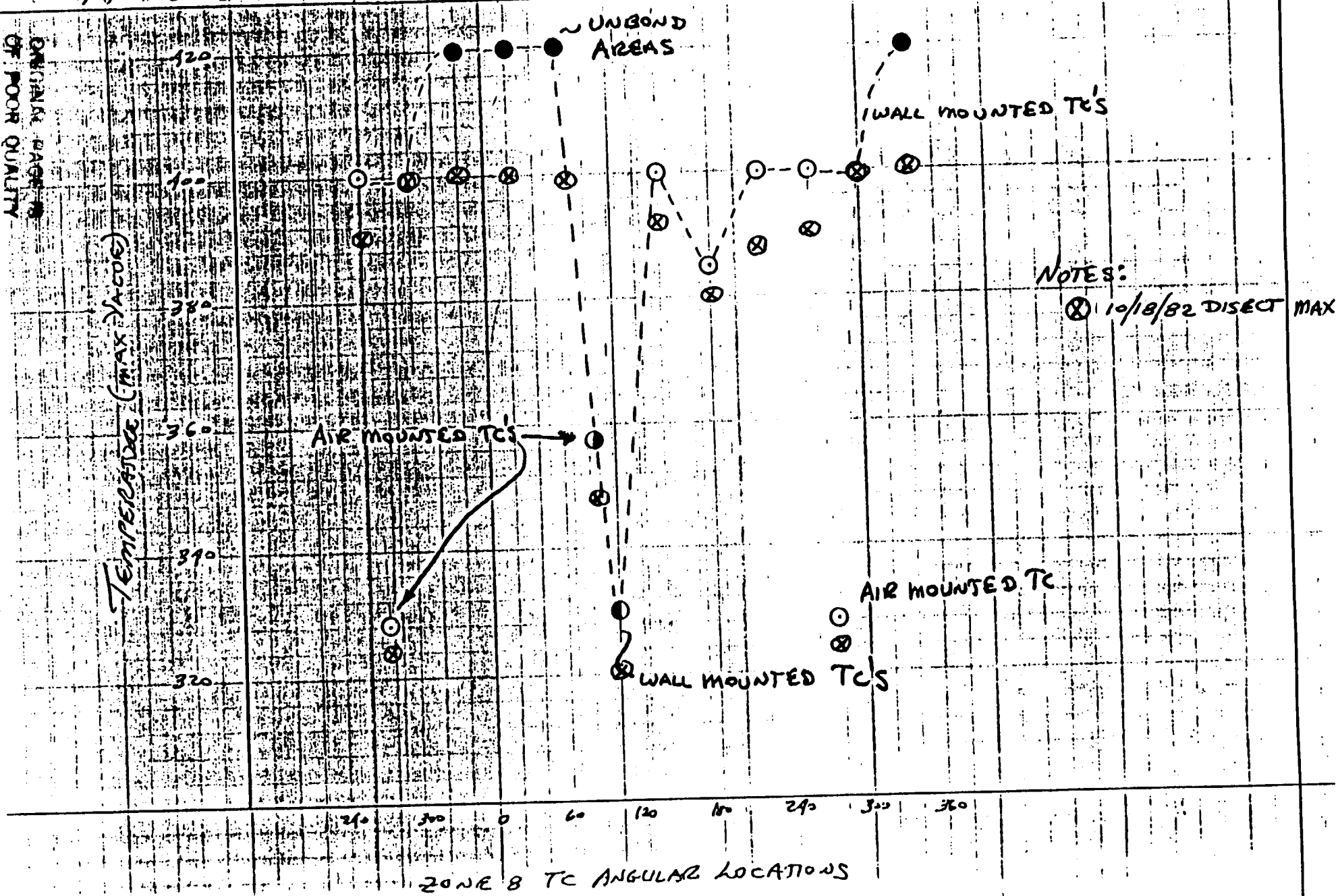
OF POOR QUALITY

FIGURE 23 FSM #31 MAX ZONE 8 TC VALUES VS OTHERS MAX



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* FSM#3 UNBONDS OCCUR IN QUADRANT OF BEARING WITH HIGHEST SEGMENTED RING AND PAD TEMPERATURES (FIGURES 21 & 22)

* RUST/UNBONDS FOUND IN OTHER DISECTED BEARINGS OCCUR IN THE SAME QUADRANT
    * DOUBLE CURE BEARING (6/15/92, REF: FIGURE 7)
    * ZONE #4 FAILURE BEARING (8/19/92, REF: FIGURE 8)

* COMPARISON WITH TWO OTHER DISSECT BEARINGS FROM SAME 20 BEARING POPULATION WHICH USED MANUAL CONTROL OF HEAT ZONES INDICATES
    * LOWER MAX & AVERAGE ZONE #8 TEMPERATURES (FIGURES 23 & 24)
    * NO DETECTED UNBONDS
    * UNBOND THRESHOLD INDICATED TO BE ABOVE 400°F

* COMPARISON WITH OTHER "SELECT" BEARINGS FROM 20 BEARING POPULATION INDICATES FSM#3 WAS AMONG HIGHEST TEMPERATURE CURES AND WAS HIGHEST AVERAGE TEMPERATURE CURE. (FIGURE 25)

* UNBOND AT 110° LOCATION REMAINS UNEXPLAINED BY CORRELATIONS UNLESS
    * ERRONEOUS TC READING - BUT THEN MUST BE CONSIDERED ANOMALOUS FOR ALL BEARINGS IN POPULATION (UNBONDS COULD EXIST)
    * MIGHT RESULT FROM BUTTERFLY CONTACT WITH FOD END RING.
        * FOUR OTHER DOCUMENTED INSTANCES OF CONTACT (4/11/86, 12/14/87, 3/25/88, 6/16/88)
        * COULD INDICT 6 FLIGHT BEARINGS & [illegible]

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OF POOR QUALITY

FIGURE 2.1

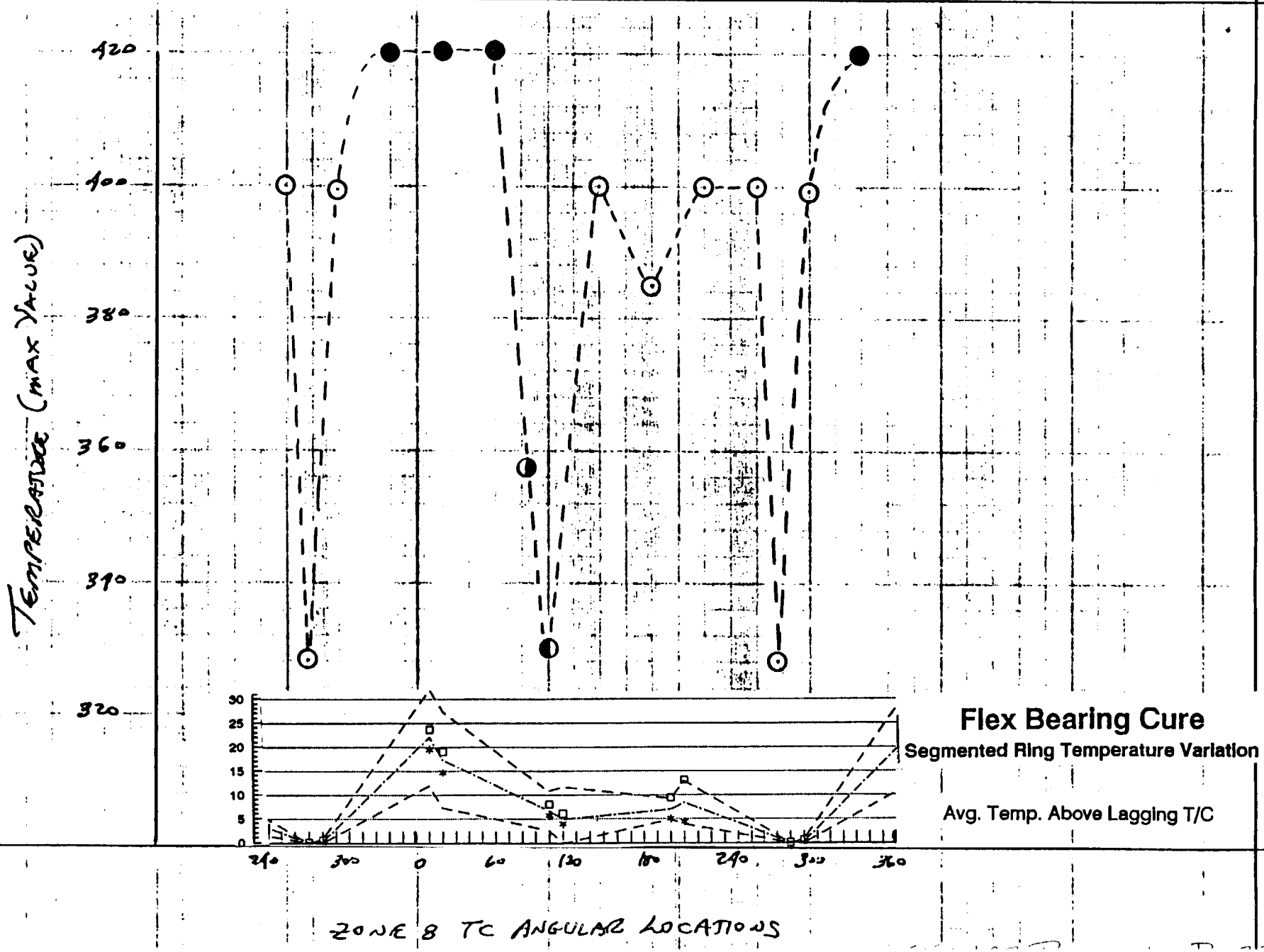


FIGURE 22

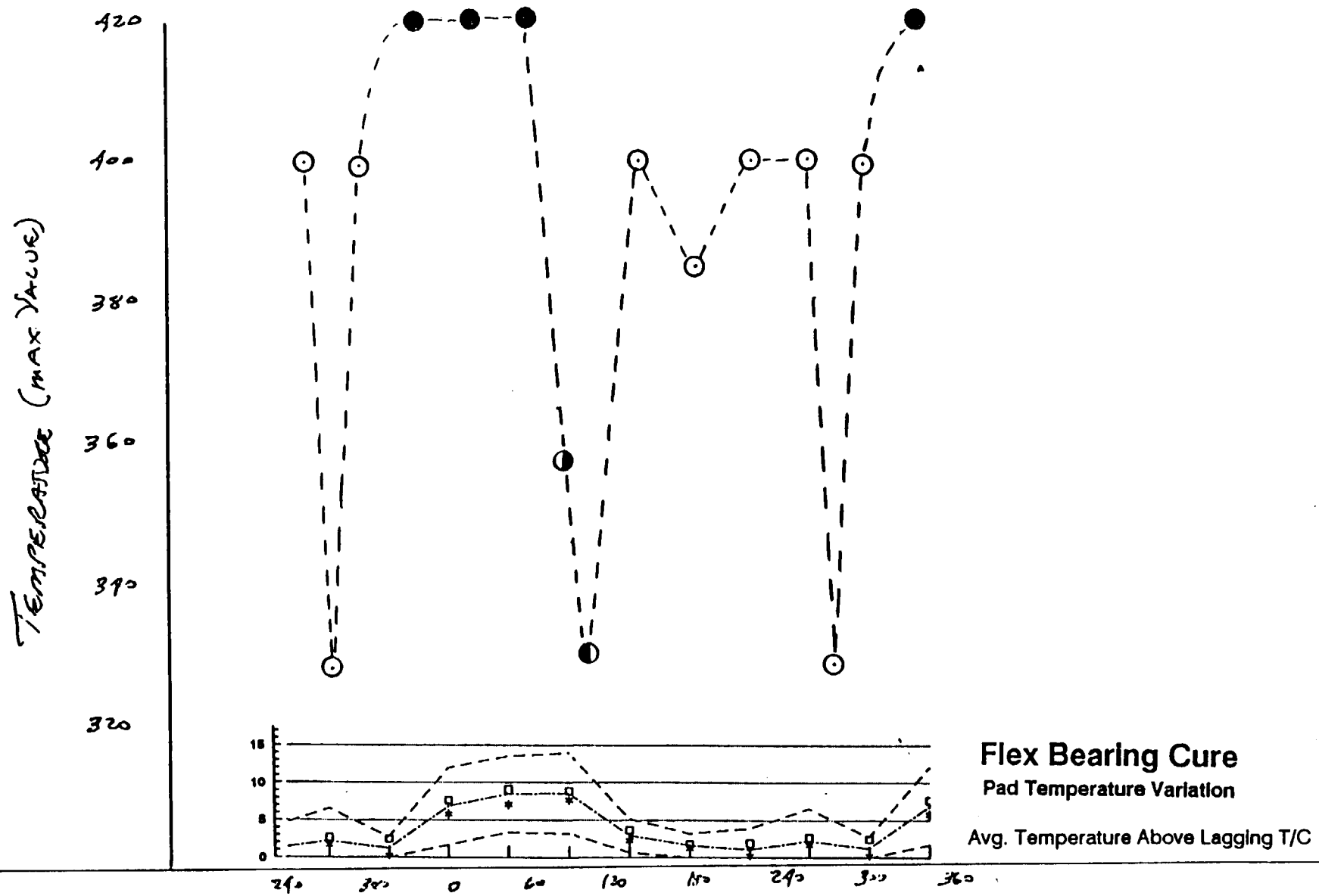

TEMPERATURE (MAX VALUE)
420
400
380
360
340
320
15
10
5
0
240
300
0
60
120
180
240
300
360
ZONE 8 TC ANGULAR LOCATIONS
Flex Bearing Cure
Pad Temperature Variation
Avg. Temperature Above Lagging T/C

FIGURE 29 FSW #3 MAX ZONE 8 TC VALUES VS OTHERS MAX

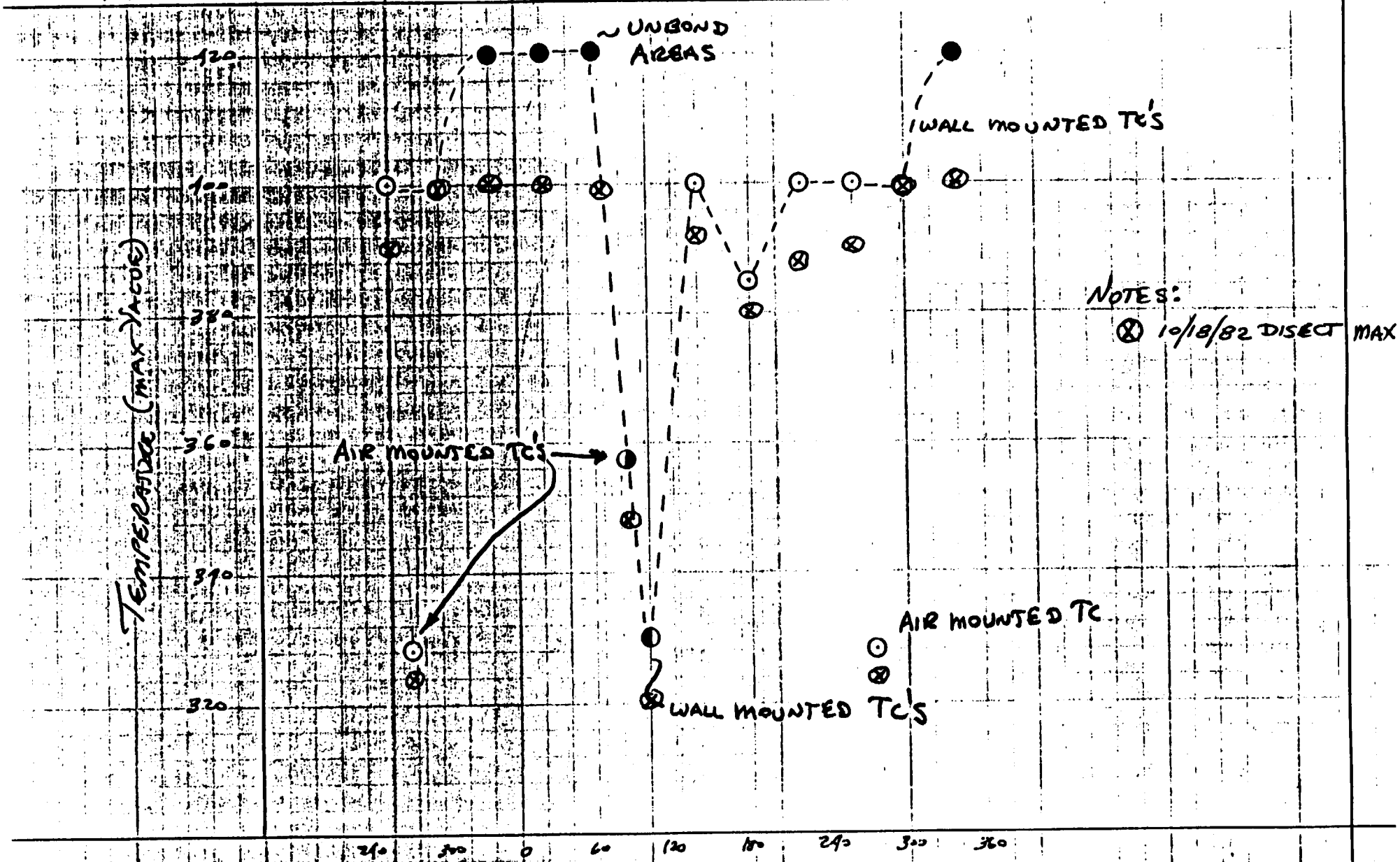
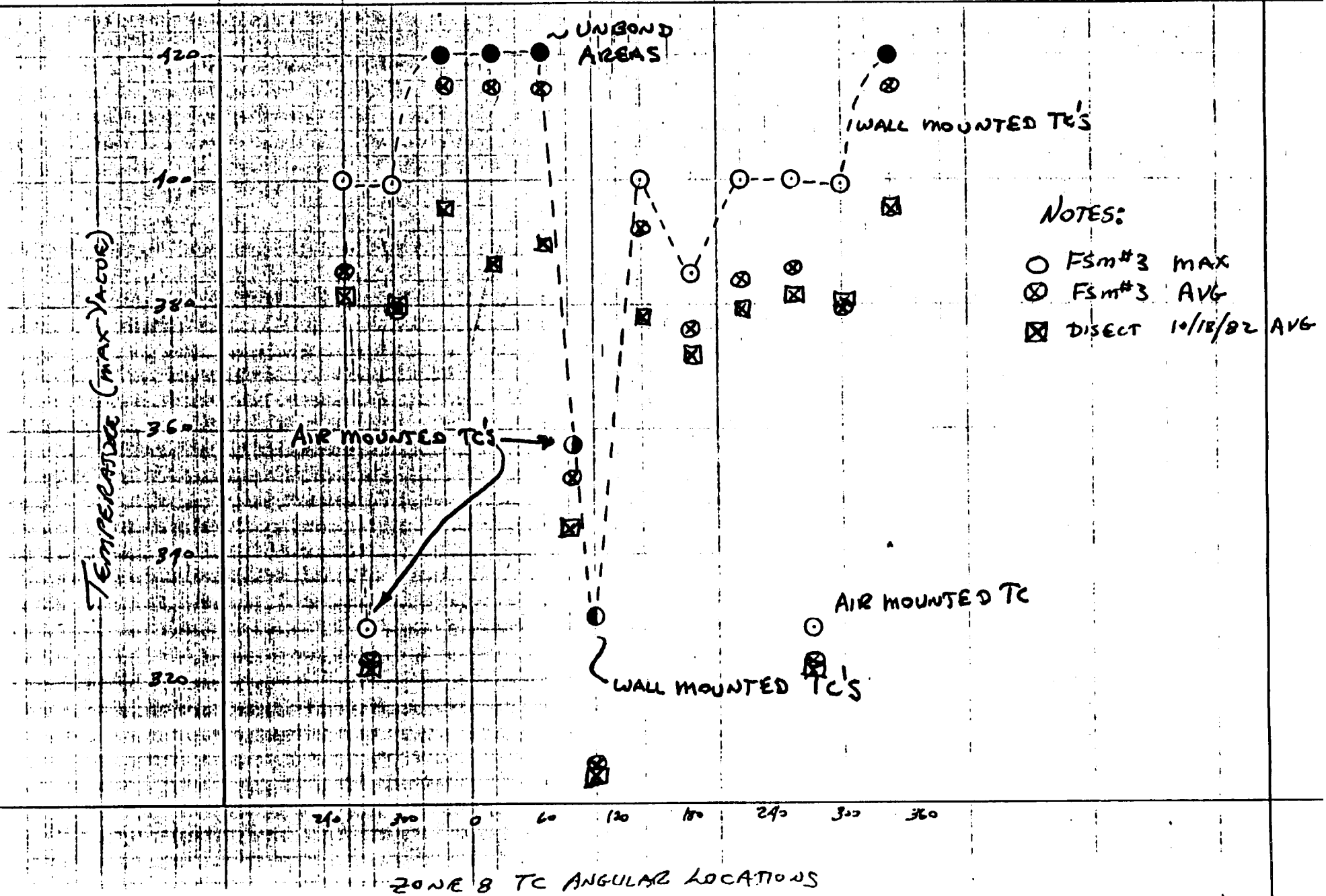


FIGURE 24 — FSM #3 MAX & AVG ZONE 8 TC VALUES VS OTHERS AVG



Part #

Serial #

Recorder #

MAX TEMP - 3RD CYCLE ZONE 8

TC Degree Time	1	2	3	4	5	6	7	8	9	10	11	12
33A 10/9/78	—	292	274	293	—	295	295	295	308	320	319	321
12/15/79	400	400	322	400	400	400	400	400	400	400	400	341
30A 12/18/80	—	—	320	365	—	342	361	367	—	365	395	320
1/30/81	400	388	342	308	372	368	378	384	—	392	400	328
31B 7/22/82	154	400	354	326	400	380	400	400	—	400	400	322
10/18/82	400	398	348	321	392	380	388	390	—	400	400	324
FSM-3 2/12/83	424	424	359	324	400	385	400	400	—	396	424	328
3/23/83	400	400	360	334	400	388	400	400	—	400	400	328
34B 4/22/83	400	394	342	314	370	356	366	366	—	366	400	314
6/6/83	399	391	342	297	371	344	366	373	—	379	399	325
30B 4/29/84									—			
10/8/83	400	400	369	353	400	382	400	400	—	400	400	334

Part # Serial # Date Cured

Recorder #

TC Degree	801 20°	802 60°	AIR 85°	803 100°	804 140°	805 180°	806 220°	807 260°		808 300°	809 340°	AIR 275°
Time	1	2	3	4	5	6	7	8	9	10	11	12
10/9/78			317									
12/15/79	378	376	315	375	357	362	366	378		361	371	335
R30A 12/18/80	N/A	N/A	310	338	N/A	325	332	340		309	350	303
1/28/81	389	385	336	290	365	358	370	374		368	390	324
3/1/81	355	351	318	270	340	330	340	341		332	355	304
R31B 7/22/82	N/A	390	347	302	377	365	371	371		367	393	318
DISECT(S) 10/18/82	387	390	344	305	378	372	379	382		380	395	323
FSM#3 2/11/83	414	413	352	306	392	376	384	386		379	415	325
3/23/83	399+	398+	352	308	400+	374	382	382		378	400	325
R34B 4/22/83	372	371	330	290	353	343	355	358		352	376	310
DISECT (F) 6/06/83	366	362	331	281	373	335	319	329		343	365	308
R30B 4/29/84	363	359	323	284	339	326	343	349		342	365	303
DISECT (S) 10/8/83	397+	396+	356	312	378+	360	352+	384+		380+	398+	329
TEM-10 5/9/85	327	325	302	277	318	298	310	311		303	320	280
DISECT (F)												

FSM [illegible]

* THERMAL ANALYSES INDICATE THAT [illegible] TC'S ARE NOT INDICATING TRUE MOLD WALL TEMPERATURE. (FIGURE 26)
  * MODEL PREDICTS [redacted] REASONABLE CALIBRATION TEMPERATURES, BUT
  * FWD END RING PREDICTIONS ARE WELL ABOVE RUBBER REVERSION TEMPERATURES (FIGURE 27), AND
  * RUBBER REVERSION NOT APPARENT.

* THERMAL ANALYSIS BASED UPON AIR TEMPERATURE MEASUREMENTS WITH CYCLING IS BETTER
  * MODEL PREDICTS REASONABLE CALIBRATION TEMPERATURES (FIGURE 28)
  * FWD END RING PREDICTIONS ARE REASONABLE (FIGURE 29)
    * IN RANGE OF RUST FORMATION
    * WELL BELOW RUBBER REVERSION TEMPERATURES
  * TRANS STATES WALL TEMPERATURE FOR THIS MODEL IS APPROX 250°F WHICH IS BELOW COLDEST LOCATION @ 100° POSITION
    * 100° POSITION READING OF 330°F IS EXACTLY THE AVERAGE OF THE OTHERS AND THE 250° WALL $\frac{410+250}{2} = 330°F$ WHICH SUGGESTS THIS TC WAS PERHAPS SHORTED TO THE WALL AS WELL AS READING THE TEMP EQUIVALENT TO THE OTHER LOCATIONS. FIGURE 30 SHOWS THE TYPE TC BEING USED IN 1979.

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FIG.26 Flex Bearing Cure Mold (Before Sep 88)
Air and Cal-Rod Temperatures in zone 8
With zone 8 TC on the wall

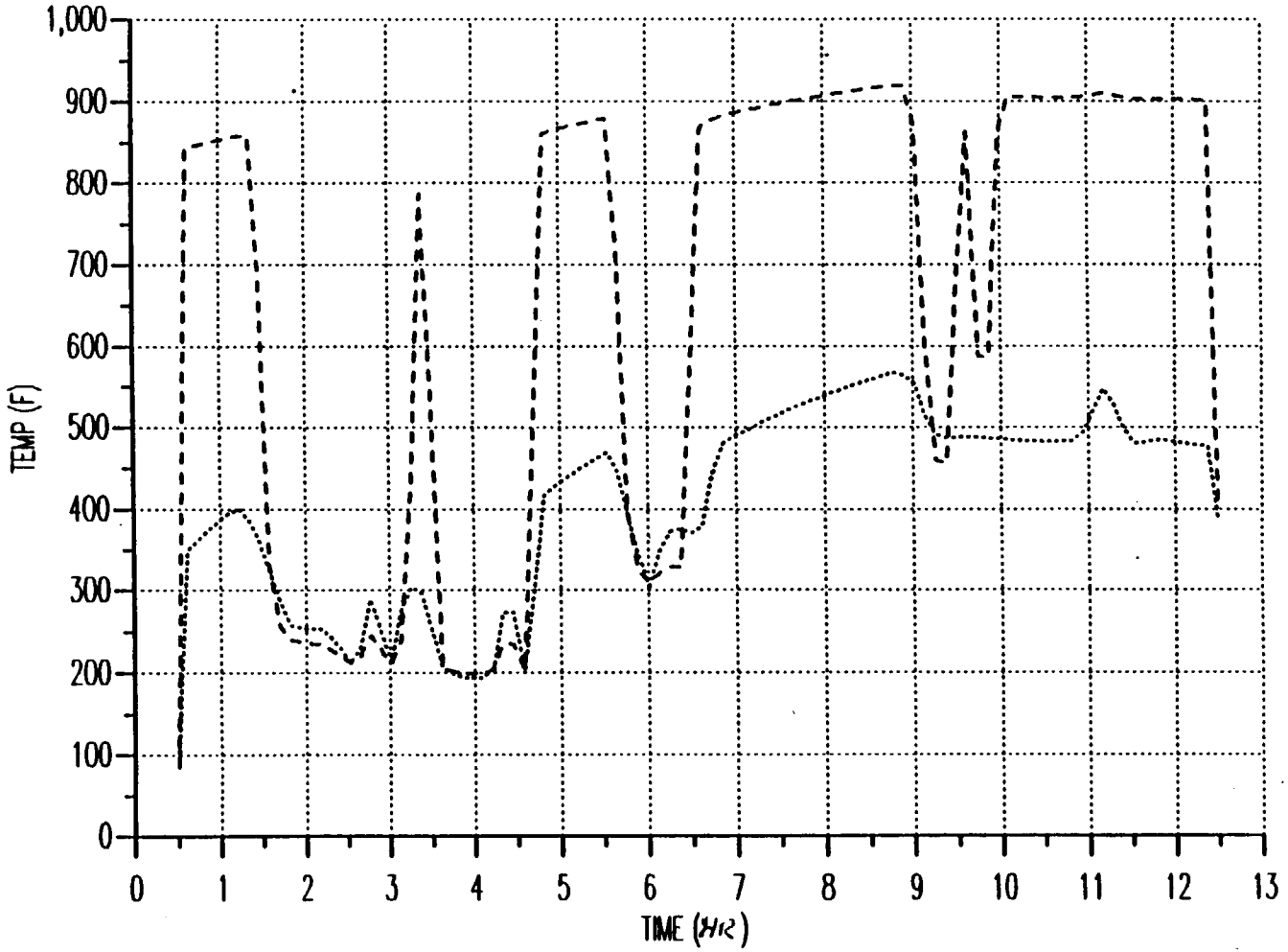


FIG.27 Flex Bearing Cure Mold (Before Sep 88)
Temperature Along FWD End Ring
With zone 8 TC on the wall

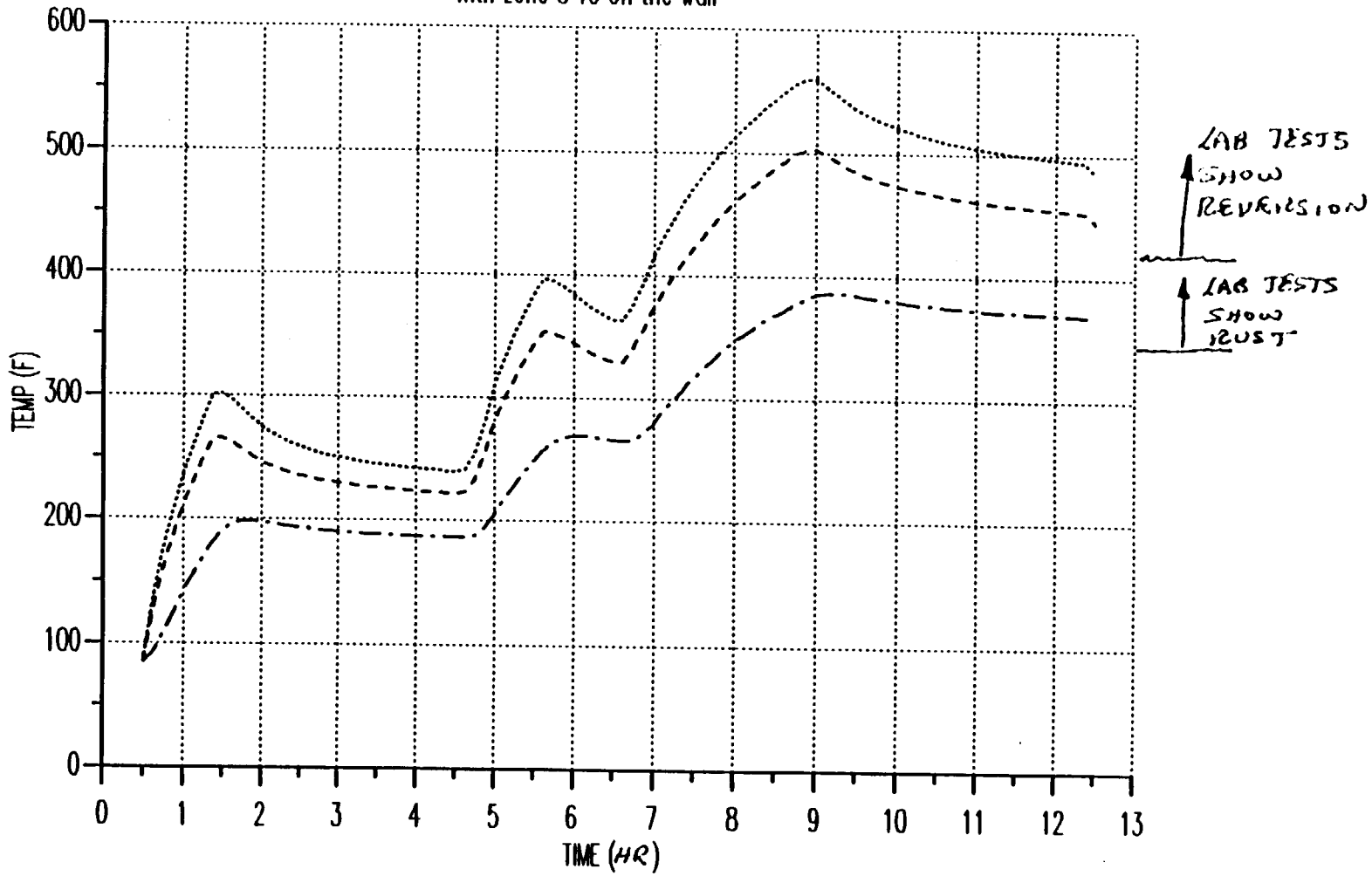


FIG.24 Flex Bearing Cure Mold (Before Sep 88)
Air and Cal-Rod Temperatures in zone 8
With zone 8 TC in the air

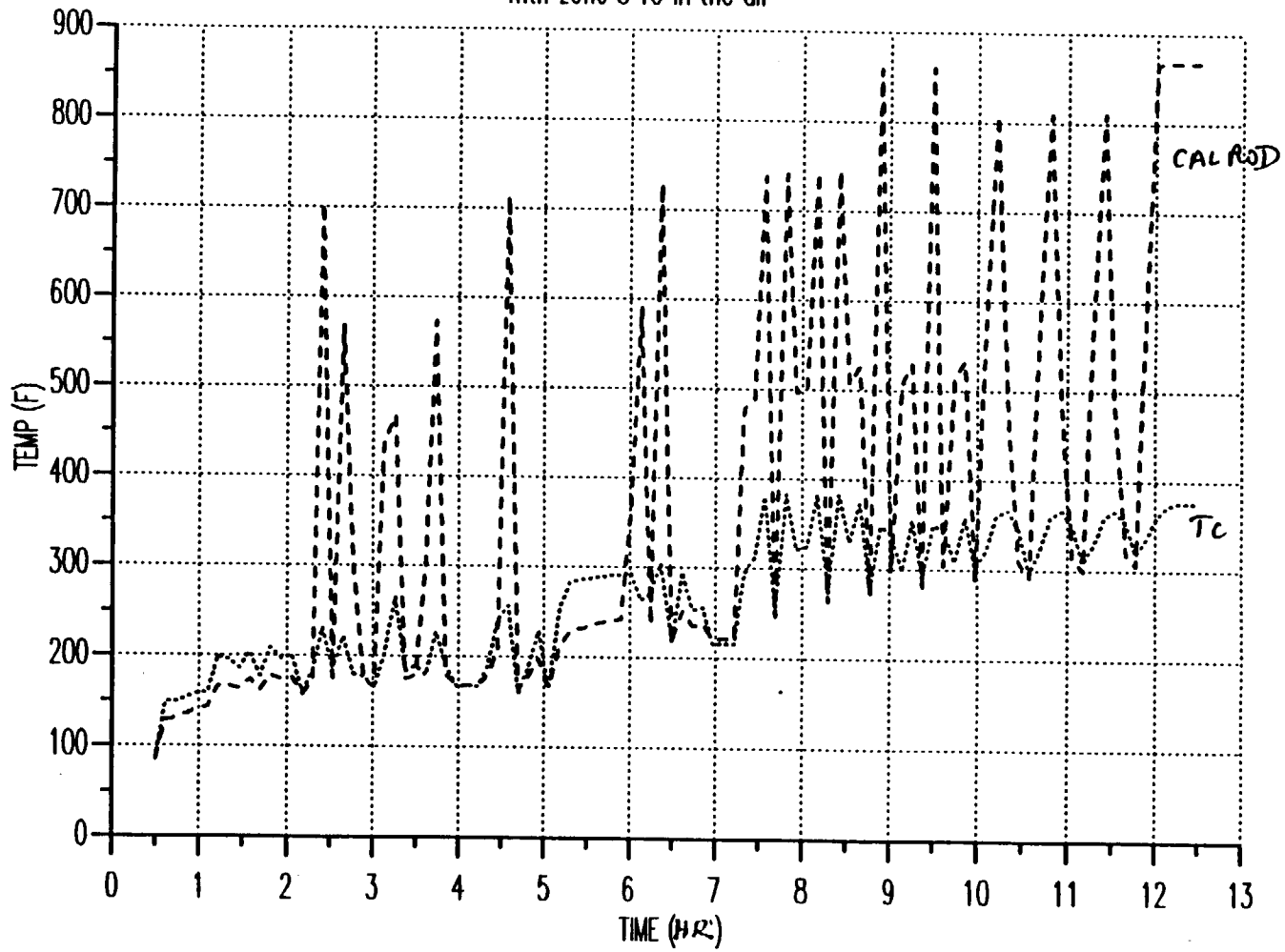


FIG.2 Flex Bearing Cure Mold (Before Sep 88)
Temperature Along FWD End Ring
With zone 8 TC in the air

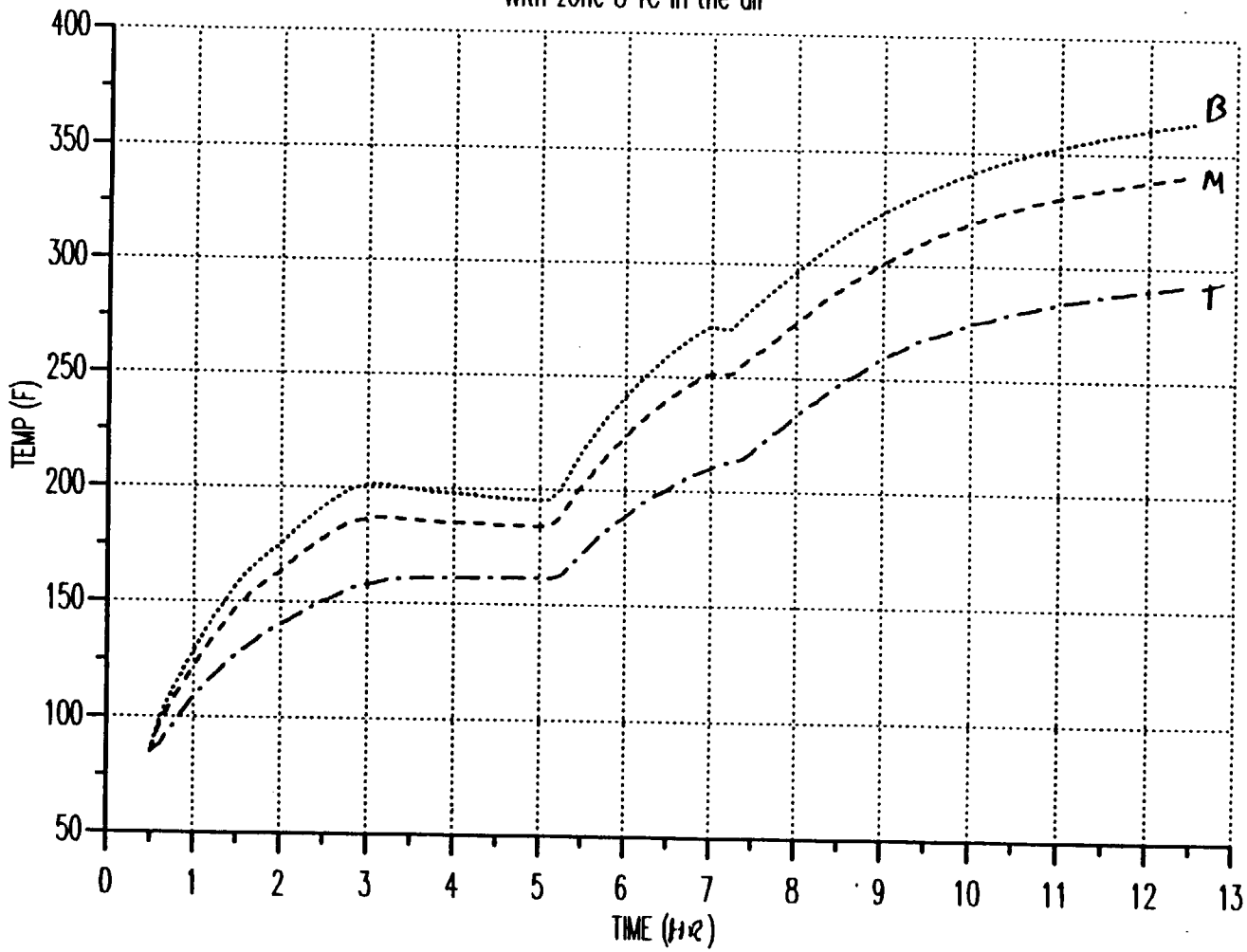


FIGURE 30

BRL NO. 20 - SNUBBED

Thiokol CORPORATION
SCIENCE AND ENGINEERING

25 February 1993
2466-FY93-M100

TO: Lyndon Paulson

CC: A. G. Christiansen, N. A. Mumford, A. L. Olsen, M. L. Clapper, D. T. Houggard

FROM: Chuck Denton

SUBJECT: **1U52840-03, S/N16, FORWARD END RING, I.D. - EDAX ANALYSIS**

As expected, the EDAX analysis of the rusty surface of this rubber was high in iron, 84%, and chlorine, 9%. The fresh cut rubber showed 11% iron, no chlorine and 78% sulfur. All were tested per LWR 719306. A copy of the LWR and both traces are attached.

C. L. Denton

/sm

P.O. Box 707, Brigham City, UT 84302-0707 (801) 863-3511

LABORATORY WORK REQUEST

№ 719306

TO: STAN / VAL					
FROM: DENTON	EXTENSION 2628	COST CENTER 2466	PROJECT NO.	TASK	SUBTASK
ORGANIZATION INSULATION	MAIL STOP 242	WORK ORDER NO. B1837		USER	PCN

SAMPLE INFORMATION

SAMPLE DESCRIPTION: Flex Seal Rubber US2840-03 S/N16	☐ RAW MATERIAL ☐ INPROCESS ☒ POST PROCESS	DATE: 16 Feb 93	
PART NO./STOCK NO.: Smuthel FER I.D. ap @ 60°	SERIAL NO./LOT NO.	ASSEMBLY PART NO.	ASSEMBLY SERIAL NO.
MIX	GRIND	SAMPLED BY	

TEST REQUIRED OR DESCRIPTION OF WORK REQUIRED, INCLUDE REASON FOR REQUEST

1. EDAX ON RUBBER SURFACE
2. ON RUST SURFACE
3.
4.
5.
6.
7.
8.

REPORT RESULTS TO	SEND COPY TO	RESULTS DESIRED BY (SPECIFIC DATE)
Denton		23 Feb 93
		AUTHORIZED SIGNATURE OR INSPECTION STAMP: C L Denton

FOR LABORATORY USE ONLY

SPECIAL INSTRUCTIONS: delivered to Paulson

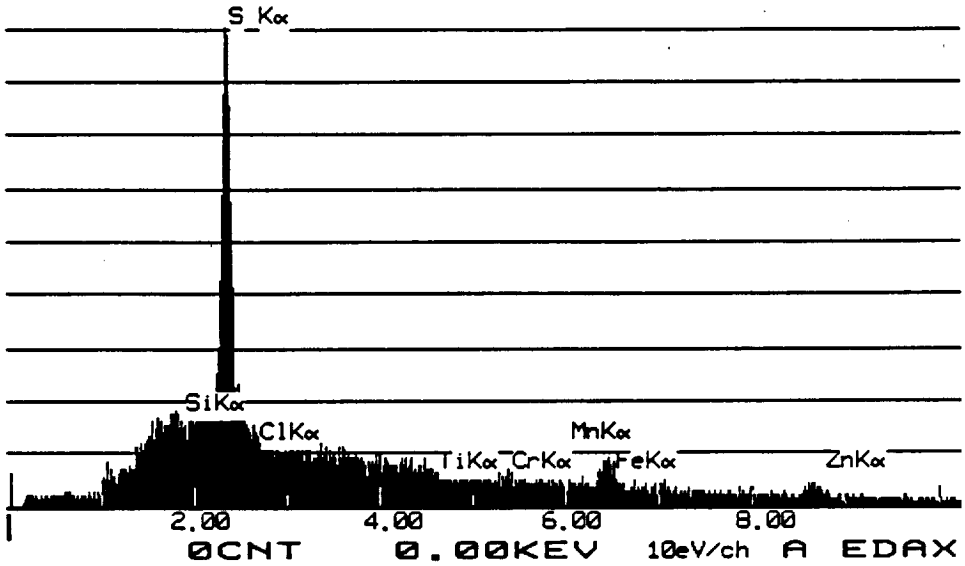
RESULTS OF LABORATORY ANALYSIS

DISPOSITION: ☐ ACCEPT ☐ REJECT ☐ RESAMPLE

DATE AND TIME COMPLETED	TIME REQUIRED	DATE REPORTED	SIGNATURE

FORM TC 716 (REV 9-91)

22-FEB-93 14:18:32 EDAX READY
RATE= 862CPS TIME= 61LSEC
FS= 819CNT PRST= 200LSEC
A =FRESH CUT RUBBER



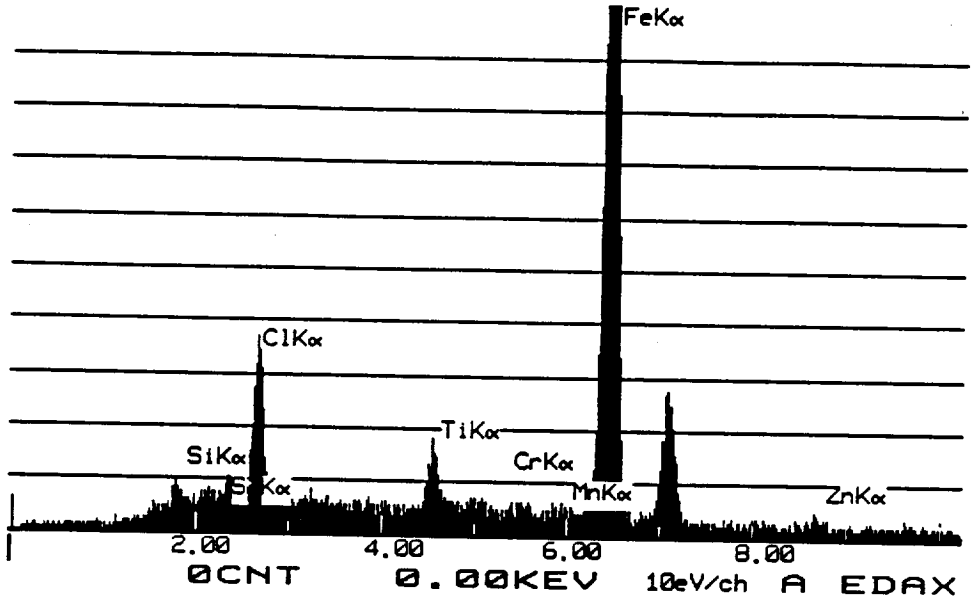
INTE-%-ZAF:
LABEL = FRESH CUT RUBBER
22-FEB-93 14:20:06
60.520 LIVE SECONDS
KV= 30.0 TILT=10. TKOFF=34.
ZAF CORRECTION

ELEM	K	Z	A	F
SIK	0.0189	1.024	0.561	1.039
S K	0.6026	1.017	0.763	1.001
FEK	0.0984	0.923	0.927	1.013
ZNK	0.0684	0.900	0.961	1.000

ELEM	CPS	WT % ELEM
SI K	3.5030	3.16
S K	93.5067	77.57
FE K	9.0053	11.36
ZN K	3.9161	7.91
TOTAL		100.00

LWR 719306

22-FEB-93 14:13:11 EDAX READY
RATE= 1108CPS TIME= 70LSEC
FS= 803CNT PRST= 200LSEC
A =RUST ON RUBBER



NTE-%-ZAF:
ABEL = RUST ON RUBBER
2-FEB-93 14:14:54
70.296 LIVE SECONDS
V= 30.0 TILT=10. TKOFF=34.
ZAF CORRECTION

ELEM	K	Z	A	F
SIK	0.0011	1.098	0.273	1.004
S K	0.0027	1.091	0.492	1.013
CLK	0.0568	1.045	0.607	1.012
TIK	0.0302	0.991	0.905	1.125
CRK	0.0063	0.990	0.945	1.271
MNK	0.0056	0.974	0.966	1.001
FEK	0.8212	0.994	0.977	1.002
ZNK	0.0146	0.972	0.845	1.000

LEM	CPS	WT % ELEM
I K	0.7255	0.37
K	1.4510	0.50
L K	30.4142	8.85
I K	14.0690	2.99
R K	2.5464	0.53
N K	2.0485	0.60
E K	260.8960	84.39
N K	2.9020	1.78

OTAL		100.00

LWR 719306

2rt # 1051060-02 Serial # 0000004 Recorded 10-7-13 #4 33A

Recorder # ONLY ONE chart

ree / ran / ie	13	14	15	16	17	18	19	20	21	22	23	24 (Air zone 8 85°)
30		85°	198°	85°		83°	121°	150°	150°	164°	157°	153°
00		91°	206°	89°		91°	151°	151°	152°	159°	157°	156°
30		101°	203°	97°		106°	151°	149°	154°	161°	157°	158°
00		111°	197°	107°		118°	153°	149°	159°	163°	159°	161°
30		120°	196°	117°		125°	154°	149°	162°	165°	161°	161°
00		127°	191°	125°		131°	155°	149°	163°	166°	161°	162°
30		133°	190°	131°		135°	155°	151°	163°	167°	163°	163°
00		139°	191°	137°		140°	155°	152°	163°	167°	163°	165°
30		143°	190°	141°		144°	155°	153°	162°	167°	163°	168°
00		147°	191°	146°		153°	183°	201°	214°	229°	222°	220°
30		155°	195°	154°		164°	210°	201°	217°	231°	225°	222°
40		160°	280°	159°		169°	218°	232°	235°	276°	261°	309°
00		169°	270°	167°		182°	231°	269°	257°	328°	307°	308°
30		187°	266°	187°		207°	257°	289°	288°	319°	315°	315°
00		209°	265°	210°		231°	277°	289°	296°	320°	316°	316°
30		228°	265°	230°		247°	[illegible]	288°	[illegible]	[illegible]	[illegible]	[illegible]
00		243°	264°	245°		259°	291°	288°	300°	[illegible]	[illegible]	[illegible]
30		256°	264°	257°		267°	292°	288°	301°	317°	315°	[illegible]
00		264°	269°	265°		274°	292°	293°	305°	312°	315°	321°
30		270°	265°	271°		279°	294°	289°	304°	314°	315°	[illegible]
00		275°	268°	277°		282°	295°	286°	304°	314°	315°	319°
30		280°	268°	281°		285°	294°	286°	305°	314°	315°	318°
00		283°	267°	284°		288°	294°	293°	306°	313°	315°	318°
[illegible]		286°	269°	287°		291°	294°	295°	307°	316°	318°	317°
[illegible]		288°	271°	289°		292°	294°	295°	307°	318°	319°	317°
Notes:		257	264	258		267	285	289	299	316	315	313

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328
~~321~~ max

Part # 1051060-02 Serial # 0000004 Date Cured 10-9-78

Recorder # ONLY ONE CHART

Time	13	14	15	16	17	18	19	20	21	22	23	24
330		290°	274°	291°		294°	295°	295°	308°	318°	319°	317°
00		291°	263°	293°		295°	293°	293°	303°	315°	315°	298°
30		292°	221°	293°		294°	277°	282°	290°	301°	301°	267°

Notes:

ORIGINAL PAGE IS
OF POOR QUALITY

#5 Part #1U51060-02 Serial #0000005 Date Cured 12-18-78

Recorder #

°C Degree / Time	1	2	3	4	5	6	7	8	24 ~~9~~	10	11	12
0020	—	—	—	—	—	—	—	80	80	—	—	—
0050	—	—	—	—	—	—	—	112	150	—	—	—
0120	—	—	—	—	—	—	—	158	156	—	—	—
0150	—	—	—	—	—	—	—	158	157	—	—	—
0220	—	—	—	—	—	—	—	160	160	—	—	—
0250	—	—	—	—	—	—	—	160	162	—	—	—
0320	—	—	—	—	—	—	—	160	162	—	—	—
0350	—	—	—	—	—	—	—	162	164	—	—	—
0420	—	—	—	—	—	—	—	164	168	—	—	—
0450	—	—	—	—	—	—	—	168	172	—	—	—
0520	—	—	—	—	—	—	—	216	216	—	—	—
0550	—	—	—	—	—	—	—	214	217	—	—	—
0620	—	—	—	—	—	—	—	312	306	—	—	—
0650	—	—	—	—	—	—	—	312	312	—	—	—
0720	—	—	—	—	—	—	—	314	316	—	—	—
0750	—	—	—	—	—	—	—	314	319	—	—	—
0820	—	—	—	—	—	—	—	314	322	—	—	—
0850	—	—	—	—	—	—	—	314	325	—	—	—
0920	—	—	—	—	—	—	—	315	326	—	—	—
0950	—	—	—	—	—	—	—	315	328	—	—	—
1020	—	—	—	—	—	—	—	315	328	—	—	—
1050	—	—	—	—	—	—	—	315	330	—	—	—
1120	—	—	—	—	—	—	—	315	326	—	—	—
1150	—	—	—	—	—	—	—	258	276	—	—	—
								314	322			

Notes: Start cure @ 0020 on 12/18/78

Set temp 270° @ 0450 on 12/18/78

Power off 1117 on 12/18/78

11

330 max

\# 12 Part # 1451060-03 Serial # 3 Date Cured 04 OCT 77

Recorder # 4

Time	1	2	3	4	5	6	7	8	9	10	11	12
1245	100	100	100	153	162	121	177	183	206	223	243	146
1315	100	100	100	207	209	157	201	192	204	207	217	146
1345	100	100	100	195	197	155	190	184	194	197	206	147
1415	103	100	100	191	191	155	185	179	189	192	200	149
1445	114	110	106	185	184	156	180	175	184	186	193	151
1515	120	117	112	182	180	156	177	172	181	183	189	152
1545	126	123	117	179	177	157	174	170	179	180	186	154
1615	131	128	118	176	174	157	172	168	176	178	183	155
1645	136	134	121	174	171	157	170	165	175	175	180	156
1715	140	138	120	173	169	158	168	164	173	174	178	157
1745	144	143	124	170	167	158	166	162	171	171	175	158
1815	148	147	124	168	165	158	164	160	170	170	174	159
1845	152	152	142	166	162	158	162	158	168	168	171	160
1915	155	155	144	165	161	158	160	157	167	167	169	161
1945	158	158	146	163	159	158	159	156	165	165	168	161
2015	159	159	147	163	159	158	153	155	164	164	167	161
2045	161	161	149	162	158	159	153	155	163	164	166	162
2115	164	164	151	162	157	158	157	154	162	163	165	163
2145	165	165	151	161	157	159	158	154	162	163	165	163
2215	166	166	153	263	298	227	287	275	291	293	302	223
2245	168	168	155	263	265	218	265	248	265	270	277	217
2315	173	173	159	261	256	216	251	242	259	262	270	217
2345	174	174	161	259	254	216	249	241	257	261	267	217
2015	178	178	166	257	251	217	221	240	255	258	264	218

Notes: Heat on @ 12:30

DR 1

max: 400°

E

1.04 Posts

Part # 1451060-33 serial # 3 Date Cured 04 OCT 79

Recorder # 4

Time / Degree	1	2	3	4	5	6	7	8	9	10	11	12
0045	181	181	168	255	249	216	245	238	254	258	263	219
0115	185	185	173	253	246	217	243	238	252	254	260	220
0145	186	187	175	253	245	217	242	236	251	253	258	220
0215	190	191	177	250	243	217	240	239	250	252	256	221
0245	191	192	174	250	242	217	240	234	250	251	255	221
0315	195	196	182	248	240	217	238	232	247	249	252	222
0345	197	198	181	247	233	217	236	221	246	247	251	223
0415	201	202	189	244	235	217	234	229	244	245	243	224
0445	203	204	190	244	234	217	233	229	246	251	258	231
0515	206	208	193	~~400~~ 402	~~400~~ 401	307	396	384	~~400~~ 404	~~400~~ 403	~~400~~ 401	305
0545	208	210	195	~~400~~ 404	~~400~~ 402	307	390	379	400	~~400~~ 406	~~400~~ 403	306
0615	213	217	201	398	400	307	384	375	395	~~400~~ 402	~~400~~ 408	307
0645	216	219	204	396	392	308	381	374	394	400	~~400~~ 398	308
0715	221	226	209	394	388	308	379	372	392	397	~~400~~ 403	310
0745	225	229	217	393	388	308	378	370	391	396	~~400~~ 402	311
0815	227	234	216	391	384	309	375	368	388	394	~~400~~ 399	313
0845	230	237	218	390	383	309	375	368	387	392	~~400~~ 398	314
0915	234	241	223	388	381	309	373	366	386	391	397	317
0945	236	244	225	388	380	310	373	365	385	390	395	316
1015	240	248	227	386	377	310	370	363	383	389	392	317
1045	241	250	230	385	376	310	369	362	382	387	391	317
1115	245	254	232	383	373	310	368	360	380	386	388	319
1145	246	256	234	383	373	310	368	360	380	385	388	319
1215	250	260	233	381	371	311	366	368	378	383	385	321
	229	235	217	385	379	308	376	369	388	394	399	313

Notes:

#13 Part #1051060-08 Serial #0000004 Date Cured 12-15-79 Lynn

Recorder #4

C	801	802	66	803	804	805	806	807		808	809	72
egree	20°	60°	85°	100°	140°	180°	220°	260°		300°	340°	275°
me	1	2	3	4	5	6	7	8	9	10	11	12
045	263°	259°	175°	261°	259°	237°	244°	251°		237°	247°	159°
050	209°	208°	163°	200°	214°	201°	209°	217°		213°	223°	155°
20	192°	191°	165°	189°	189°	181°	186°	191°		185°	195°	157°
50	179°	177°	165°	175°	172°	169°	172°	177°		171°	178°	159°
20	167°	165°	163°	163°	158°	158°	159°	164°		159°	165°	159°
50	160°	157°	162°	157°	151°	152°	152°	157°		152°	159°	160°
320	156°	151°	160°	151°	143°	146°	145°	151°		145°	153°	162°
350	155°	148°	159°	148°	139°	143°	141°	147°		143°	152°	163°
20	155°	148°	161°	148°	139°	143°	141°	147°		143°	152°	166°
430	305°	299°	226°	301°	293°	278°	284°	297°		280°	295°	226°
50	254°	251°	214°	247°	241°	236°	241°	252°		243°	255°	218°
20	245°	241°	214°	237°	229°	228°	231°	241°		232°	243°	219°
550	239°	235°	213°	231°	221°	222°	225°	234°		225°	236°	[illegible]
20	233°	230°	213°	226°	215°	218°	221°	229°		219°	230°	221
45	283°	283°	237°	303°	299°	295°	305°	330°		331°	359°	273
50	400°	400°	301°	400°	400°	400°	400°	400°		400°	400°	[illegible]
20	416 ~~400°~~	416 ~~400°~~	322°	413 ~~400°~~	402 ~~400°~~	400°	406 ~~400°~~	410 ~~400°~~		406 ~~400°~~	410 ~~400°~~	328
50	399°	399°	319°	398°	385°	383°	389°	399°		389°	[illegible]	[illegible]
20	392°	389°	318°	387°	371°	373°	377°	392°		375°	390°	335
50	384°	382°	318°	379°	362°	366°	370°	385°		366°	381°	337
20	378°	377°	315°	373°	355°	361°	364°	379°		359°	373°	335
50	375°	373°	315°	370°	351°	358°	361°	376°		355°	363°	337
20	371°	370°	313°	366°	347°	355°	358°	373°		351°	365°	340°
50	369°	367°	313°	364°	345°	353°	356°	370°		349°	360°	340
20	367°	366°	312°	362°	343°	351°	355°	369°		347°	358°	341°
150	341°	340°	306°	333°	312°	323°	326°	337°		316°	322°	325
220	298°	298°	277°	293°	274°	285°	285°	294°		279°	285°	295

Notes: ~~373~~ ~~377~~ ~~376~~ ~~370~~ ~~379~~ ROLLERS # 1, 3, 4, 6, 7A, 8, 9 SET AT 220 ~~362~~ 230 ~~372~~ 12-15-79

ZONE #2 SET AT 155° AT 1210 12-15-79

1418 12-15-79 RESET ZONES TO 220°

DEBULK-CHANGED ALL TEMP CONTROLLERS TO 335° AT 1630 12-15-79

ZONE #2 SET TEMP. AT 320° 1700 12-15-79

ZONE 1 ZONE 3 SET AT 330° 1740 12-15-79

ZONE 4 SET AT 335° 1741

max 400°F

E

#14 Part # 1451060-11 Serial # 00000001 Date Cured 29 May 80

Recorder # 4

TC Degree												
Time	1	2	3	4	5	6	7	8	9	10	11	12
1709	82	82	82	86	88	88	92	96	—	104	114	98
1730	228	225	132	218	220	190	206	208	—	198	210	158
1800	186	186	132	186	188	170	184	186	—	183	196	162
1830	176	175	120	173	172	160	170	173	—	170	180	162
1900	169	168	—	166	162	155	162	166	—	162	170	162
1930	164	162	162	160	156	150	156	160	—	156	164	162
2000	160	158	162	156	150	148	150	156	—	152	160	162
2030	158	154	162	152	146	144	148	152	—	148	156	162
2100	156	150	164	150	142	142	146	152	—	152	168	168
2130	246	244	222	244	240	224	240	246	—	241	259	221
2200	241	238	223	236	230	218	232	247	—	231	248	222
2230	238	234	223	232	225	216	227	232	—	226	242	222
2300	234	230	222	228	220	213	223	228	—	223	238	222
2330	412 ~~400~~	409 ~~400~~	336	409 ~~400~~	401 ~~400~~	375	403 ~~400~~	409 ~~400~~	—	400	419 ~~400~~	338
2400	401 ~~400~~	398	338	398	390	365	392	398	—	388	403 ~~400~~	338
0030	392	386	339	388	366	357	381	388	—	376	400	338
0100	381	367	339	379	366	357	381	388	—	376	400	338
0130	376	372	339	373	358	348	366	372	—	361	384	338
0200	372	369	340	369	354	346	362	371	—	357	378	338
0230	370	366	340	365	350	342	359	368	—	354	372	338
0300	368	364	341	362	347	342	357	365	—	352	370	338
0330	367	363	341	361	345	342	356	364	—	350	368	338
0400	365	361	341	359	343	340	354	362	—	350	366	338
0430	294	293	295	288	269	278	281	287	—	278	288	280

Notes: 380 376 376 379 386

Turned on heat @ 1709 on 29 May 1980

Turned power off @ 0403 30 May

Repaired TC #3 @ 1900 29 May 1980

Controllers set at 220° @ 2058 29 May 1980

Controllers reset to 335° @ 2303 29 May 1980

max 400°F

E

#16 Part # 1051060-11 Serial # 0000002 Date Cured 18 Dec 80 LWW

Recorder # 4 RSRM 30A

Degree	801 20°	802 60°	81 85°	803 100°	804 140°	805 180°	806 220°	807 260°		808 300°	809 340°	82 275°
12	1	2	3	4	5	6	7	8	9	10	11	12
00			159°	161°		153°	161°	163°		160°	167°	161°
30			177°	173°		163°	171°	174°		170°	179°	176°
00			168°	170°		160°	166°	170°		167°	175°	164°
30			167°	177°		168°	172°	177°		175°	184°	165°
00			165°	175°		166°	169°	175°		172°	181°	163°
30			165°	176°		168°	171°	176°		175°	183°	163°
00			166°	177°		169°	172°	177°		174°	183°	163°
30			224°	319°		312°	336°	350°		350°	382°	246°
30			226°	261°		247°	260°	265°		259°	214°	223°
00			220°	219°		206°	213°	217°		213°	223°	217°
30			223°	205°		193°	195°	202°		195°	209°	217°
00			259°	311°		309°	336°	359°		379°	400°	299°
30			320°	365°		342°	361°	367°		365°	395°	320°
00			313°	331°		312°	323°	331°		308°	347°	309°
30			308	335°		319°	328°	338°		302°	349°	303°
00			301°	293°		312°	317°	327°		315°	335°	[illegible]
30			308°	339°		323°	329°	338°		301°	349°	[illegible]
00			308°	341°		326°	331°	339°		299°	345°	301°
30			310°	343°		327°	332°	339°		299°	345°	[illegible]
00			309°	342°		328°	332°	339°		299°	344°	300°
30			311°	343°		329°	332°	339°		299°	343°	301°
00			311°	343°		329°	333°	339°		299°	343°	301°
30			294°	307°		295°	291°	296°		277°	293°	277°

1000 HEAT ON 0712 12/18/80
CHANGED HEAT TO 220 DEG 1105
CHANGE TO MAIN RAM - TURNED HEAT UP TO 320 1255
16'6 2 HRS. 290° LAG TEMP
OUT OF CURE AT 1816 12/18/80
TC 801 802 & 804 WERE REMOVED PRIOR TO CURE & NEVER REINSTALLED.

MAX ~~346~~ 395

Part # 1US1060-11 Serial # 0000003 Date Cured 1/28/81 JAM

Recorder # 4

...ree	1	2	3	4	5	6	7	8	9	10	11	12
...e												
...00	154	152	164	130	144	142	146	148	—	146	152	162
...30	158	154	166	138	146	146	150	154	—	152	160	162
...00	178	172	166	138	164	162	166	170	—	170	178	164
...30	182	178	166	144	170	168	172	176	—	174	184	164
...00	184	180	168	146	172	168	172	176	—	174	184	164
...15	196	196	178	156	208	210	226	242	—	266	300	214
...30	266	258	222	166	244	232	244	248	—	252	272	224
...00	240	234	224	170	222	216	226	228	—	230	244	222
...30	226	222	228	178	208	206	212	216	—	212	226	222
...0	242	236	230	188	218	218	230	242	—	256	288	248
...30	~~400~~ 419	388	326	238	372	356	378	384	—	392	~~400~~ 420	328
...00	382	372	334	260	358	346	362	366	—	358	384	324
...30	390	382	336	278	366	354	368	374	—	366	392	324
...00	394	386	336	288	368	360	372	376	—	368	394	324
...30	390	386	336	296	370	364	376	380	—	372	398	325
...00	388	386	336	300	366	362	374	380	—	374	398	326
...30	394	392	340	302	368	362	370	374	—	366	388	324
...00	388	386	338	304	364	360	372	376	—	372	396	328
...30	390	392	342	308	372	368	376	378	—	370	388	324
...00	388	388	340	308	366	362	372	376	—	372	394	328
...30	378	378	334	304	350	346	352	350	—	338	354	310
...00	290	296	286	282	268	276	272	272	—	262	274	262
...30	268	272	272	262	252	258	254	254	—	246	256	248
	391										392	

Notes: Heat turned on @ 0500 1/29/81

Heat shut off @ 1526 1/29/81

Controller turned to 220° @ 0815 on 1/29/81

Temp up to 320° @ 1000 1/29/81

Start 2 hr cure @ 1326 1/29/81

max 400°

E

LYNN

Part # 1U51060-11 Serial # 0000004 Date Cured ~~FEB 82~~ 2/11/82 : 3:11:31

Recorder #4

	801	802	81	803	804	805	806	807		808	809	82
ree	20°	60°	85°	100°	140°	180°	220°	260°		300°	340°	275°
	1	2	3	4	5	6	7	8	9	10	11	12
12										241°	266°	185°
55	233°	224°	182°	123°	234°	223°	237°	242°		187°	201°	165°
00	218°	207°	175°	112°	197°	180°	193°	192°				
30	199°	190°	178°	121°	181°	170°	179°	182°		177°	189°	172°
00	166°	161°	168°	126°	152°	148°	155°	160°		160°	171°	167°
30	189°	183°	170°	137°	174°	169°	176°	181°		177°	189°	167°
00	191°	187°	170°	142°	177°	173°	179°	185°		181°	194°	168°
30	191°	189°	171°	145°	178°	175°	181°	186°		181°	193°	167°
00	189°	187°	171°	147°	176°	173°	179°	183°		178°	189°	167°
12	257°	257°	212°	173°	280°	277°	299°	316°		329°	365°	239°
30	265°	259°	229°	170°	250°	239°	251°	253°		247°	265°	222°
00	238°	235°	228°	173°	223°	217°	227°	232°		227°	243°	223°
30	227°	225°	230°	179°	209°	207°	214°	220°		213°	226°	222°
00	226°	223°	231°	186°	209°	208°	213°	220°		213°	227°	222°
15	400°	400°	325°	238°	400°	400°	400°	400°		400°	400°	331°
30	372°	362°	313°	233°	350°	337°	358°	363°		366°	398°	310°
00	359°	350°	320°	247°	337°	327°	342°	347°		339°	364°	309°
30	346°	339°	322°	257°	323°	317°	329°	335°		327°	349°	309°
00	357°	347°	319°	266°	327°	320°	329°	335°		323°	344°	301°
30	357°	351°	318°	273°	333°	330°	339°	345°		333°	355°	303°
00	357°	352°	317°	274°	333°	330°	339°	345°		334°	356°	303°
30	355°	353°	317°	279°	335°	333°	343°	347°		336°	357°	304°
00	355°	353°	318°	280°	336°	335°	343°	347°		336°	356°	303°
30	354°	353°	319°	282°	337°	335°	344°	347°		335°	355°	303°
00	356°	355°	319°	281°	333°	329°	336°	298°		320°	334°	295
15	385°	383°	335°	364°	364°	357°	366°	366°		349°	367°	311°
30	346°	347°	318°	283°	329°	328°	335°	338°		329°	348°	303°
00	350°	351°	319°	285°	334°	333°	339°	342°		330°	347°	302
30	329°	333°	309°	281°	312°	311°	315°	316°		300°	311°	285
00	269°	275°	276°	263°	258°	264°	263°	264°		253°	259°	255

Notes: HEAT ON 0745 2-11-82
HEAT UP TO 200° 2-11-82
HEAT UP TO 320° DEBULK @ 1300 2-11-82
START CURE 1700 2-11-82
1920 HEAT TUNNEL

MAX 400°

E

#19 Part # 1451060-13 Serial # 2 Date Cured 5/7/81

Recorder # 4

TC Degree Time	1	2	3	4	5	6	7	8	9	10	11	12
0415	219	136	116	104	167	169	181	199	—	221	250	164
0445	165	161	147	106	158	147	154	154	—	152	158	147
0515	158	156	158	115	156	150	156	158	—	156	162	160
0545	153	151	164	122	147	143	148	151	—	147	155	163
0615	165	161	169	132	156	152	156	160	—	158	165	166
0645	183	178	169	142	174	169	174	179	—	174	183	167
0715	175	171	165	143	164	161	165	169	—	165	173	163
0745	176	173	166	145	166	164	168	166	—	162	171	161
0815	279	271	225	164	257	238	253	254	—	253	272	223
0845	246	241	225	122	232	223	234	237	—	235	250	225
0915	234	231	229	179	219	213	223	226	—	220	233	224
0945	226	223	231	184	209	206	214	118	—	211	225	223
1015	243	238	232	194	226	221	230	235	—	229	243	224
1045	244	231	323	246	404	374	233	240	—	239	240	328
1115	345	338	330	254	322	355	325	329	—	325	399	325
1145	318	363	331	218	349	340	355	363	—	354	379	323
1215	369	366	328	275	351	343	360	366	—	358	332	319
1245	376	371	329	287	356	351	364	369	—	362	385	319
1315	381	375	330	296	310	354	364	366	—	358	329	320
1345	377	372	330	296	359	359	365	366	—	360	382	320
1415	376	372	330	293	355	352	364	366	—	359	380	320
1445	376	374	321	244	359	354	366	369	—	356	373	318
1515	371	369	328	243	355	350	364	370	—	360	378	320
1545	372	372	330	245	359	352	366	370	—	355	370	317
AVG	356	356	328	262	353	353	349	354		345	360	321

Notes: Turned on @ 0415 5/7/81

08:12 INCREASED SETTING 1, 2, 3, 4, 6, 8, 9 TO 220°

7A TO 200

10:32 INCREASE SETTING 1, 4, 5, 6, 8, 9, 2, 3 TO 320° 7A TO 250

2 HOUR CURE START @ 1430 - 5/7/81

max 400°F E

#12 Part # 1451060-13 Serial # 2 Date Cured 5/7/81

Recorder # 4

C zone												
ime	1	2	3	4	5	6	7	8	9	10	11	12
1615	372	372	329	243	353	346	361	366	—	354	372	320
1645	297	302	293	277	280	283	287	291	—	277	284	274
1715	266	270	272	259	252	257	258	262	—	252	256	256
1745	253	254	256	245	239	244	244	249	—	240	245	245
1815	243	243	248	234	231	236	236	239	—	232	236	236
1845	235	235	239	225	224	227	227	229	—	225	228	228
1915	227	227	230	218	215	220	219	222	—	217	220	220
1945	219	218	221	207	208	212	211	214	—	210	213	214
2015	212	210	214	201	202	207	206	209	—	205	208	208
2045	207	204	206	195	198	202	203	202	—	200	202	203
2115	202	199	202	191	193	197	198	198	—	196	198	198
2145	198	195	198	187	181	193	192	192	—	191	193	193
2215	196	192	195	182	187	190	190	190	—	189	191	191
2245	189	187	189	179	182	188	187	186	—	184	185	186
2315	186											

Notes: 1629 Power To #12 cut off 5-7-81

#20 Part # 1451060-13 Serial # 3 Date Cured 4-1-82

Recorder # 4

TC Degree Time	1	2	3	4	5	6	7	8	9	10	11	12
6:35	174°	172°	166°	126	146	159	166	166	—	164	176	162
7:05	176	171	169	134	144	146	148	148	—	144	155	160
7:35	182	178	171	142	172	168	173	174	—	171	184	164
8:05	190	184	171	148	177	172	179	180	—	175	188	164
8:35	189	186	171	150	178	174	178	180	—	175	189	164
8:50	339	329	253	180	316	290	307	302	—	290	317	225
9:05	288	283	243	180	274	258	273	275	—	263	287	267
9:35	258	252	241	184	240	234	243	245	—	241	261	232
10:05	240	240	241	192	224	222	230	233	—	227	242	232
10:35	246	244	243	198	230	228	236	240	—	231	231	249
11:05	281	281	259	220	291	291	312	324	—	346	388	278
11:35	400	400	347	266	393	376	396	394	—	384	399	322
12:05	368	366	336	272	350	344	358	359	—	344	374	314
12:35	373	368	337	284	348	347	349	351	—	348	378	316
13:05	382	380	339	296	356	356	367	368	—	355	385	316
13:30	383	383	340	303	357	359	369	369	—	356	385	316
14:05	385	387	343	310	360	362	373	372	—	356	384	316
14:35	383	38-	344	312	360	364	373	371	—	356	382	318
15:05	385	387	346	314	362	366	374	371	—	355	382	316
15:35	385	390	347	317	362	367	374	371	—	355	381	316
16:05	385	390	348	318	362	367	374	371	—	355	381	316
16:35	384	390	348	319	362	367	374	368	—	348	371	312
17:05	286	295	293	283	268	282	280	276		260	271	264
					355	354	365	366		355	384	313

Notes: warm up @ 05:37 4-1-82
Heat on @ 605 4-1-82
Increase Heat to 220° @ 0830 4-1-82
Increase Heat to 320 @ 1100 - 4-1-82
Lagger @ 290°, 1430 4-1-82
Power Shut down 1632 4-1-82

max 400°F

E

#7 Part # 1U51060-13 Serial # 0000004 Date Cured 7/22/82 Tex.

Recorder # 4 RSRM 31 B

	801	802	81	803	804	805	806	807		808	809	82
	1	2	3	4	5	6	7	8	9	10	11	12
730	94	181	146	130	218	221	241	259	—	282	319	186
300	105	194	172	124	193	180	190	192	—	188	202	168
330	112	155	160	126	161	155	162	165	—	162	170	168
00	117	166	174	134	162	157	163	167	—	163	168	168
30	115	180	172	144	176	171	176	181	—	178	189	168
00	115	185	173	150	180	176	181.	185	—	180	192	168
30	116	187	173	153	181	178	182	186	—	182	192	168
00	115	188	174	154	182	178	183	186	—	182	193	168
30	122	260	235	181	256	244	255	257	—	252	273	237
00	128	238	235	184	230	222	230	233	—	228	243	226
230	133	226	236	190	216	212	218	220	—	215	230	226
00	138	~~400~~ 405	340	250	400	380	400	400	—	400	~~400~~ 421	322
30	146	381	340	265	370	356	372	373	—	366	400	320
00	151	367	340	278	356	344	356	358	—	352	382	320
30	151	384	344	294	372	360	370	373	—	366	396	320
00	151	390	346	304	376	366	372	374	—	370	398	320
30	152	394	348	310	378	368	372	374	—	368	398	320
00	152	396	350	316	380	368	372	372	—	368	396	320
30	154	396	352	320	382	370	372	372	—	368	396	320
00	154	398	354	322	383	372	372	372	—	368	395	320
30	152	384	348	320	368	358	354	352	—	350	374	310
00	152	394	352	326	386	374	372	372	—	368	394	316
30	150	394	352	322	378	366	364	360	—	358	384	306
0	148	298	296	278	282	278	266	264	—	264	274	258
Avg:		~~390~~ 391	~~347~~ 344	~~322~~ 322	~~377~~ 377	~~365~~ 365	371	371		367	~~393~~ 395	318

Heat on at 17:30 7/22/82

Temp turned to 220° @ 2055 7/22/82

Temp turned to 320° @ 2239 7/22/82

Out of cure 0430 7/22/82

max 400°F

Part # 1051060-[illegible] Serial # [illegible]5 Date Cured 10 18 [illegible] JAY

Recorder # 4 #22

Time	1	2	3	4	5	6	7	8	9	10	11	12
	[illegible]	332 [illegible]	[illegible]	803 100°	804 140°	805 180°	[illegible] 220°	[illegible]	808 [illegible]	809 300°	810 340°	[illegible]
[illegible]	250	247	186	145	259	242	252	255	—	255	232	[illegible]
[illegible]0	170	169	166	126	165	158	[illegible]	168	—	168	182	167
[illegible]00	153	150	166	128	143	140	144	148	—	144	156	[illegible]
[illegible]30	177	174	170	140	163	163	[illegible]	172	—	169	181	163
[illegible]00	132	180	169	[illegible]	173	168	172	178	—	[illegible]	[illegible]	[illegible]
[illegible]30	184	182	170	149	175	170	174	179	—	174	[illegible]	[illegible]
[illegible]00	184	183	169	151	177	172	178	183	—	181	204	171
[illegible]05	284	288	228	191	309	297	316	325	—	332	372	236
[illegible]30	265	265	234	180	259	243	254	256	—	252	235	224
[illegible]00	240	241	233	182	232	223	230	234	—	229	248	[illegible]
[illegible]30	272	272	233	[illegible]	215	211	217	[illegible]	—	[illegible]	[illegible]	[illegible]
[illegible]00	306	308	276	228	228	318	236	250	—	362	400	290
[illegible]30	400	398	340	264	392	372	388	390	—	386	415 ~~400~~	322
[illegible]00	376	378	340	272	368	354	368	372	—	364	396	322
[illegible]30	384	382	342	290	372	362	374	379	—	400	403 ~~400~~	322
[illegible]00	390	388	342	302	378	368	379	384	—	400	409 ~~400~~	324
[illegible]30	390	390	344	308	376	372	380	384	—	400	409 ~~400~~	324
[illegible]00	388	391	344	312	372	373	380	383	—	400	396	322
[illegible]30	388	392	344	314	378	374	380	383	—	370	396	323
[illegible]00	388	392	345	317	379	376	380	382	—	368	394	324
[illegible]30	386	392	346	319	379	376	380	382	—	368	392	324
[illegible]00	386	392	347	320	380	378	380	383	—	369	391	324
[illegible]30	386	392	348	321	380	378	380	382	—	368	388	324
[illegible]00 X	385	382	348	321	382	380	382	384	—	367	386	322
[illegible]P	290	298	293	284	285	290	286	286	—	270	276	272

Notes: * HEAT [illegible] @ 0250 [illegible]

** HEAT UP [illegible]

*** [illegible]

Power shut off @ 1400 on 01/19/82

1/6	389	390	344	305	378	372	379	382		380	~~395~~ 397	323

max 400°F

6

Part # 1U51060-13 Serial # 0000006 Date Cured 11-11-82

Recorder # 4

TC Degree Time	1	2	3	4	5	6	7	8	9	10	11	12
0934	191°	187°	161°	120°	190°	177°	192°	192°	–	200°	211°	164°
1004	156°	155°	162°	119°	150°	143°	150°	152°	–	150°	159°	158°
1034	177°	172°	189°	132°	169°	162°	170°	172°	–	172°	175°	174°
1104	171°	176°	170°	141°	171°	165	172	175	–	175	190	166
1134	186	181	169	146	173	167	173	177	–	175	187	163
1204	171	168	163	145	159	155	159	163	–	155	170	159
1234	164	161	170	147	154	152	157	159	–	154	171	165
1304	267	262	229	175	257	242	262	267	–	272	300	229
1334	235	232	230	179	221	213	223	228	–	223	242	221
1404	218	214	230	182	199	195	203	208	–	201	220	220
1434	245	239	230	185	226	219	228	234	–	227	247	219
1504	–	–	341	252	–	381	–	–	–	–	–	324
1534	316	316	307	261	315	313	334	350	–	344	–	318
1604	351	345	318	275	329	321	334	341	–	330	361	302
1634	351	345	317	279	320	312	322	326	–	–	342	292
1704	348	344	311	285	322	317	328	334	–	–	353	295
1734	343	341	315	287	318	313	322	327	–	–	342	295
1804	338	336	318	288	315	310	319	325	–	–	341	294
1834	345	344	318	292	322	316	325	330	–	–	347	295
1904	347	347	320	295	325	320	329	333	–	320	349	295
1934	349	349	321	297	327	321	330	334	–	321	350	295
2004	349	349	321	298	329	322	331	334	–	–	350	295
2034	349	349	321	299	329	322	332	334	–	–	351	295
2104	314	318	299	288	283	281	284	255	–	306	291	267
Avg	344	342	348	310	323	319	328	333		334	317	300

Notes: 0904 Start Time 11-11-82 #4 Recorder TCC-SL-16-26
1255 Heat Turned Up
1500 Turned Heat Up ← Applied More Pressure
1900 In Cure
2100 Turned off Power

11/12

max 364

Part # 145,060-13 Serial # 000000 6 Date Cured 11-11-6-

Recorder # 4

C zero ime	1	2	3	4	5	6	7	8	9	10	11	12
2134	272	275	277	267	255	255	255	256	—	247	262	249
2204	257	259	263	252	243	243	241	243	—	229	248	238

Notes:

FIGURE 16

Part # 1465060 Serial # 0000007 #34 Date Cured 2/11/83

Recorder # 4 FSM-3

	801	802	81	803	804	805	806	807		808	809	82
	20	60	85	100	140	180	220	260		300	340	275
	1	2	3	4	5	6	7	8	9	10	11	12
:30	176	171	168	127	165	155	162	162	X	160	173	162
:00	154	149	168	129	143	140	148	148	X	146	158	163
:30	184	179	172	141	172	164	170	173	X	170	184	163
:00	188	184	171	147	178	169	176	180	X	178	193	164
:30	191	187	172	150	180	171	176	178	X	175	188	163
:00	174	173	172	150	165	160	163	167	X	164	175	163
:30	340	327	254	183	312	280	300	296	X	326	382	236
:00	244	240	230	178	229	216	225	227	X	223	242	217
:30	220	219	230	180	206	200	204	208	X	206	218	216
:00	216	214	230	187	202	197	200	208	X	203	220	218
7:30	421 ~~400~~	421 ~~400~~	342	256	400	383	400	400	X	396	421 ~~400~~	32
8:00	398	391	348	276	382	360	378	379	X	368	405 ~~400~~	323
8:30	394	389	349	288	378	360	374	377	X	368	405 ~~400~~	323
9:00	416 ~~400~~	416 ~~400~~	349	300	383	378	381	387	X	387	416 ~~400~~	323
9:30	407 ~~400~~	407 ~~400~~	350	308	388	370	380	384	X	381	407 ~~400~~	327
10:00	420 ~~400~~	420 ~~400~~	356	318	398	382	388	390	X	376	420 ~~400~~	323
10:30	417 ~~400~~	417 ~~400~~	352	320	392	379	387	391	X	385	417 ~~400~~	327
11:00	419 ~~400~~	419 ~~400~~	358	324	399	381	385	384	X	378	419 ~~400~~	32
11:30	420 ~~400~~	420 ~~400~~	355	324	396	382	388	388	X	389	420 ~~400~~	32
12:00	415 ~~400~~	415 ~~400~~	359	324	395	377	380	380	X	370	415 ~~400~~	32
12:30	424 ~~420~~	424 ~~400~~	359	330	400	385	388	388	X	374	424 ~~400~~	32
13:00	308	322	310	300	304	300	290	290	X	278	290	27
13:30	278	288	288	279	273	271	261	262	X	255	262	25
AVG	414	413	352	306	392	376	384	386		379	415	32

Notes: Start cure @ 0156 2/11/83
Heat up to 220° @ 0518 2/11/83
Debulk @ 0706
2 hour 290° cure at 10:36
12:36 power off.
2069

Part # 1451060-13 Serial # 0000008 Date Cured 3/23/83

Recorder # 4

TC Degree	801	802	81	803	804	805	806	807		808	809	32
Time	1	2	3	4	5	6	7	8	9	10	11	12
800	118	114	116	104	400	108	108	110	—	400	116	112
830	170	164	164	122	400	150	156	158	—	156	168	158
900	144	136	164	124	400	128	130	134	—	130	144	160
930	172	166	164	138	400	154	156	162	—	160	172	158
1000	178	172	166	144	400	160	162	168	—	166	180	160
1030	180	174	166	146	400	162	164	166	—	164	176	156
1100	176	172	166	146	400	160	162	164	—	162	174	158
1130	276	268	236	174	400	240	256	256	—	250	274	218
1200	224	222	222	172	400	200	206	210	—	206	222	212
1230	208	202	222	176	400	186	188	192	—	188	206	212
1300	202	194	226	182	400	182	178	184	—	180	198	216
1330	400	400	344	246	400	374	400	400	—	400	438 ~~400~~	328
1400	405 ~~400~~	392	348	272	400	348	366	368	—	370	404 ~~400~~	328
1430	390	380	348	284	400	352	366	368	—	360	394	324
1500	409 ~~400~~	400	352	302	400	372	382	384	—	374	402 ~~400~~	324
1530	409 ~~400~~	400	348	310	400	370	380	384	—	382	411 ~~400~~	326
1600	407 ~~400~~	400	350	320	400	376	384	386	—	386	415 ~~400~~	328
1630	407 ~~400~~	403 ~~400~~	350	322	400	380	386	386	—	380	408 ~~400~~	324
1700	407 ~~400~~	400	350	318	400	376	380	382	—	382	411 ~~400~~	326
1730	419 ~~400~~	405 ~~400~~	356	326	400	382	384	380	—	372	400	330
1800	419 ~~400~~	403 ~~400~~	356	328	400	380	382	382	—	380	408 ~~400~~	32[illegible]
1830	416 ~~400~~	411 ~~400~~	358	334	400	388	390	384	—	376	400	32[illegible]
1900	418 ~~400~~	411 ~~400~~	360	334	400	388	388	382	—	374	402 ~~400~~	3[illegible]
1930	398	409 ~~400~~	356	332	400	386	388	384	—	382	411 ~~400~~	326
Notes:	310	320	306	302	400	302	290	286	—	278	286	27[illegible]

Heat on @ 0800 3/23/83 ~~3[illegible]~~ ~~3[illegible]~~ 352 308 ~~400~~ 374 In cool down 1930 3/23/83 ~~4[illegible]~~ 30[illegible]

Temperature up to 220° @ 1115 3/23/83 N/A 382 382 378

Debulk @ 1306 3/23/83 407 401

Lager @ 290° @ 1730 3/23/83 max 400 408

(34 D) Jay

Part # 1451060-13 Serial # 0000009 Date Cured 4/22/83

Recorder # 4

TC Degree	801	802	81	803	804	805	806	807		808	809	82
Time	1	2	3	4	5	6	7	8	9	10	11	12
330	212	214	168	144	256	248	272	286	—	300	342	188
400	188	182	168	120	178	166	178	179	—	180	192	166
430	160	158	166	114	159	152	160	162	—	160	168	164
500	158	154	168	132	152	148	154	158	—	155	166	164
530	176	170	164	142	164	160	164	167	—	162	172	158
600	174	170	162	145	162	159	162	166	—	162	170	154
630	169	167	161	146	159	157	160	162	—	159	168	153
700	178	176	166	150	172	166	171	174	—	170	180	160
730	164	164	160	146	156	154	155	158	—	156	164	154
750	250	252	210	192	286	278	302	322	—	346	400	24[illegible]
830	233	230	222	175	218	208	216	218	—	214	228	21[illegible]
900	224	222	229	182	208	200	208	210	—	202	216	21[illegible]
930	282	282	268	230	304	298	324	344	—	366	400	2[illegible]
1000	400	394	342	262	370	344	362	360	—	348	374	30[illegible]
030	358	350	328	270	328	316	330	336	—	332	364	31[illegible]
100	376	368	332	286	352	338	352	356	—	346	374	3[illegible]
130	384	376	332	290	354	340	356	360	—	346	376	31[illegible]
200	386	382	334	293	360	346	358	358	—	348	372	30[illegible]
230	382	378	332	296	358	348	361	365	—	360	386	31[illegible]
[illegible]	384	384	336	304	366	355	366	366	—	356	378	31[illegible]
[illegible]	380	380	334	302	356	350	358	360	—	356	380	31[illegible]
[illegible]	376	380	336	309	362	356	364	365	—	356	376	31[illegible]
[illegible]	380	38[illegible]	338	308	358	352	360	360	—	350	370	3[illegible]
[illegible]	374	378	336	312	360	356	362	364	—	356	376	3[illegible]
[illegible]	378	384	340	314	362	356	362	362	—	350	366	31[illegible]
[illegible]	378	385	340	315	362	356	360	360	—	348	364	3[illegible]

Notes:

HEAT ON 0330 4/22/83 POWER OFF AT 1600 4/22/83

~~372 371 336 290 353 343 355 350 352 376 31[illegible]~~

HEAT UP TO 220° @ 0745 4/22/83 379 378 335 375

HEAT UP TO 320° @ 0830 4/22/83

END CURE AT 1400 4/22/83

Max 400

(34B)

Part #1U51060-13 Serial #0000009 Date Cured 4/22/83

Recorder # 4

°C Degree Time	1	2	3	4	5	6	7	8	9	10	11	12
230	292	298	296	280	272	280	276	278	—	266	270	268
700	262	266	266	253	245	254	250	252	—	244	246	250

Notes:

Part # 1051060 -13 Serial # 0000010 Date Cured 5-22-85

Recorder # 4

Time	801	802	81	803	804	805	806	807	C	808	809	82
	1	2	3	4	5	6	7	8	X	10	11	12
00	285	271	206	122	268	232	250	251	–	242	261	180
30	186	178	167	112	175	159	171	173	–	172	186	164
00	154	151	165	117	147	139	147	152	–	149	159	164
30	144	136	163	123	129	128	132	138	–	136	151	163
00	178	171	159	138	164	158	164	170	–	169	181	165
30	180	174	167	143	165	159	164	169	–	165	176	159
00	167	164	158	143	155	153	156	162	–	160	169	155
30	254	248	226	173	247	231	245	251	–	249	269	220
00	220	217	221	169	205	197	206	211	–	206	220	213
30	205	198	219	171	183	181	187	192	–	188	210	215
00	224	218	232	184	202	198	203	209	–	206	225	221
30	399	391	342	245	371	344	366	373	–	379	399	326
00	324	314	336	258	345	328	343	348	–	340	370	313
30	359	352	330	271	341	329	345	354	–	347	378	312
00	368	360	327	278	338	327	338	345	–	334	360	302
30	359	354	322	280	329	323	334	342	–	339	319	[illegible]
00	367	363	327	286	339	331	337	344	–	334	357	302
30	376	373	332	289	346	337	343	346	–	337	362	304
00	365	365	329	293	346	341	347	352	–	346	372	30[illegible]
30	367	365	328	291	339	334	341	345	–	344	372	30[illegible]
00	371	371	332	294	346	339	344	346	–	338	361	304
30	371	371	332	295	346	341	345	346	–	336	361	304
00	363	365	330	297	347	343	347	350	–	344	368	307
30												

Notes:

[illegible] - Start [illegible]

2230 - Heat up

0405 - In Cure

0605 - Power off [illegible] 1 hour

MAX 399

Part # 1451060 13 Serial # 11 Date Cured 7-28-83

Recorder # 4

	1	2	3	4	5	6	7	8	9	10	11	12
00	192	183	148	112	187	174	184	186	—	183	198	145
30	178	165	217	140	268	242	256	253	—	253	400	192
00	278	266	207	140	268	242	257	258	—	254	400	192
30	183	176	166	127	173	162	170	172	—	168	400	160
00	166	162	164	132	158	153	157	161	—	158	400	160
30	154	151	159	136	147	145	148	152	—	150	400	157
00	167	162	160	139	157	153	156	162	—	160	400	158
30	169	167	160	144	162	158	160	166	—	164	400	157
00	306	296	245	171	281	251	269	266	—	259	400	219
30	260	257	234	185	259	244	257	261	—	260	400	230
00	236	231	223	182	238	220	229	234	—	234	400	221
30	239	235	229	190	229	222	224	232	—	227	400	219
00	398	298	336	230	391	365	394	398	—	398	400	329
30	398	398	342	260	398	380	398	398	—	398	400	325
00	398	390	342	268	372	351	365	369	—	372	400	324
30	372	366	337	285	357	348	361	371	—	368	400	326
00	368	364	335	292	346	339	347	358	—	357	400	321
30	369	367	335	301	359	353	360	370	—	368	400	322
00	370	372	338	312	366	360	365	373	—	368	400	322
30	371	373	339	313	364	359	364	372	—	367	400	322
00	350	357	329	314	348	344	342	350	—	342	400	308
30	336	344	322	308	334	330	326	336	—	326	400	298
00	334	350	326	304	333	327	324	328	—	316	400	294
30	338	344	322	302	326	314	320	318	—	308	400	298
Avg	364	367	333	292	365	346	0353	359		355	400 ?	314

Notes: HEAT on @ 1645 160

HEAT up TO 220° @ 1945

HEAT up TO 320 @ 2140

N/A

In 2 hr cure @ 0200 on 7/29/83 @ 290°

Out of cure 0400 on 7/29/83

max 398

Part #145/060-13 Serial #0000011 Date Cured 7/28/83

Recorder # 4

gree												
ne	1	2	3	4	5	6	7	8	9	10	11	12
00	333	348	321	304	329	326	324	330	—	324	400	298
30	294	304	298	293	286	287	276	278	—	268	400	266

Notes:

:9 Part # 105.0[illegible] Serial # [illegible] Date Cured [illegible]

Recorder # 4

[illegible]	801	802	81	803	804	805	806	807	C	808	809	32
e	1	2	3	4	5	6	7	8	X	10	11	12
0	187	180	163	123	185	167	192	198	–	205	128	175
0	204	195	177	132	190	170	187	189	–	184	198	170
0	181	175	170	134	168	155	167	170	–	165	176	164
30	178	171	166	139	163	153	163	167	–	163	174	161
0	186	181	170	149	181	168	182	188	–	186	201	170
50	202	195	176	152	188	172	186	189	–	185	199	169
0	195	189	174	152	180	166	178	181	–	176	189	165
50	264	255	228	175	249	225	254	261	–	274	305	233
00	249	243	229	186	245	229	253	260	–	264	293	234
50	260	252	237	190	236	222	233	237	–	230	248	220
00	248	245	237	200	238	226	240	247	–	244	268	230
30	440 ~~400+~~	440 ~~400+~~	344	260	416 ~~400+~~	382	418 ~~400+~~	427 ~~400+~~	–	430 ~~400+~~	442 ~~400+~~	331
00	400+	389	339	267	368	338	371	378	–	390	402 ~~400+~~	330
30	412 ~~400+~~	412 ~~400+~~	353	296	390	368	391	400+	–	392	404 ~~400+~~	33[illegible]
00	417 ~~400+~~	417 ~~400+~~	360	308	395	375	393	398	–	388	400+	329
030	399	399	361	317	394	376	393	399	–	389	399	330
100	399	399	356	324	387	371	391	399	–	393	399	334
0	389	386	347	315	354	344	361	373	–	380	399	333
0	398+	398+	358	321	367	350	363	367	–	354	381	318
30	399	399	366	333	388	370	386	392	–	381	399	330
0	393	392	352	322	351	339	351	359	–	361	399	327
30	399	399	369	333	384	366	379	383	–	371	399	326
0	387	388	352	326	352	344	359	371	–	377	398+	332
50	399	399	369	334	380	361	375	379	–	367	397	324
500	335	340	323	313	297	289	296	303	–	292	315	283

Notes:

2010 – Turned up [illegible]

2220 – Time [illegible] Turn up

0250 – Start Cure

0450 – Out of Cure

402 401 379 354 386 382 401

max 400°F

#30 Thyne Part #1451060-13 Serial # 0000013 Date Cured 10-20-83

Recorder # 4

TC Degree	801 20°	802 60°	81 85°	803 100°	804 140°	805 180°	806 220°	807 260°		808 300°	809 340°	82 375°
Time	1	2	3	4	5	6	7	8	9	10	11	12
1225	180°	400°	177°	118°	213°	176°	203°	177°	141°	400°	400°	178°
1255	206°	400°	178°	126°	192°	173°	198°	204°	159°	400°	400°	166°
1325	168°	400°	164°	128°	163°	168°	180	187°	400°	400°	400°	166°
1355	158°	400°	164°	133°	154°	148°	158°	163°	400°	400°	400°	163°
1425	166°	400°	170°	142°	164°	157°	167°	163°	400°	400°	400°	166°
1455	180°	400°	173°	150°	178°	167°	178°	182°	400°	400°	400°	167°
2025	174°	400°	171°	153°	179°	171°	195°	200°	400°	400°	400°	175°
2055	184°	400	174°	151°	181°	171°	186°	184°	400°	400°	400°	172°
2125	~~208°~~ 238°	400°	250°	192°	278°	254°	254°	260°	400°	400°	400°	234°
2155	219°	400°	229°	190°	234°	230°	248°	253°	400°	400°	400°	233°
2225	214°	400°	230°	242°	219°	214°	227°	234°	400°	400°	400°	224°
2255	220°	400°	234°	188°	219°	214°	223°	227°	400°	400°	400°	220°
2325	376°	400°	~~357°~~ 356°	257°	400°	386°	384°	390°	400°	400°	400°	326°
2355	373°	400°	356°	284°	321°	358°	378°	375°	400°	400°	400°	320°
0025	350°	400°	344°	293°	368°	358°	377°	380°	400°	400°	400°	328°
0055	320°	400°	329°	292°	340°	350°	350°	354°	400°	400°	400°	345°
0125	365°	400°	343°	301°	355°	346°	356°	353°	400°	400°	400°	345°
0155	361°	400°	353°	316°	379°	368°	360°	377°	400°	400°	400°	320°
0225	350°	400°	355°	323°	373°	374°	370°	383°	400°	400°	400°	324°
0255	335°	400°	347°	315°	351°	347°	365°	360°	400°	400°	400°	324°
0325	361°	400°	361°	324°	374°	362°	367°	363°	[illegible]	[illegible]	[illegible]	312°
0355	355°	400°	371°	334°	374°	383°	384°	382°	400°	400°	400°	325°
0425	374°	400°	373°	339°	382°	385°	392°	386°	400°	400°	400°	329°
0455	368°	400°	373°	346°	399°	388°	394°	391°	400°	400°	400°	
	360	400	358	215	376	368	375	375				322

Notes: Heat turned on @ 1655 10/20/83
Heat up to 220 @ ~~0230~~ 2055
Heat up to 320° @ 2300
In Cure @ 04:12
Out of Cure 06:12

max 400

#30 Thrust Part # [illegible] Serial # [illegible] Date Cured [illegible]

Recorder #

TC Degree Time	1	2	3	4	5	6	7	8	9	10	11	12
0525	372°	400°	369°	340°	386°	373°	378°	370°	400°	400°	400°	321°
0555	375°	400°	377°	345°	398°	382°	388°	383°	400°	400°	400°	326°
0625	334°	400°	360°	340°	370°	362°	394°	376°	400°	400°	400°	334°
Out of Cure 0655	282°	400°	300°	296°	280°	280°	273°	270°	400°	400°	400°	262°

Notes:

Out of Cure 0612

Part # 1051060-13 Serial # 0000014 Date Cured 4-29-84

Recorder # 4 RS 30 B

Time	801 20°	802 60°	81 85°	803 120°	804 140°	805 180°	806 220°	807 260°		808 300°	809 340°	82 275°
12	1	2	3	4	5	6	7	8	X	10	11	12
14	96	94	48	85	92	92	90	90	—	89	94	88
14	202	198	0	123	197	173	193	197	—	201	219	161
14	189	184	0	126	180	160	176	179	—	179	193	159
14	177	173	164	130	176	152	164	167	—	176	178	158
14	167	164	163	133	156	146	154	159	—	157	167	158
14	158	157	162	135	148	140	146	152	—	149	158	156
14	173	170	165	142	161	151	158	164	—	161	172	157
14	176	174	164	145	164	155	162	178	—	165	176	157
14	175	173	164	147	163	155	161	166	—	165	174	158
14	255	252	222	179	244	220	241	247	—	247	266	213
14	262	258	232	188	246	230	242	248	—	246	261	217
14	249	245	229	190	232	220	230	236	—	232	244	217
14	243	239	230	193	224	217	224	231	—	230	250	223
14	391	385	324	255	374	340	375	383	—	388	400	309
14	370	364	317	261	344	323	343	348	—	343	368	296
14	343	337	300	265	323	309	327	335	—	326	350	292
14	343	337	314	268	319	305	326	334	—	331	358	302
14	345	340	318	276	321	308	326	332	—	324	347	297
14	350	354	328	287	335	325	340	347	—	340	365	304
14	367	362	328	294	340	330	344	349	—	339	362	304
14	366	362	327	296	339	329	343	349	—	340	364	305
14	368	365	328	299	342	332	346	350	—	342	365	305
14	369	365	328	300	343	335	346	351	—	343	368	306
14	370	367	328	302	345	337	349	353	—	344	366	305
14	370	368	329	303	345	337	349	353	—	345	367	305
14	370	369	329	303	347	338	350	353	—	345	367	306
14	289	289	281	271	265	275	272	274	—	261	274	257
	363	359	323	284	339	326	343	349		342	365	303

0920
1340

400 max

E

* 32 Part # 145 1060-13 Serial # 15 Date Cured 10 Aug 84

Recorder # 4

TC Degree	801 20°	802 40°	31 75°	803 100°	804 140°	805 180°	806 220°	807 260°		808 300°	809 340°	810 375°
Time	1	2	3	4	5	6	7	8	9	10	11	12
0930	180	208	152	126	212	186	200	206		200	216	167
1000	174	210	174	140	227	192	222	230		226	249	175
1030	139	158	165	124	154	141	154	160		161	174	167
1100	148	160	176	136	166	150	162	166		162	173	176
1130	160	186	176	144	178	162	173	178		172	182	165
1200	154	190	170	150	176	163	174	180		175	185	164
1230	148	162	164	150	173	162	172	180		176	188	165
Heating 1250	156	182	168	149	174	163	171	176		170	179	160
1300	260	322	212	191	242	264	274	299		283	304	221
1330	179	224	212	164	222	209	219	227		221	236	209
1400	170	200	212	172	200	195	204	214		211	230	216
1430	188	220	229	177	206	198	205	212		204	216	220
1500	209	248	237	186	236	223	232	242		232	246	224
1530	213	254	236	201	240	226	237	246		250	268	230
1600	178	203	223	189	190	188	192	202		193	205	219
1630	188	219	231	198	213	210	216	231		223	238	229
loss power 1648 *	192	225	228	200	224	222	238	258		270	305	252
1700	223	250	243	218	258	254	273	248		310	347	269
1730	270	305	286	232	288	272	285	275		282	299	252
1800	272	304	296	246	292	305	305	315		300	317	290
1830	289	325	309	255	307	293	305	317		302	319	291
1900	281	328	305	271	327	317	333	349		338	360	301
1930	277	323	298	267	313	303	326	344		338	362	301
2000	294	350	311	284	338	326	344	358		343	363	301

Notes: Start Cure 0930 10 Aug 84 | Heat up 1250 | turn heat up 1635 1648 loss power.
1700 power back.

max 363

Part # 1451060-13 serial # 15 Date Cured 10 Aug 84

Recorder # 4

°C Degree Time	1	2	3	4	5	6	7	8	9	10	11	12
2030	278	326	298	269	310	302	321	338		305	352	298
2100	274	354	303	282	333	322	342	356		344	362	302
2130	290	350	310	286	342	328	346	359		344	359	301
2200	294	332	300	271	311	301	313	358		312	328	272
2230	277	330	299	271	310	302	312	323		313	329	283
2300	293	354	311	275	310	301	312	324		340	352	299
2330	284	342	304	275	323	310	323	334		314	322	289
2400	283	341	304	275	323	312	323	354		314	322	289
0030	281	341	305	275	325	309	323	334		314	321	289
0100	289	352	302	279	335	322	335	346		326	335	293
0130	274	336	302	284	337	328	343	354		344	356	301
0200	280	344	305	286	341	331	347	361		346	358	302
0230	289	351	308	279	335	317	335	343		345	358	301
0300	288	353	310	288	347	328	349	361		343	356	300
0330	292	349	313	287	348	327	348	359		339	351	298
0400	278	346	308	288	346	326	350	363		340	362	302
0430	278	339	303	275	321	302	320	350		309	320	301
0500	270	330	301	283	335	317	343	348		345	361	301
0530	291	354	312	282	339	317	338	346		325	336	282
0600	288	352	310	280	334	310	333	342		320	330	290
0630	292	360	314	290	350	327	350	361		342	356	299
0700	231	278	269	258	252	264	266	278		260	262	258
0730	213	255	255	243	240	246	244	255		240	241	246
0800	204	251	251	238	236	251	241	251		238	241	240

Notes: 0430 Time in cure. 0630 time out cure

281 336 293 273 324 311 328 335 326 343 293

3.3 Part #1451060-13 Serial #0000016 Date Cured 5/3/85

Recorder # 4

:	801	802	81	803	804	805	806	807	8C	808	809	82
gree												
ne	1	2	3	4	5	6	7	8	9	10	11	12
20	188	180	180	138	178	154	170	174	—	172	183	172
50	208	200	184	155	200	172	192	194	—	192	204	172
0	204	198	178	158	196	172	188	190	—	188	204	169
0	186	182	166	154	176	160	168	168	—	166	176	154
20	188	182	166	156	178	164	172	172	—	168	180	156
0	182	180	166	156	176	162	168	168	—	166	176	156
2	196	196	178	176	220	198	228	242	—	274	304	208
20	400	392	288	238	290	308	354	348	—	336	356	242
50	292	286	254	208	286	244	274	274	—	274	294	236
20	254	248	242	200	242	218	234	236	—	234	250	228
50	242	240	242	204	230	216	224	226	—	222	238	226
4	334	374	308	276	376	328	352	354	—	342	366	274
30	304	300	280	240	300	280	290	298	—	288	310	262
5	286	282	278	238	272	248	266	266	—	263	286	262
30	290	292	296	250	280	262	272	278	—	266	284	270
00	318	314	298	266	304	280	294	296	—	288	308	276
30	346	342	306	280	330	304	322	324	—	320	342	286
0	338	334	306	284	324	306	316	318	—	310	328	286
30	334	330	304	286	322	306	316	316	—	308	326	286
00	336	336	304	290	328	310	320	320	—	312	328	286
30	336	335	302	292	328	310	320	320	—	312	328	286
00	330	330	302	290	322	308	316	316	—	308	320	284
30	330	330	302	292	326	308	318	318	—	308	320	286
00	328	330	302	292	324	306	318	316	—	306	318	286

Notes: Chart on 1520 - data from 1520 to 1720 shows cooling trend of mold temp after chart was turned on Data erratic 5/3/85

Heat to 220° @ 1912 on 5/3/85
Heat to 320° @ 2104 on 5/3/85
Debulk @ 2255 5/3/85

Power off @ 0345 on 5/4/85

MAX ~~346~~ 384

Part # 1U51060-13 Serial # 0000016 Date Cured 5/3/85

Recorder # 4

°C degree												
Time	1	2	3	4	5	6	7	8	9	10	11	12
30	324	326	302	290	320	306	314	314	—	306	316	286
45	328	330	302	292	322	306	316	314	—	304	314	284
100	284	288	276	274	278	278	276	274	—	264	270	260
430	260	262	258	254	252	256	252	252	—	244	248	246

Notes:

Bearing #34 Part #1451060-13 Serial # 0000017 Date Cured 20 SEP 85

Recorder # 4

°C	801	802	81	803	804	805	806	807	8C	808	809	82
Degree												
Time	1	2	3	4	5	6	7	8	9	10	11	12
1040	74	74	–	–	72	72	74	70	70	72	74	72
1100	84	84	–	–	98	96	88	90	98	72	96	94
1140	132	134	–	–	94	92	86	94	72	76	90	90
1210	148	154	–	–	172	156	138	158	78	98	160	106
1240	152	168	–	–	180	156	146	162	108	134	162	130
1310	154	160	–	–	182	162	150	162	124	145	166	140
1340	156	160	–	–	180	164	152	162	130	148	168	150
1410	160	162	–	–	180	167	168	162	138	153	167	152
1440	160	161	–	–	180	168	160	160	143	158	168	155
1510	158	159	–	–	180	172	164	164	150	160	170	160
1540	160	160	–	–	179	171	166	164	154	162	170	162
1610	160	160	–	–	178	172	168	166	156	162	172	162
1640	172	172	–	–	182	176	172	173	158	164	173	166
1710	197	196	–	–	222	210	200	204	162	170	210	184
1740	222	224	–	–	227	216	208	218	170	188	212	196
1810	221	222	–	–	228	216	212	218	182	204	214	200
1840	220	220	–	–	229	217	214	220	190	209	216	204
1910	218	220	–	–	230	220	216	220	198	218	218	208
1940	224	226	–	–	247	236	230	232	204	222	236	216
2010	304	306	–	–	324	309	286	302	212	234	294	254
2040	322	324	–	–	322	302	294	310	234	256	288	276
2110	318	320	–	–	324	304	300	310	248	272	294	284
2140	317	320	–	–	317	288	298	308	264	283	296	286
2210	316	320	–	–	306	288	292	302	274	288	292	286

Notes: Start cure @ 1040 on 20 SEP 85

In cure (290° Hold) @ 0159 on 9/21/85

End of cure @ 0400 on 9/21/85

18

329

~~325~~ max

Bearing #34 Part # 1U51060-13 Serial #0000017 Date Cured 20 SEP 81

Recorder # 4

°C	801	802	81	803	804	805	806	807	8C	808	809	81
Degree												
Time	1	2	3	4	5	6	7	8	9	10	11	12
2240	320	323	–	–	306	288	292	304	280	294	292	288
2310	318	320	–	–	322	306	307	313	288	300	308	300
2340	324	324	–	–	326	312	314	320	294	304	312	306
0010	324	323	–	–	324	312	315	320	298	308	313	308
0040	321	322	–	–	326	314	318	322	304	314	314	310
0110	324	324	–	–	326	316	320	324	308	316	316	312
0140	328	328	–	–	326	314	320	326	312	318	316	312
0159	328	328	–	–	326	314	320	326	312	318	316	312
0210	329	329	–	–	326	314	320	326	314	320	316	312
0240	323	322	–	–	325	314	318	322	316	320	316	312
0310	322	324	–	–	324	313	318	322	316	321	316	312
0340	322	324	–	–	326	314	320	322	317	322	317	312
0400	324	324	–	–	324	312	318	322	318	322	314	314
	321	323			322	307	309	~~325~~ 317	289	301	307	300

Notes:

Part # 1451060-13 Serial # 0000018 Date Cured 4 NOV 85

Recorder # 4

re	1	2	3	4	5	6	7	8	9	10	11	12
e												
0	104	104	—	—	114	116	114	114	90	90	116	112
10	102	100	—	—	108	112	110	108	92	90	108	104
30	142	146	—	—	156	158	148	148	94	98	156	148
10	150	154	—	—	172	170	164	164	104	122	168	160
0	158	160	—	—	172	170	166	164	122	142	164	158
20	160	162	—	—	172	170	166	164	136	154	164	160
30	160	160	—	—	174	178	170	168	146	160	172	166
10	162	160	—	—	176	174	168	166	154	162	168	162
10	168	166	—	—	172	176	170	170	158	166	170	164
55	202	200	—	—	208	216	204	210	160	170	210	200
10	218	220	—	—	224	224	214	218	166	178	214	210
40	222	224	—	—	224	226	214	218	180	202	216	208
10	222	222	—	—	226	226	216	220	190	210	216	212
40	220	220	—	—	224	224	218	220	196	212	218	214
10	222	223	—	—	222	222	218	220	200	214	214	214
50	300	302	—	—	290	290	280	290	210	228	284	280
10	314	316	—	—	310	310	302	310	214	236	302	300
40	322	328	—	—	306	310	308	318	234	258	310	282
10	322	324	—	—	316	316	310	316	250	278	310	296
10	320	322	—	—	320	318	316	318	264	284	312	300
10	324	324	—	—	324	320	320	322	270	288	314	302
40	322	324	—	—	322	320	316	320	280	294	316	304
10	322	324	—	—	322	320	316	320	286	298	314	306
40	320	322	—	—	322	320	320	320	290	300	316	308

Notes:

Start of debulk @ 0250 3 NOV 85

IN 290° HOLD @ 0920 3 NOV 85

END OF CURE @ 1120 3 NOV 85

330 max

Part #1451060-13 Serial # 0000018 Date Cured 4 NOV 85

Recorder # 4

re	1	2	3	4	5	6	7	8	9	10	11	12
e	320	322	—	—	320	320	316	320	294	304	316	309
10	322	322	—	—	328	328	324	324	298	306	326	314
0	330	330	—	—	324	324	322	326	302	308	322	314
0	328	328	—	—	320	320	320	326	304	310	318	314
0	330	330	—	—	322	322	322	326	306	311	320	314
2	328	328	—	—	322	322	322	326	306	312	320	314
0	323	323	—	—	318	320	318	322	308	314	318	314
0	322	322	—	—	320	320	319	322	308	314	320	314
0	322	322	—	—	322	322	320	322	310	314	320	314
0	322	322	—	—	322	322	320	322	312	314	320	314
0	316	314	—	—	314	314	314	318	310	310	316	310
0	306	302	—	—	304	306	304	308	300	294	306	304
0	298	294	—	—	302	302	300	302	290	284	300	302
	323	324			320	320	317	~~357~~ 321	285	299	316	307

Notes:

MAX 330

#34 Part #1451060-13 Serial # 19 Date Cured 26 NOV 1985

Recorder # 4

...ze	801	802	81	803	804	805	806	807	—	808	809	82
...2	1	2	3	4	5	6	7	8	9	10	11	12
...0	104	104	—	—	108	108	98	100	75	75	114	112
...0	150	148	—	—	178	172	158	164	80	100	178	186
...0	150	148	—	—	176	172	164	164	96	112	176	178
...0	152	154	—	—	176	174	164	164	112	138	172	162
...0	156	156	—	—	174	166	164	162	130	150	168	162
...0	158	160	—	—	172	166	162	162	140	154	166	162
...0	158	158	—	—	172	166	164	162	146	156	168	164
...0	164	164	—	—	176	170	166	166	150	158	172	168
...0	160	160	—	—	174	170	166	164	152	160	172	168
...0	158	158	—	—	176	170	168	164	156	162	172	168
...0	166	168	—	—	228	218	206	192	152	174	224	218
...0	214	206	—	—	224	216	208	212	172	190	218	208
...0	220	220	—	—	220	212	212	218	188	204	218	210
...00	220	220	—	—	218	212	213	218	194	206	214	211
...00	218	218	—	—	220	212	214	218	198	210	216	214
...00	293	272	—	—	304	290	280	297	208	226	292	292
...00	310	304	—	—	308	302	294	308	226	248	306	302
...00	316	316	—	—	312	304	302	312	248	270	312	304
...00	322	322	—	—	314	306	306	316	264	284	312	306
...00	326	324	—	—	316	308	310	318	276	292	312	308
...0	324	322	—	—	316	308	310	318	284	298	314	310
...0	322	322	—	—	318	310	314	320	292	304	318	314
...0	324	324	—	—	318	310	314	320	298	308	318	314
			—	—								

Temp turned on @ 1734 26 NOV 85

Temp turned up to 220° @ 2213 26 NOV 85

Temp turned up to 330° @ 0035 27 NOV 85

In 2 hr. cure @ 0533 27 NOV 85

END OF CURE @ 0740 27 NOV 85

C-2.

MAX 326

Part # 1U51060 Serial # 19 Date Cured

Recorder # 4

°C degree / Time	1	2	3	4	5	6	7	8	9	10	11	12
500	324	324	—	—	316	308	314	320	300	310	316	312
538	324	324	—	—	318	308	316	320	304	312	318	314
600	322	324	—	—	318	308	316	318	308	314	318	314
230	324	324	—	—	318	310	316	320	310	318	316	316
00	324	324	—	—	320	310	318	322	312	316	320	318
40	324	324	—	—	318	308	318	320	314	318	316	314
300	314	312	—	—	310	300	312	314	312	310	310	308
330	304	302	—	—	304	296	308	304	304	300	302	300
	320	318			315	306	309	316	282	294	313	310

Notes:

Part # 1051060-13 Serial # 0000020 Date Cured 20 DEC 85

Recorder # 4

Time	801 20°	802 60°	81 85°	803 100°	804 140°	805 180°	806 220°	807 260°		808 300°	809 340°	82 275°
	1	2	3	4	5	6	7	8	9	10	11	12
:12												
:30	123°	127°			119°	115°	111°	112°	74°	77°	124°	123°
:0	155°	160°			174°	167°	162°	149°	83°	92°	172°	173°
:30	155°	159°			177°	169°	165°	163°	95°	116°	176°	175°
:0	160°	162°			181°	172°	168°	167°	115°	138°	178°	169°
:30	160°	162°			179°	173°	166°	165°	129°	149°	173°	164°
:0	159°	160°			178°	174°	167°	166°	140°	155°	172°	162°
:30	160°	160°			178°	172°	167°	166°	147°	159°	171°	161°
:00	159°	159°			180°	174°	169°	168°	152°	161°	172°	163°
:30	161°	160°			178°	174°	169°	168°	157°	163°	172°	164°
:00	160°	160°			178°	174°	171°	168°	161°	165°	172°	165°
:30	207°	206°			217°	206°	200°	209°	163°	171°	206°	186°
:0	219°	221°			229°	218°	214°	221°	173°	188°	213°	203°
:30	220°	221°			229°	221°	216°	219°	186°	202°	214°	208°
:00	220°	221°			227°	217°	216°	219°	193°	208°	214°	210°
:30	219°	219°			227°	218°	217°	219°	201°	212°	217°	213°
:0	[illegible]	246°			313°	291°	282°	297°	209°	225°	285°	[illegible]
:30	312°	312°			325°	308°	301°	311°	227°	246°	303°	259
:0	316°	316°			325°	311°	305°	312°	247°	268°	307°	[illegible]
:30	315°	317°			325°	315°	306°	309°	263°	281°	317°	313°
:0	316°	318°			325°	315°	309°	313°	275°	289°	317°	[illegible]
:30	318°	319°			327°	317°	313°	317°	284°	295°	325°	317°
:00	318°	319°			325°	315°	313°	317°	292°	301°	318°	316
:30	319°	319°			325°	315°	315°	318°	298°	305°	319°	318
:00	319°	319°			323°	315°	315°	318°	302°	308°	320°	318°

[illegible] IN OVEN 2230 2225 20 DEC 85

POWER TURNED OFF AT 2235 20 DEC 85

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327 max

Part # 1U51060-13 Serial # 0000020 Date Cured 20 DEC 85

Recorder # 4

ze	801 20°	802 60°	81 85°	803 100°	804 140°	805 180°	806 220°	807 260°		808 300°	809 340°	82 275°
2	1	2	3	4	5	6	7	8	9	10	11	12
30	320°	320°			322°	313°	315°	318°	305°	311°	318°	316°
00	319°	319°			323°	314°	316°	319°	307°	313°	319°	317°
30	320°	320°			323°	315°	317°	319°	310°	313°	319°	318°
00	320°	320°			323°	315°	317°	320°	311°	314°	319°	318°
30	321°	321°			323°	315°	318°	320°	313°	317°	319°	318°
00	313°	310°			315°	307°	312°	313°	311°	311°	311°	310°
	316	317			323	312	310	315	282	292	314	310

Part # 1051060-13 Serial # 0000021 Date Cured 11 Apr. 1986

Recorder # 4

Time	801	802	81	803	804	805	806	807		808	809	82
	1	2	3	4	5	6	7	8	9	10	11	12
12	50	80	—	—	82	80	80	81	—	74	80	78
30	90	91	—	—	85	83	83	86	—	76	84	82
0	86	87	—	—	85	82	82	84	—	78	83	81
0	160	168	—	—	138	134	125	145	—	87	140	136
0	148	149	—	—	211	189	166	167	—	123	190	185
0	148	150	—	—	215	194	166.	160	—	154	186	172
0	170	152	—	—	185	173	160	165	—	173	168	160
0	202	204	—	—	215	196	198	212	—	188	192	205
0	232	236	—	—	210	202	205	220	—	207	199	201
0	233	247	—	—	210	203	208	220	—	217	201	203
0	316	317	—	—	291	275	285	311	—	230	269	291
0	339	342	—	—	300	289	296	322	—	254	283	285
0	334	337	—	—	297	288	295	316	—	281	284	286
0	332	333	—	—	298	290	298	315	—	334	287	289
0	331	331	—	—	302	294	301	316	—	280	293	292
0	32[illegible]	[illegible]	—	—	307	299	306	318	—	270	299	298
0	327	327	—	—	309	300	307	316	—	273	301	350
0	326	327	—	—	308	300	307	317	—	275	300	300
0	327	328	—	—	310	302	309	318	—	278	302	30[illegible]
0	327	329	—	—	311	306	310	319	—	281	304	303
0	327	328	—	—	311	311	311	319	—	283	305	30[illegible]
0	301	302	—	—	299	300	299	302	—	256	293	292
	297	292	—	—	291	295	293	295	—	270	287	286
Max	327	328			305	298	304	316		281	296	296

[illegible] - 160 [illegible]
[illegible]
[illegible]
0000 - [illegible]

[illegible] - [illegible]
1105 - [illegible]
1110 - [illegible], As Zone 5
[illegible]
1300 - Start Cure
1500 - End Cure, Heat off

339 max

#39 Part # 1451060-13 Serial # 0000022 Date Cured 7-31-86

Recorder # ZONE 8 3RD CYCLE ABOVE 300°F

Time	801	802	81	803	804	805	806	807		808	809	82
	1	2	3	4	5	6	7	8	9	10	11	12
1940	319	316	293	321	302	288	300	305		305 ~~272~~	329 ~~30~~	275
2010	329	326	309	331	311	299	311	316		313	337	290
2040	320	315	306	321	300	293	302	308		305	325	290
2110	327	322	306	327	307	300	309	316		311	330	288
2140	325	321	303	327	306	300	307	315		310	328	288
2210	324	321	303	327	307	302	308	316		311	328	287
2240	319	318	302	321	303	298	305	313		306	320	287
2310	319	318	301	322	304	299	306	313		306	320	287
2340	329	328	305	334	315	310	317	324		318	333	291
~~2010~~												
~~2410~~												
~~0040~~												
~~2440~~												
~~2510~~												
~~2540~~												
~~2610~~												
~~2640~~												

Notes:

AVG 323 321 303 326 306 299 307 314 309 328 28

9

MAX 337

#40 Part # 1451060-13 Serial # 0000023 Date Cured 11-7-86

Recorder # ZONE 8, 3RD CYCLE ABOVE 300°F

Time	801	802	81	803	804	805	806	807		808	809	82
	1	2	3	4	5	6	7	8	9	10	11	12
001	309	303	273	313	295	282	295 ~~194~~	300		300	318	259
031	307	303	279	309	294	283	296	302		298	313	265
101	334	329	290	339	321	310	322	329		325	342	275
131	337	332	293	341	322	315	325	332		329	345	279
201	333	331	294	337	320	315	324	331		324	338	281
231	332	330	295	336	320	315	325	331		324	337	282
301	318	317	288	322	306	304	313	319		312	321	278
331	315	314	288	318	304	302	312	317		308	317	278
401	317	317	290	322	307	305	315	320		312	321	280
431	314	314	288	320	305	304	314	318		309	317	280
501	318	318	290	324	309	308	318	322		314	322	28[illegible]
531	325	325	295	330	317	315	325	330		321	329	28[illegible]
601	324	324	295	329	316	314	325	330		320	327	28[illegible]
631	321	321	293	327	313	312	322	327		319	325	28[illegible]
701	320	320	293	325	312	312	322	327		319	323	28[illegible]
731	320	321	294	325	314	313	324	328		319	323	28[illegible]
801	322	323	296	327	316	315	326	331		320	325	29[illegible]
831	313	314	291	318	307	307	318	322		313	316	28[illegible]
901	316	317	293	322	310	310	321	326		317	319	29[illegible]
931	323	325	297	329	318	317	329	333		323	327	29[illegible]
2001	323	324	297	328	317	317	328	333		323	326	29[illegible]
~~2031~~												
~~2101~~												
~~2131~~												
Avg	321	320	291	326	312	308	319	324		317	325	28[illegible]

Notes:

MAX 345

KIRKHILL RUBBER COMPANY

ATTENTION: MARK OLSEN

FROM: LINDA HILL

SUBJECT: CHANGES TO SPECIAL PROCESS PROCEDURE 0002

REFERENCE: STW5-2943

N/C	WRITTEN 9/30/78	
"A"	OCR 60548	CORRECT CODE #, OBTAIN SAMPLE FOR TESTING, ADD MARKING
"B"	OCR 60555	ADDED NEW BOLLING
"C"	OCR 60569	CHANGED HOLLAND CLOTH TO KODACEL FILM
"D"	OCR 60578	CHANGED TOLUENE TO METHYLCHLOROFORM INCREASE #1RSS FROM 300 LBS TO 330 LBS ADDED DUMP TEMPERATURE, VISCOSITY REDUCTION ADDED MIXING TIME TO HYCAR 1312 CHANGED FINAL BATCH DUMP FROM 3 MINUTES TO 4 ± 15 SECONDS
"E"	OCR 60586	ADD STORAGE REQUIREMENTS PER SPEC USE OF ACCEPTANCE TAGS, INSTRUCTIONS FOR USING STYRENE LIDS AND KODACEL
"F"	OCR 60592	PREMASTICATING MIXING
"G"	OCR 76964	CHANGED A4-200 TO PMS-1, ADD APPROPRIATE PMS TO BASELINE
"H"	OCR 82575	ADDED VACUUM PUMP AS EQUIPMENT REQUIRED
"I"	OCR 85598	CHANGED 40 RPM TO 30 RPM
"J"	OCR 93308	REPLACED WORM CHAMBER
"K"	OCR 93343	CHANGED GRAMS TO POUNDS
"L"	OCR 93366	ADDED MINT TO HYCAR 1312
"M"	OCR 117992	CLARIFY WEIGHT IN OUNCES
"N"	OCR 118005	ADDED NEW TO ALTAX
"O"	OCR 117994	CORRECT TYPO ERROR

An ESOP Company
Kirkhill RUBBER SINCE 1919
300 E. CYPRESS • BREA, CALIFORNIA 92621 • (714) 529-4901 TELEX 65-5366 • TWX 910-596-1213 • FAX (714) 990-5202

KIRKHILL RUBBER COMPANY

"P"	OCR 118067	CLARIFY INSPECTION PROCESS
"Q"	OCR 118068	ADDED FORM 62-5"A" FOR HYCAR 1312 CALCULATIONS
"R"	OCR 118076R1	NAME CHANGE HYCAR TO NIPOL
"S"	OCR V000138	REMOVAL OF LIFTING KODACEL
"T"	OCR 118033	CHANGED ZINC OXIDE TORRANCE TO ZINC OXIDE MEMPHIS
"U"	OCR 118043	CHANGED METHYL TUADS TO NEW MT
"V"	OCR 118066	SIMPLIFY MARKING
"W"	OCR V000506	USE OF TYPE 5 CLEAN-OUT CHARGES

An ESOP Company
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300 E. CYPRESS • BREA, CALIFORNIA 92621 • (714) 529-4901 TELEX 65-5366 • TWX 910-596-1213 • FAX (714) 990-5202

LORD

Lord Corporation
Elastomer Products Division
2000 West Grandview Blvd.
P. O. Box 10038
Erie, PA 16514-0038
814:868-3611
Telex: 291935

February 5, 1993

5308

Mr. Allan Olson
Thiokol Corp., Space Operations
P.O. Box 707
Mailstop 692
Brigham City, UT 84302-0707

Allan:

As we discussed on the telephone, generally Chemlok 205® primer will protect metal from corrosion. This primer is formulated with corrosion inhibiting chemicals that are active both during vulcanization and after the bond is formed. Chemlok 205 will protect the metal both in the cured and uncured state, but the film is much more resistant to severe environments when fully cured. As with most protective coatings, the chemical resistance increases with crosslink density.

There are a number of improper applications conditions that can lead to deficient protection. Since many of the active ingredients in Chemlok 205 (and in Chemlok covercoats) are dispersed rather than dissolved in solvent, improper mixing can result in poor corrosion protection. It is critical that all Chemlok products be well mixed prior to and during application, particularly if further diluted. Dry film thickness is also critical. Chemlok 205 should be applied in the range of 0.2—0.4 mils. Generally, the higher the film thickness, the better the corrosion protection. Care should be taken not to exceed 0.5 mils, as cohesive failure in the primer film could occur.

Excessive heat could overwhelm the ability of Chemlok 205 to scavenge corrosion inducing chemicals. Even sporadic exposure of bonded assemblies to temperatures in excess of 400°F could lead to thermal decomposition of primer and covercoat. Rust could occur under these circumstances.

Generally, the rubber serves to protect the bondline from aggressive environments. Normally we conduct salt fog resistance tests on bonded assemblies rather than on the primer or primer/covercoat films. When this type of testing is conducted, we score the bondline and expose the metal edges to increase the difficulty of the test. We have conducted a limited number of tests on films alone. The results of at least two of these are enclosed. When this type of test is conducted, the cured film is scored to expose the metal. Generally rust will initiate at the score line.

In EL-1315, metals were primed but the primer was neither cured nor scored. In the second report, the Chemlok 205 films were cured at various temperatures. In this work, two lots of regular Chemlok 205 were compared to Chemlok 205A. Chemlok 205A is a solvent modification of Chemlok 205. The active ingredients are the same. Although the film thicknesses are relatively high, you can see that the environmental resistance does improve when the Chemlok 205 is adequately cured. Higher temperature cures should lead to increased crosslink density. Even after a period of 30 days in our salt fog chamber, much of the Chemlok 205 remains intact.

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Allan, Scott mentioned that this rust was discovered after the rubber insulation had been removed with a high pressure water washout. With such a method, is a possibility that the rust could have formed as a result of this recovery process? Failure analysis is very difficult and we frequently find it impossible to tell whether rust is a result of improper application or whether it formed after the bond failed.

Please feel free to call, if you have additional questions.

Sincerely,

Karen M Bond

Karen M. Bond
Senior Technical Service Representative
Elastomer Products Division

cc: Scott Mildenhall
Thiokol Space Operations
P. O. Box 707
Mailstop L-50
Brigham City, UT 84302-0707

E. L. Polaski
F. L. Lanting
R. D. Abbott

A. Ols[o]n memo

30 Day Salt Spray
Comparison of Chemlok 205 and Chemlok 205A

Purpose: Determine salt spray resistance of Q-panels coated with Chemlok® 205.

Primers: Chemlok 205, lot HLA
Chemlok 205A, lot HJA
Chemlok 205, lot JCB

Conditions: Primers were baked under the following conditions:

10' @ 250°F
10' @ 300°F
10' @ 350°F
10' @ 400°F

Procedure: Coated Q-panels with Chemlok 205 lots (two Q-panels per test) and taped off tops to protect from corrosion. Front and back was scored with an X with a razor blade.

Film thicknesses were determined:

Chemlok 205, lot HLA	≈ 0.60 mils	
Chemlok 205A, lot HJA	≈ 0.09 mils	Dipped at full strength
Chemlok 205, lot JCB	≈ 0.50 mils	

After the 30 day period in the salt spray the samples were taken out and wiped down. A putty knife was used to remove deposits and excessive peeling and chipping. A final evaluation is below. Each evaluation is an average of two Q-panels.

Temp. Bake	Chemlok 205A, lot HJA	Chemlok 205, lot JCB	Chemlok 205, lot HLA
250°F	2% primer intact 88% corroded primer 10% bare metal	5% primer intact 80% corroded primer 15% bare metal	10% primer intact 80% corroded primer 10% bare metal
300°F	50% primer intact 40% corroded primer 10% bare metal	80% primer intact 10% corroded primer 10% bare metal	85% primer intact 5% corroded primer 10% bare metal
350°F	70% primer intact 25% corroded primer 5% bare metal	75% primer intact 10% corroded primer 15% bare metal	85% primer intact 5% corroded primer 10% bare metal
400°F	75% primer intact 20% corroded primer 5% bare metal	80% primer intact 10% corroded primer 10% bare metal	90% primer intact 8% corroded primer 2% bare metal

LORD memo 5 Feb '93

Date: 08/22/91 Investigation Number: EL-1315

TEST PROCEDURE:

Substrate: GBS (Grit blasted steel) coupons, vapor degreased and coded.
ZPS (Zinc phosphatized steel), no surface prep or degreasing.

Adhesives: All adhesives were dip applied to coupons. The first group was coated with CH610 (used as a primer). The second group was a one-coat system without CH610.

Adh.	Film Thickness (GBS - ZPS)
CH205	0.35 - 0.45
TY-PLY BN	0.60 - 0.65
TS1677-27	0.17 - 0.25
B2772-34	0.12 - 0.19
EP5880-11	0.03 - 0.19
CH802	0.98 - 0.80
CH217	0.50 - 0.60
CH610	< 0.1

-------KEY------
SR = Spotty Rust

Test: Exposure to outside weather until rust appears.

NOTE: Seven days of exposure was duration of test. Coated metal coupons were evaluated for extent of rust formation on both sides of the test coupon.

ZPS:	NO PRIMER	W/CH610 PRIMER
CH205	No rust. No flaking.	No rust. <20% of CH205 film flaked from primed surface.
EP5080-11	No rust. No flaking.	No rust. <10% flaking.
B2772-34	10-25% SR. No flaking.	10-25% SR. No flaking.
CH802	No rust. No flaking.	10% rust at flaked area. <20% flaking.
CH217	No rust. No flaking.	No rust. No flaking.
TY-PLY BN	No rust. No flaking.	No rust. 5% flaking.
TS1677-27	No rust. <1% flaking.	No rust. <10% flaking.
CONTROL	10-50% rust (uncoated coupon).	

GBS:	NO PRIMER	W/CH610 PRIMER
CH205	No rust. No flaking.	No rust. <5% flaking.
EP5880-11	5-10% light rust*. No flaking.	5-10% light rust*. No flaking.
B2772-34	No rust. No flaking.	50-75% rust. <5% flaking.
CH802	No rust. <20% flaking. 50-75% black spots**.	No rust. <10% flaking. 50-75% black spots**.
CH217	No rust. No flaking.	No rust. No flaking.
TY-PLY BN	No rust. <1% flaking.	No rust. No flaking.
TS1677-27	No rust. No flaking.	No rust. <10% flaking.
CONTROL (uncoated coupons)		80-100% rust.

* May be due in part to low film thicknesses.

**Black spots are characteristic of CH802 film. CH802 is a waterborne primer. Components in the primer undergo a galvanic reaction with grit blasted surfaces that result in some phase separation as the film dries. This does not affect performance.

LORD memo 5 Feb '93

LORD

Lord Corporation
Chemical Products Division
2000 West Grandview Blvd.
P. O. Box 10038
Erie, PA 16514-0038
814:868-3611
Telex: 291935
FAX: 814:864-3452

Mr. Scott Mildenhall
Thiokol Corporation
Space Operations
Mail Stop L-50
P. O. Box 707
Brigham City, UT 84302-0707

February 5, 1993

Dear Mr. Mildenhall:

Karen Bond has asked me to address two questions that you had regarding the MSDS for CHEMLOK 205. These questions deal with the content of ethyl benzene in the technical grade of xylene that we purchase, and the reporting of formaldehyde on the MSDS.

1. Xylene/Ethyl Benzene

As Karen may have told you, in late 1992 we were made aware of the fact by our supplier MSDS for xylene that our purchased technical grade of Xylene contains 19% ethyl benzene rather than being 100% xylene. This discovery caused us to immediately revise affected product MSDS's (including CHEMLOK 205) and forward these MSDS's to customers with the attached cover letter.

Please be advised that this change on the MSDS does not in any way represent a change in the formulation for CHEMLOK 205. We have in the past and will continue to use this technical grade xylene in our products. As the enclosed cover letter notes, this change does affect reporting requirements for SARA 313 purposes.

2. Formaldehyde In Section II of the MSDS

As you are aware, formaldehyde now appears on the new version of the CHEMLOK 205 MSDS at 1% and had not appeared on previous MSDS's. The reason for this change is that we have recently phased in a new computer-based MSDS generation system with enhanced reporting capabilities. This has enabled us to more accurately define the actual (in can) ingredients of our products, especially those ingredients at very low levels such as in this case of formaldehyde.

Additionally for your information, the actual amount of formaldehyde in CHEMLOK 205 is 0.19% by weight. Our MSDS system rounds up to 1% any amount over 0.1% in Section II. Again, please note that this does not reflect any change in formulation.

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LORD

We hope that this adequately answers your questions on CHEMLOK 205 and apologize for any inconvenience that these changes may have caused. If you need additional information, please call me at 814-868-3611, Ext. 3524.

Sincerely,

John A. Misterovich

John A. Misterovich
Product Safety Specialist

/slh
cc: K. M. Bond
DDH/DHG/KBK/CHEMLOK File

FORM 12A 7/

LORD

LORD Corporation
Chemical Products
Route 98 South Street
Saegertown, PA 16433

FAX 814-763-4318

DATE: February 3, 1993

No. Of Pages: 1

PHONE 814-763-2345

TO (COMPANY): Thiokol Corporation
ATTENTION OF: Wayne Dodd
FAX NUMBER: 801-863-3848
FROM: Steve Marshall
Manager, Quality Assurance Section
Elastomer Products

REFERENCE: Follow-up to 2/3/93 letter (FAX)

The chronology for the Chemlok 205 and Chemlok 220 only goes back to 1985, not 1979 as requested. Our policy was to keep the primary batch record for seven years. This has recently been revised to ten years.

Steve

LORD

Lord Corporation
Chemical Products Division
South Street
P. O. Box 556
Saegertown, PA 16433-0556
814:763-2345
TWX: 510-6952000
FAX: 814:763-4318

February 3, 1993

Mr. Wayne A. Dodd
Buyer
Space Operations Procurement
Thiokol Corporation
P.O. Box 707
Brigham City, UT 84302-0707

Dear Mr. Dodd,

Per your recent request, please find attached a chronology of information indicating the timing of changes made in Chemlok R 205 and Chemlok 220 since 1985. The changes indicated were driven by two forces: environmental/legislative issues and continuous quality improvement issues.

In addition, please provide us with written details concerning the "unbonds" found in the tear down of the thrust bearing. Specifically, we would be interested to learn of the details of the failure mode.

If you have any questions, please do not hesitate to contact either of us.

Sincerely,

S.T. Marshall
Manager, Quality Assurance
Elastomer Products Division

A.J. Clampa
Business Manager
Elastomer Products Division

STM/cb

Chemlok 205: Process, formulation, supplier & specification change history- 1985-1992

Raw materials (Alternate source, process improvements, etc.)

1/88	Carbon Tetrachloride reduction in film former to 1%
1/90	Resin(A) manufacture moved production site, later sold business
3/90	Second source for film former approved
11/91	Carbon Tetrachloride reduction to 0.1% in film former.
6/92	Resin (B) manufacturer site change evaluation begun-on going

Specification:

1/88	Revised bond testing requirements to test only as single coat
6/89	Revised targeted solids from 25.5 to 25.0%
6/90	Rubber test formulation revised due to rubber stock raw material discontinuation.

Formulation:

7/85	Removed Cellosolve Solvent due to potential toxicity concerns.
12/86	Changed solvent system-added Dowanol PM & reduced xylene content.

Process:

1/85	Revised the pigment dispersion and resin A/B addition procedure.

Chemlok 220: Process, formulation, supplier & specification change history-
1985-1992

Raw materials (Alternate source, process improvements, etc.)

1/88	Carbon Tetrachloride reduction in film former to 1%
10/89	Pigment supplier process revision
3/91	Second source for film former approved
11/91	Carbon Tetrachloride reduction to 0.1% in film former

Specification:

10/87	Revised density spec; Revised NR bond procedure

Formulation:

No direct changes outside raw material trace component changes primarily the Carbon Tetrachloride level in the film former

Process:

Essentially no changes

7408

		Supplier (Lord Corp) Lot No.
Lot 0010	7461-0009	TLI (Jan 79)
Lot 0014	7461-0011	WHK (Oct 79)
~~Lot 0014~~	~~7461-0011~~	~~WHK~~
Lot 0015	7461-0012	WLF (Mar. 1980)
Lot 0016	7461-0013	XIG (Oct. 1980)
Lot 0017	7461-0014	XKH
Lot 0018	7461-0015	YBI
Lot 0019	7461-0016	YIA
Lot 0020	7461-0017	YIA
Lot 0021	7461-0018	YKF
~~Lot 0021~~	~~7461-0018~~	~~YKF~~
Lot 0022	7461-0019	ACA
Lot 0023	7461-0020	AIA
Lot 0025	7461-0023	BCA
Lot 0026	7461-0024	CAC
Lot 0027	7461-0025	CJF

(reidentified from 0025)

7408 - chemlok 220 adhesive

Bondline		Supplier (Lord Corp.) Lot No.
P- Lot 0029	7461 - 0027	
P- Lot 0030	" 0028	DLB
P- Lot 0031	" 0030	DLB
P- Lot 0032	" 0031	EEB
P- Lot 0034	" 0032	FBA
P- Lot 0035	" 0033	FEBR
P- Lot 0036	" 0034	GBCR
5- Lot 0037	" 0035	GEAR
5- Lot 0038	" 0036	GEBR
5- Lot 0039	" 0037	GLDR
5- Lot 0040	" 0038	HLBR
5- Lot 0041	" 0038	HLBR
5- Lot 0042	" 0038	HLBR
5- Lot 0043	" 0039	JGBR
5- Lot 0045	" 0043	KAAR

7407

		Supplier (Lord Corp) Lot No.
Lot 0010	7460-0021	WAE (Jan 79)
0011	-0024	WAB
0014	-0027	WHL
~~0014~~	~~-0027~~	~~WHL~~
0015	- 0025	WOB
0016	- 0029	XCO
0017	- 0030	YAG
0018	- 0038	JJ ?
0019	- 0038	YJJ
~~0019~~	~~- 0038~~	~~YJJ~~
0020	— 0051	ADA
0021	— 0052	AFF
0022	— 0054	AGF
0023	— 0041	ACF
0025	— 0059	BED
0026	— 0063	BLA
0027	- 0064	CBC
0028	- 0066	(84 or 85)
0048	- 0135	

7407 - Chemlok 205 primer

Hand [illegible]		Supplier (Lord Corp) Lot No.
P Lot 0029	7460 - 0067	
P Lot 0030	- 0070	
P Lot 0031	- 0070	
P Lot 0032	- 0071	DJD
P Lot 0033	- 0074	DLB
P Lot 0034	- 0079	ELE
P Lot 0035	- 0081	~~ELE~~
P Lot 0036	- 0083	FEJ
P Lot 0037	- 0086	FLF
5 P Lot 0038	- 0100	GGA
5 P Lot 0039	- 0102	HBE
5 P Lot 0041	- 0113	HIL
S Lot 0042	- 0114	JBG
S Lot 0043	- 0115	JHE
S Lot 0044	- 0116	JLE
S Lot 0045	- 0131	KFD
S Lot 0046	- 0133	KHA

STOCK # 6591 = TR3005A Elastomer

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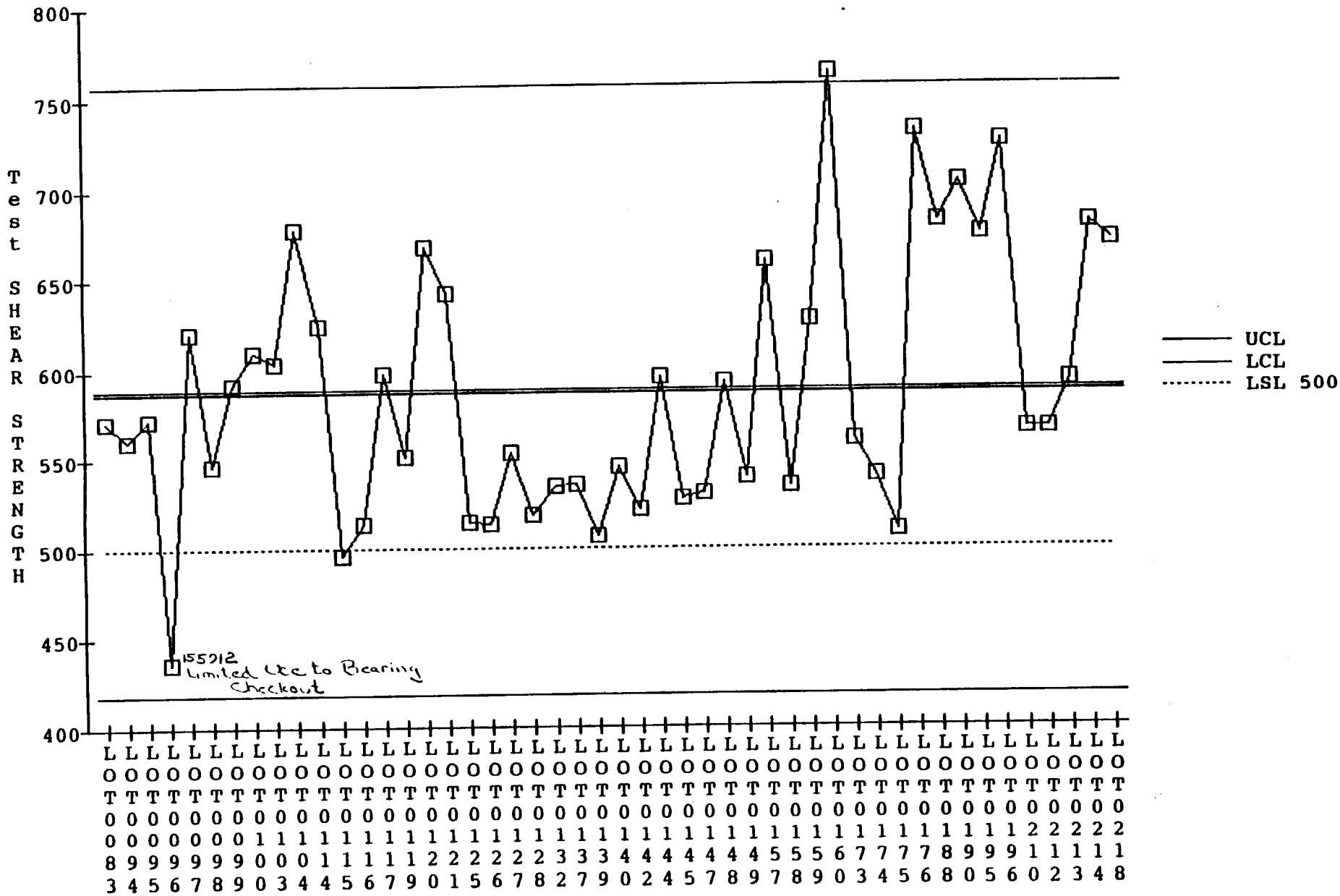

Prepared by Raw Materials PQE 25-FEB-93

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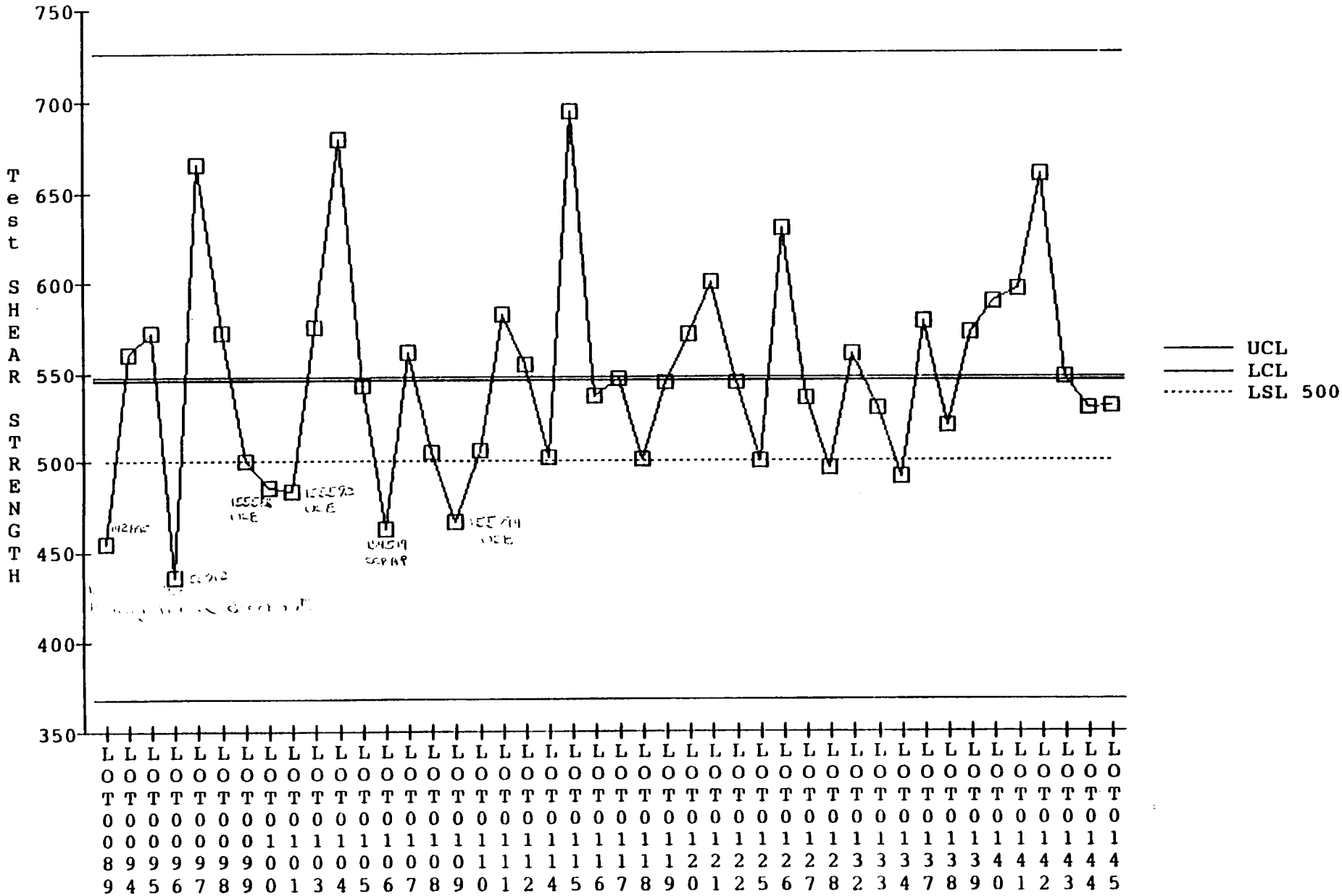

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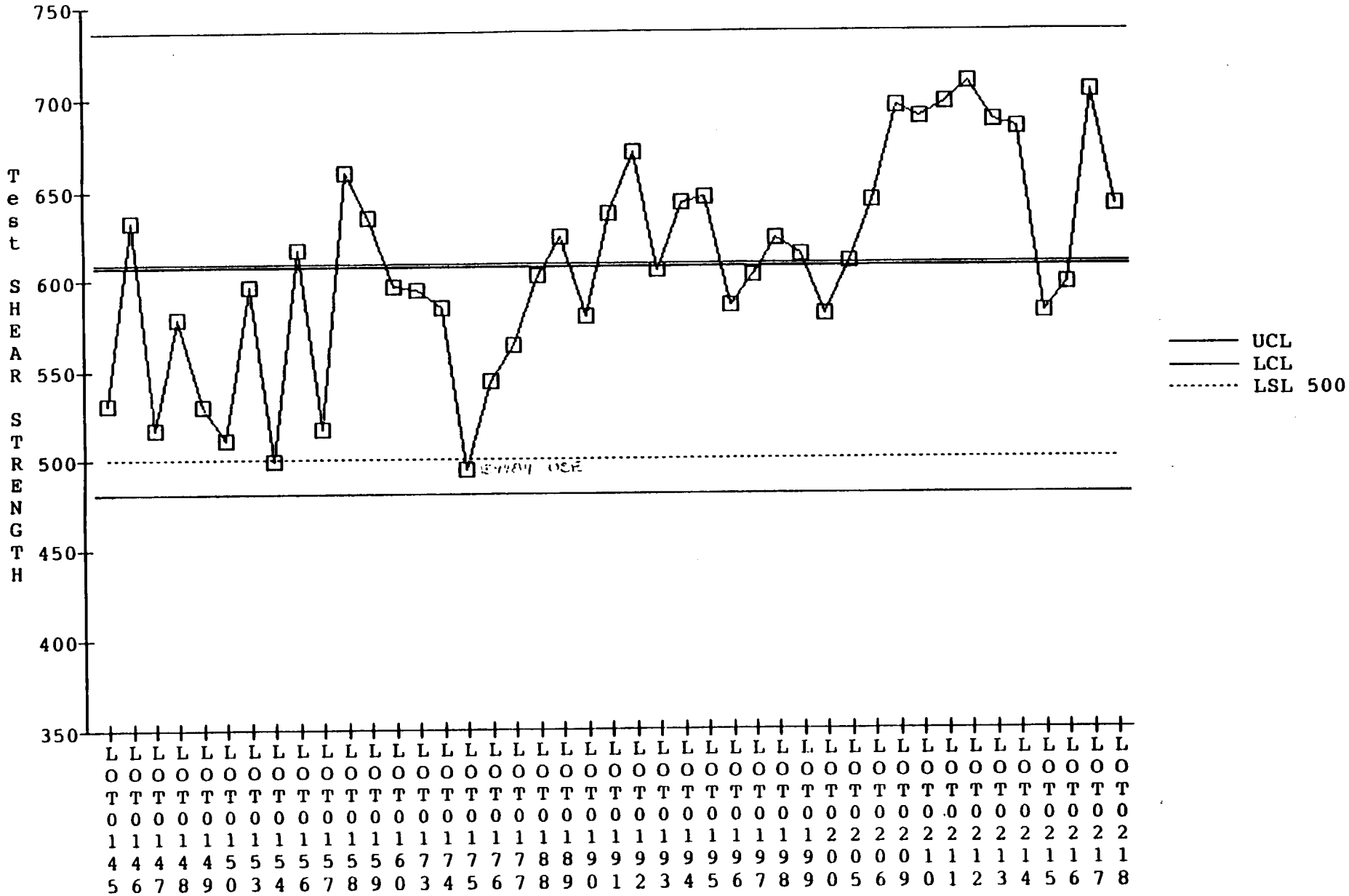
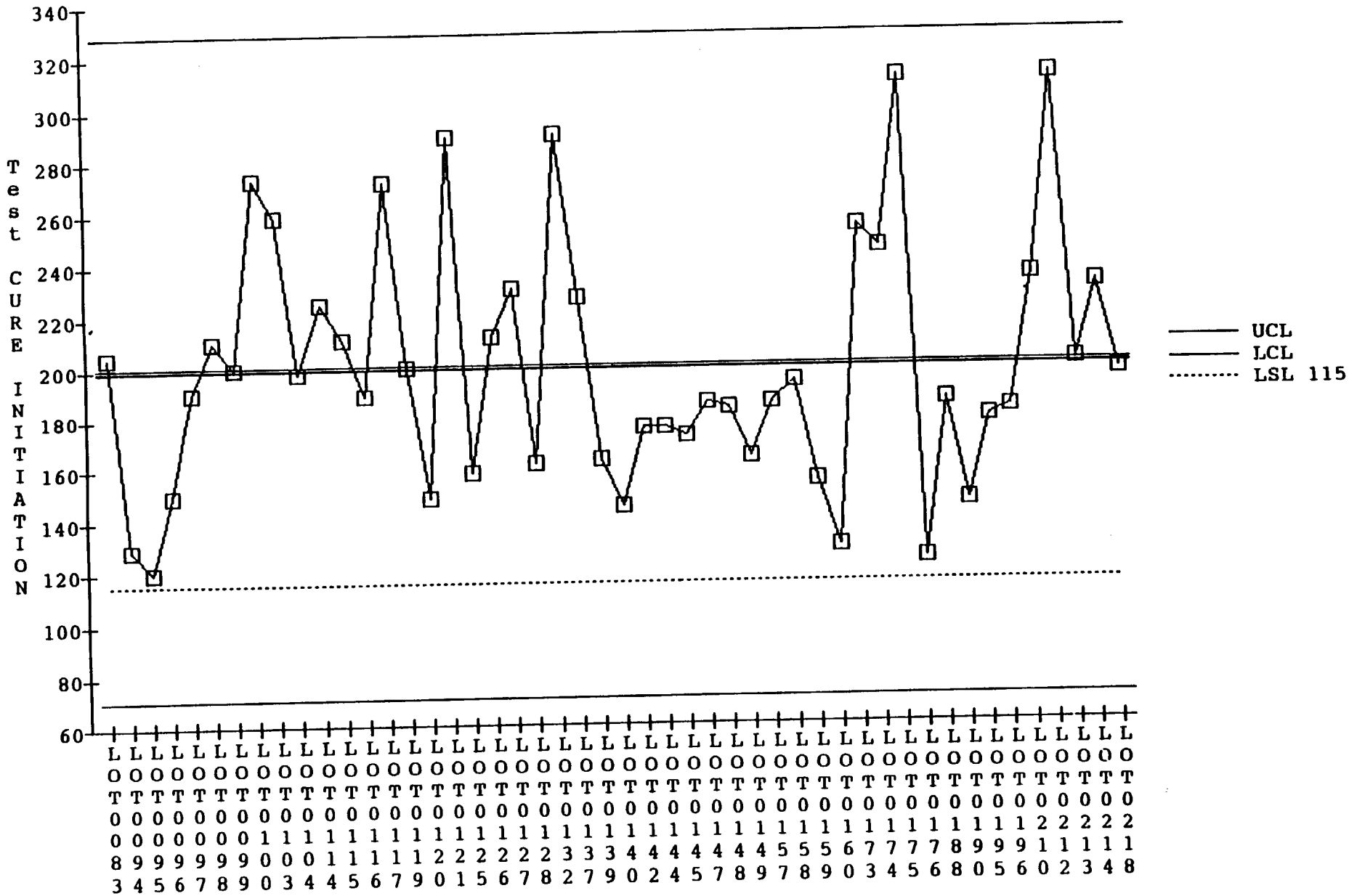


Prepared by Raw Materials PQE 25-FEB-93

I chart for 6591_3_T0458



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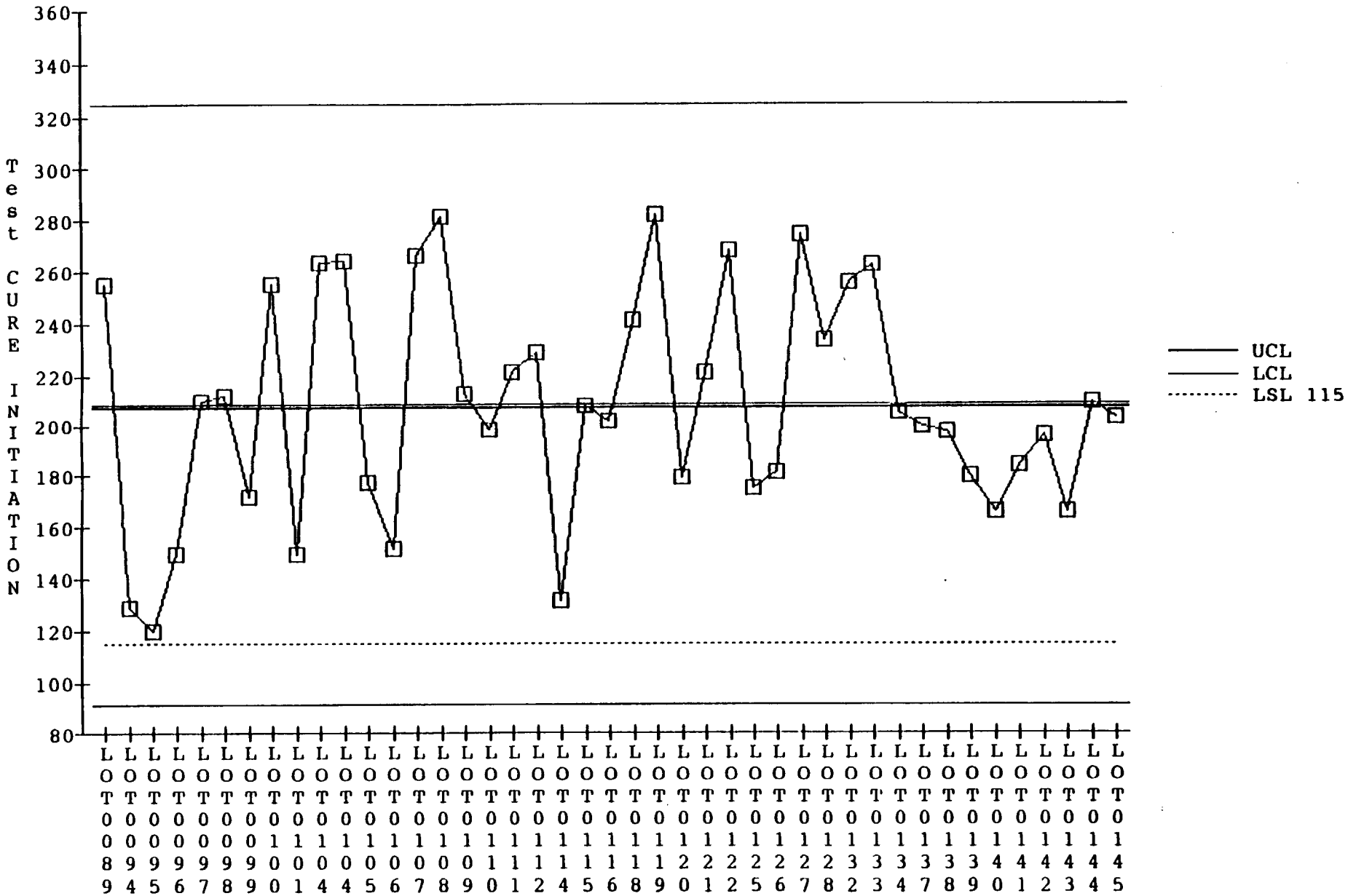

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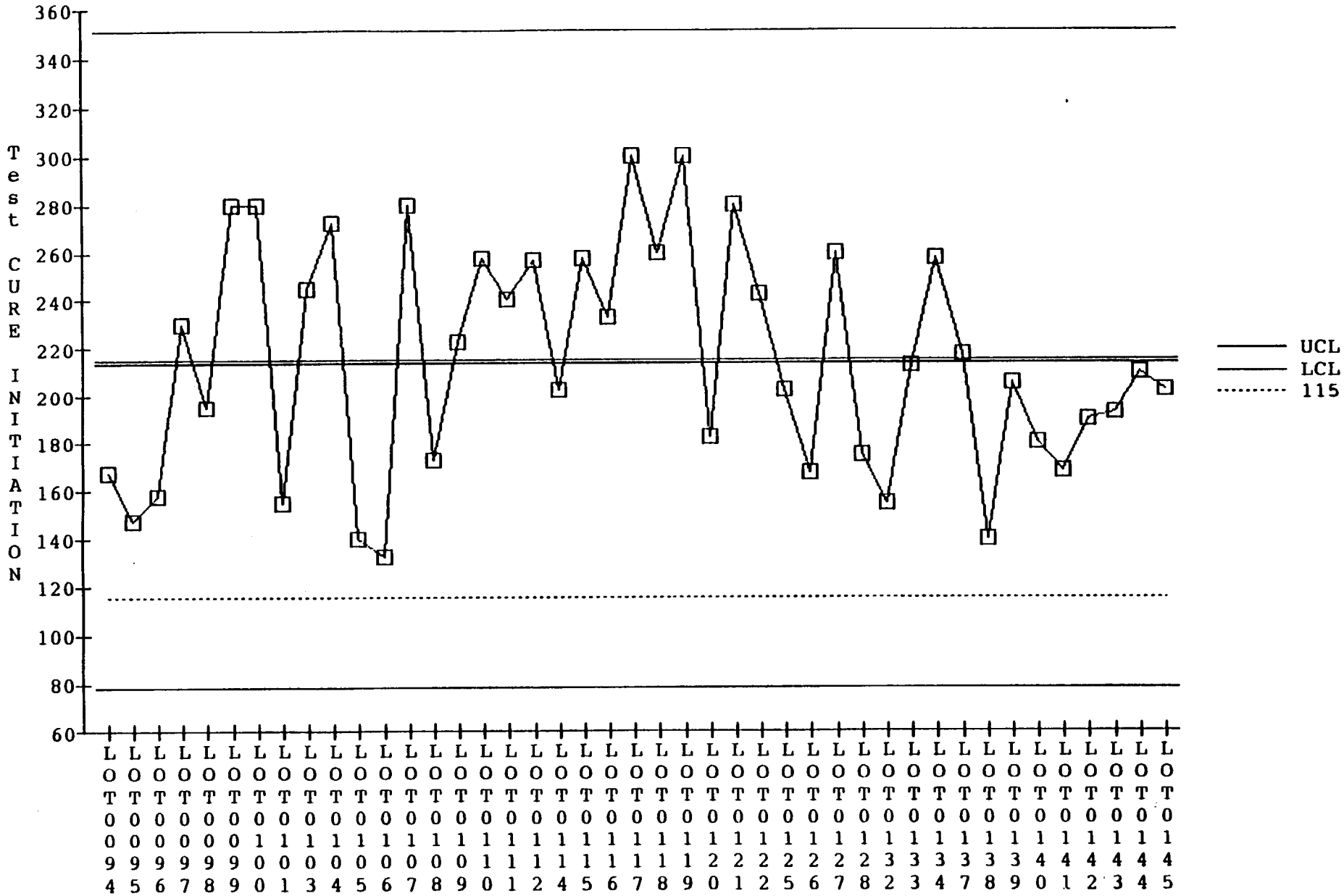

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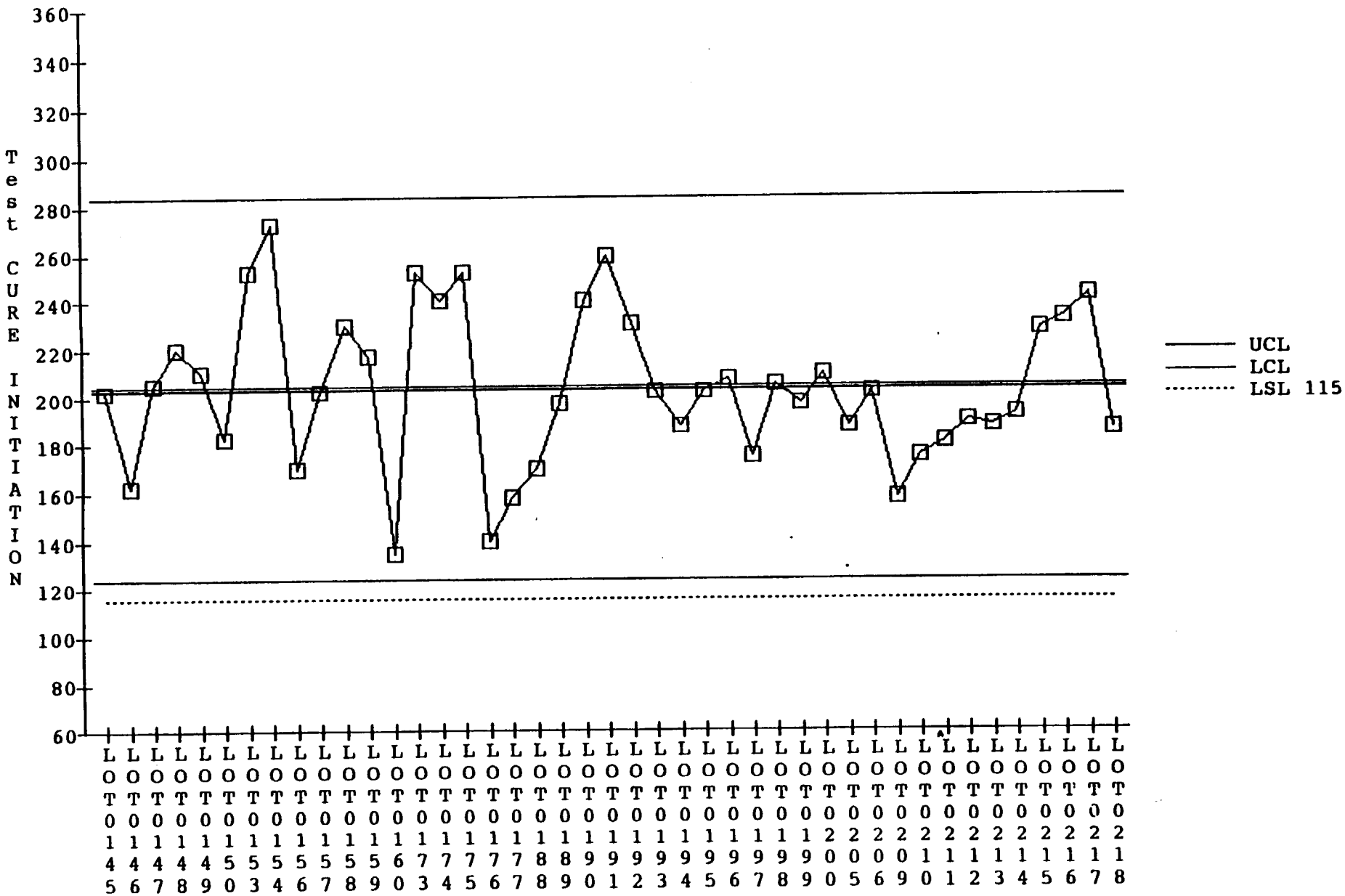

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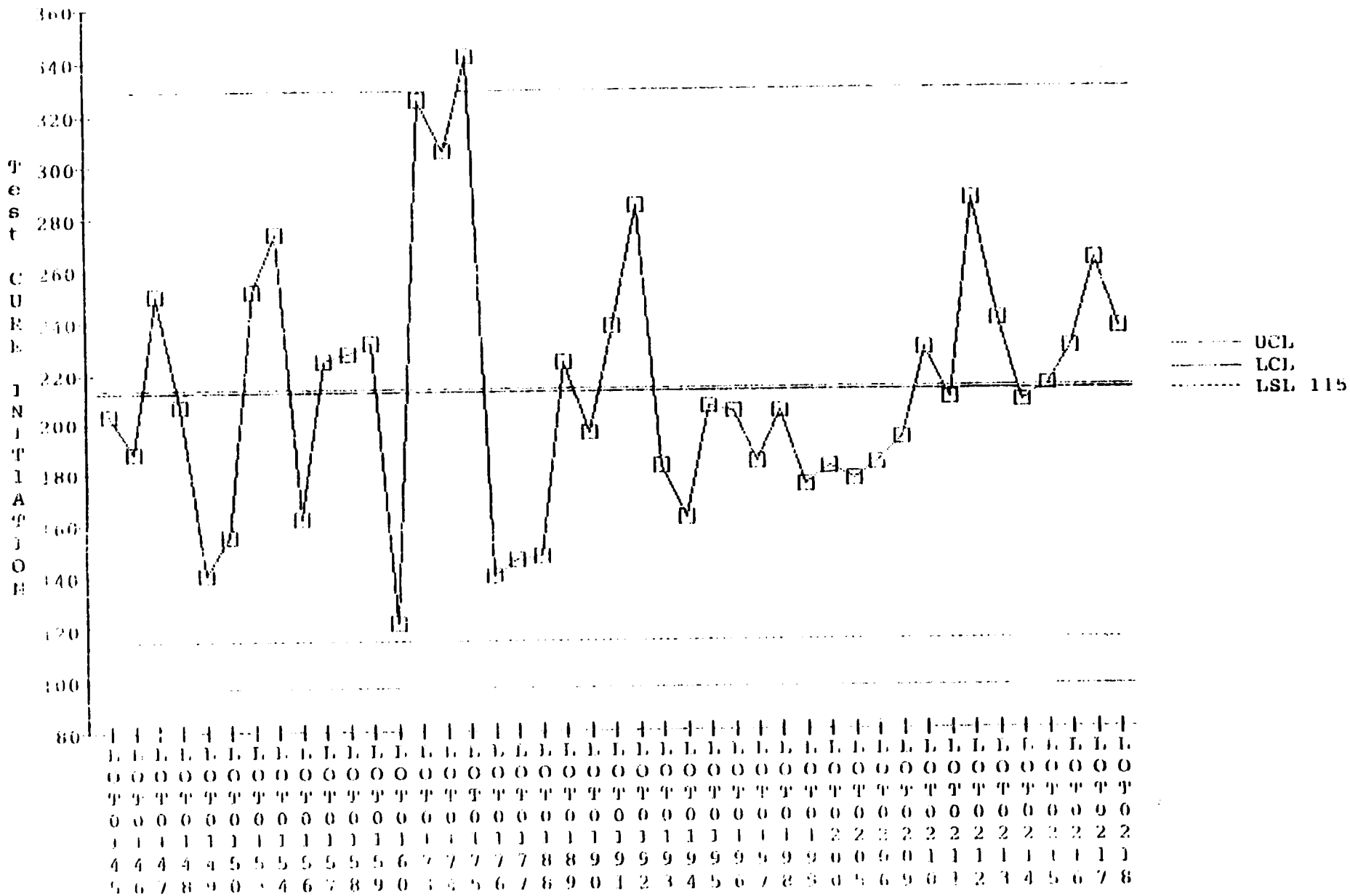

Prepared by Raw Materials PQE 25 FEB 93

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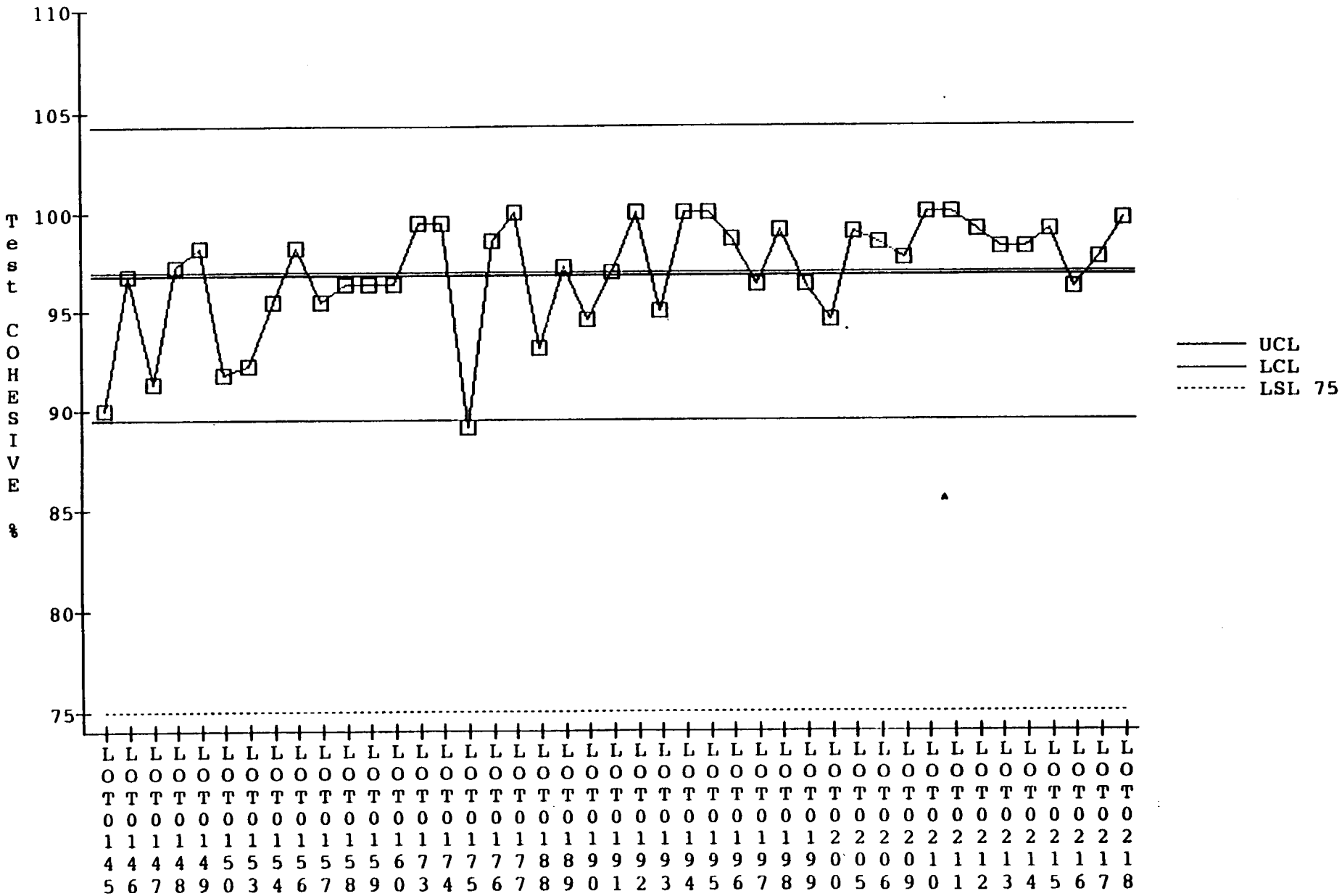

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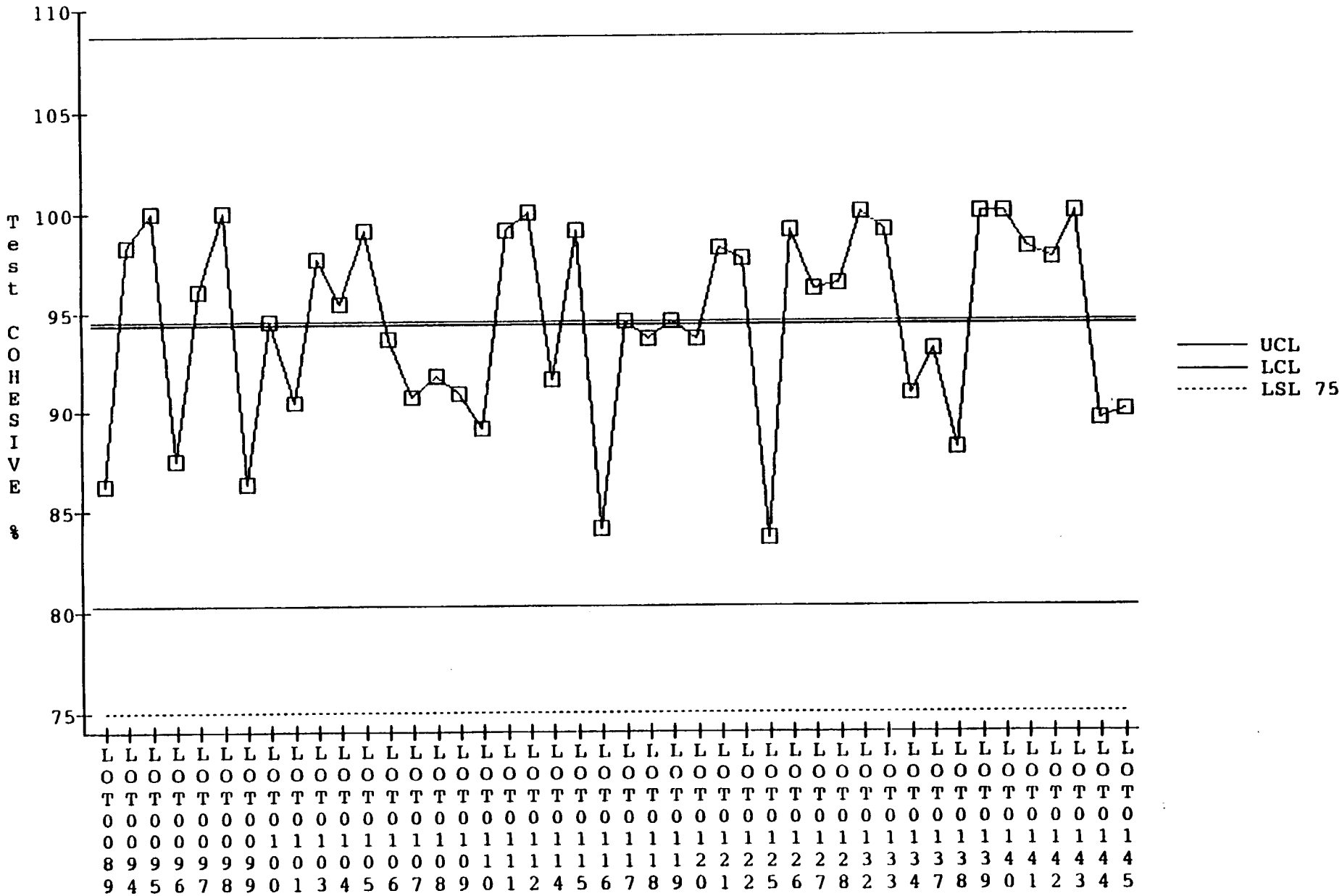

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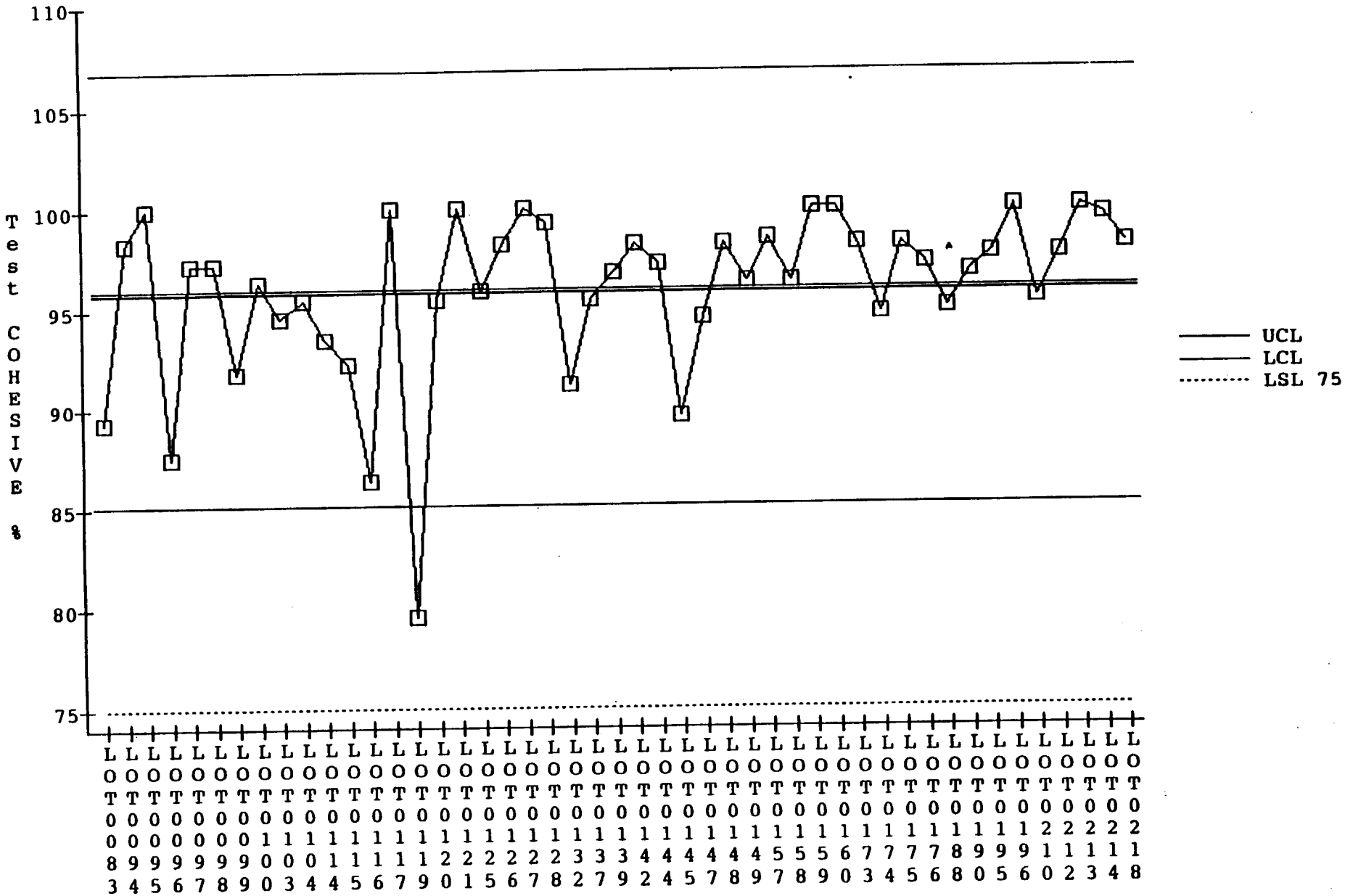

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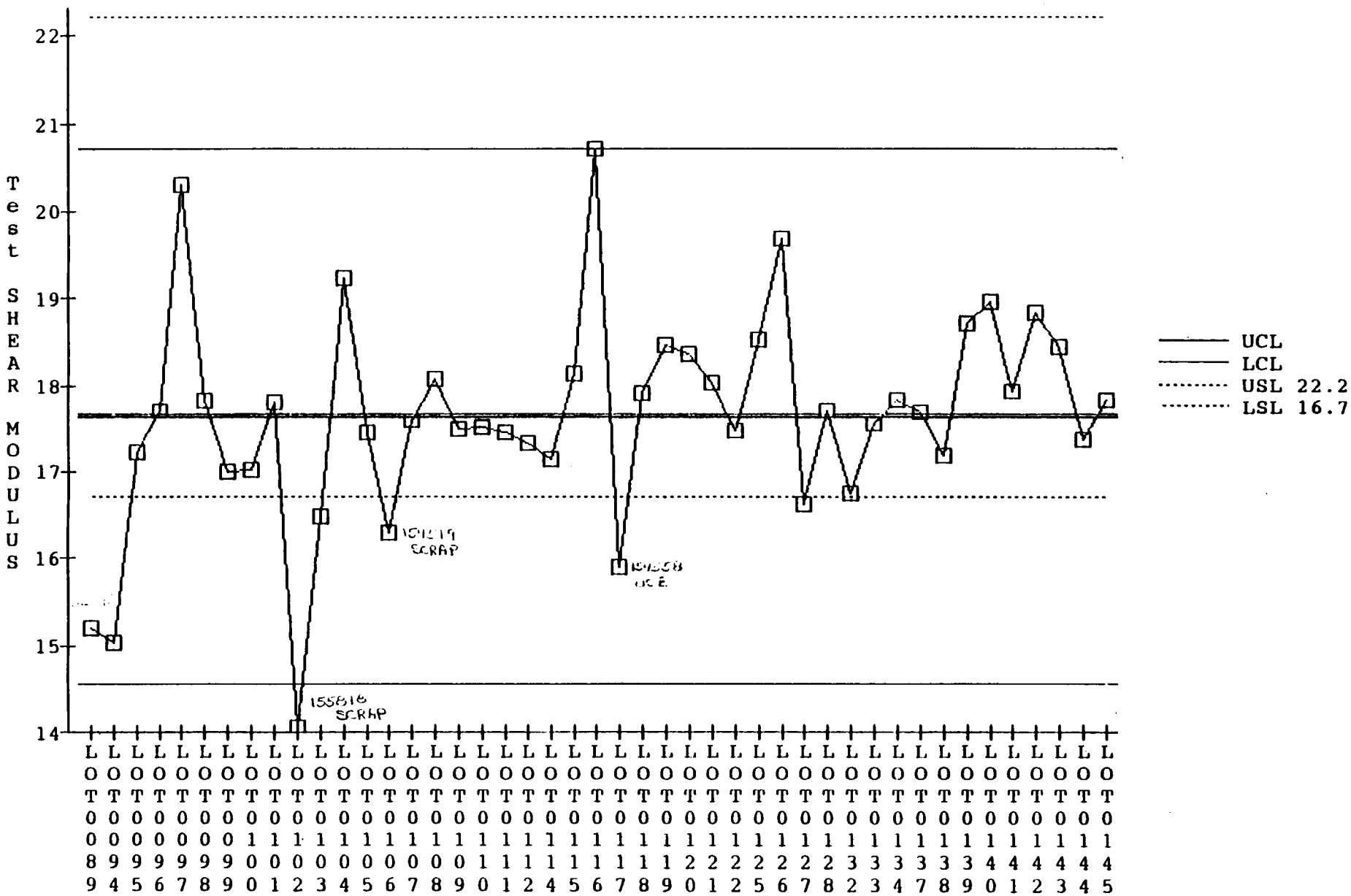

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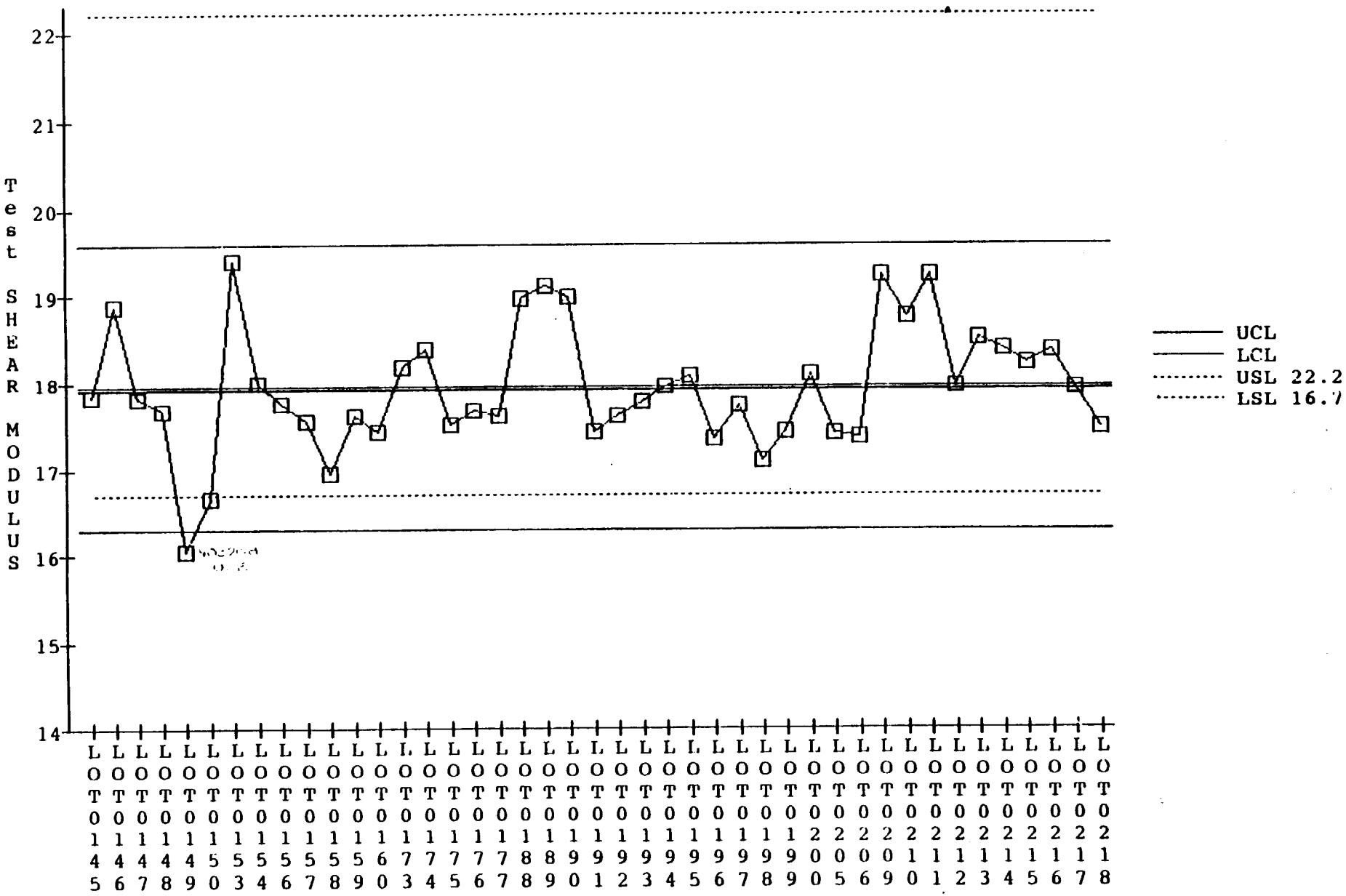

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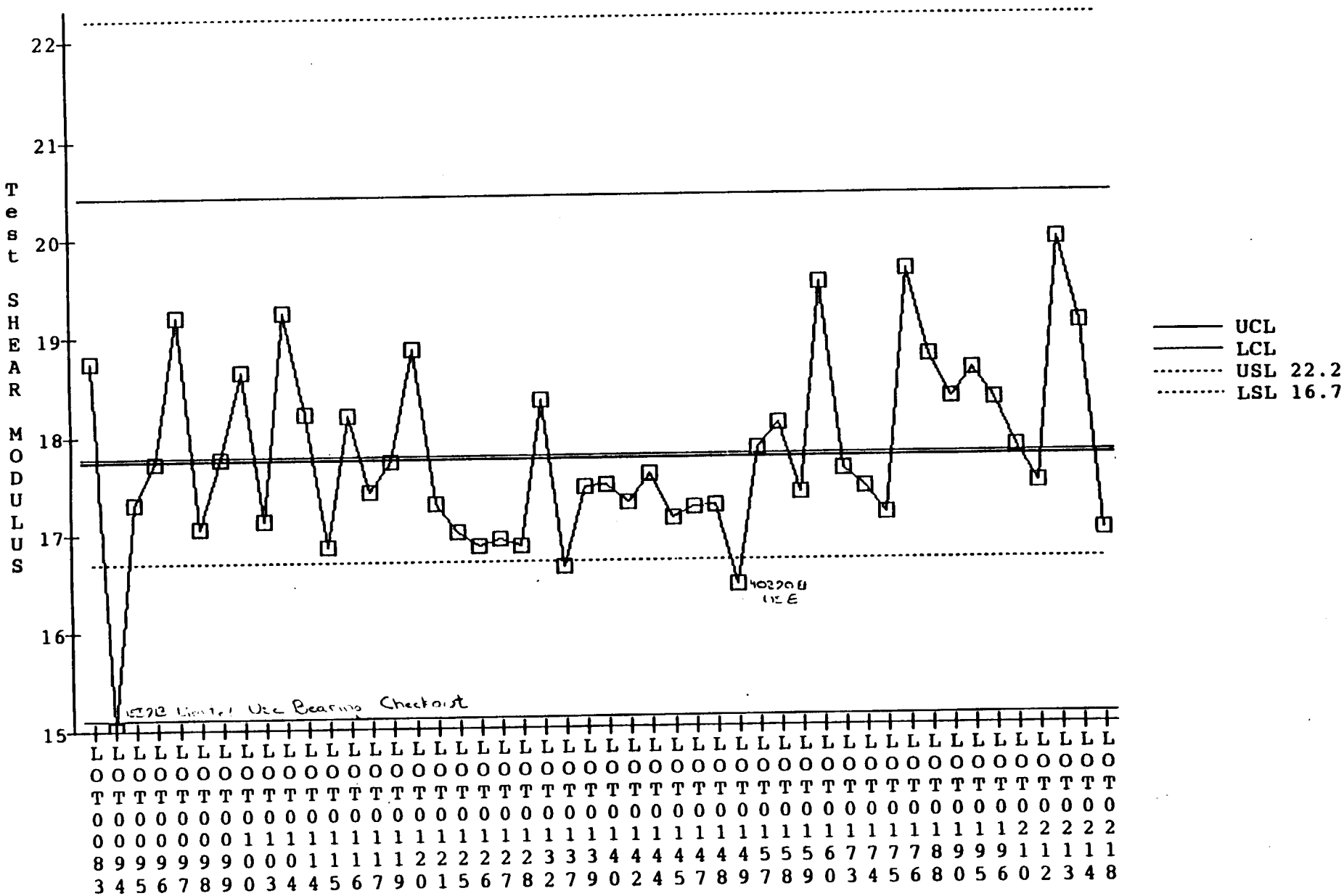

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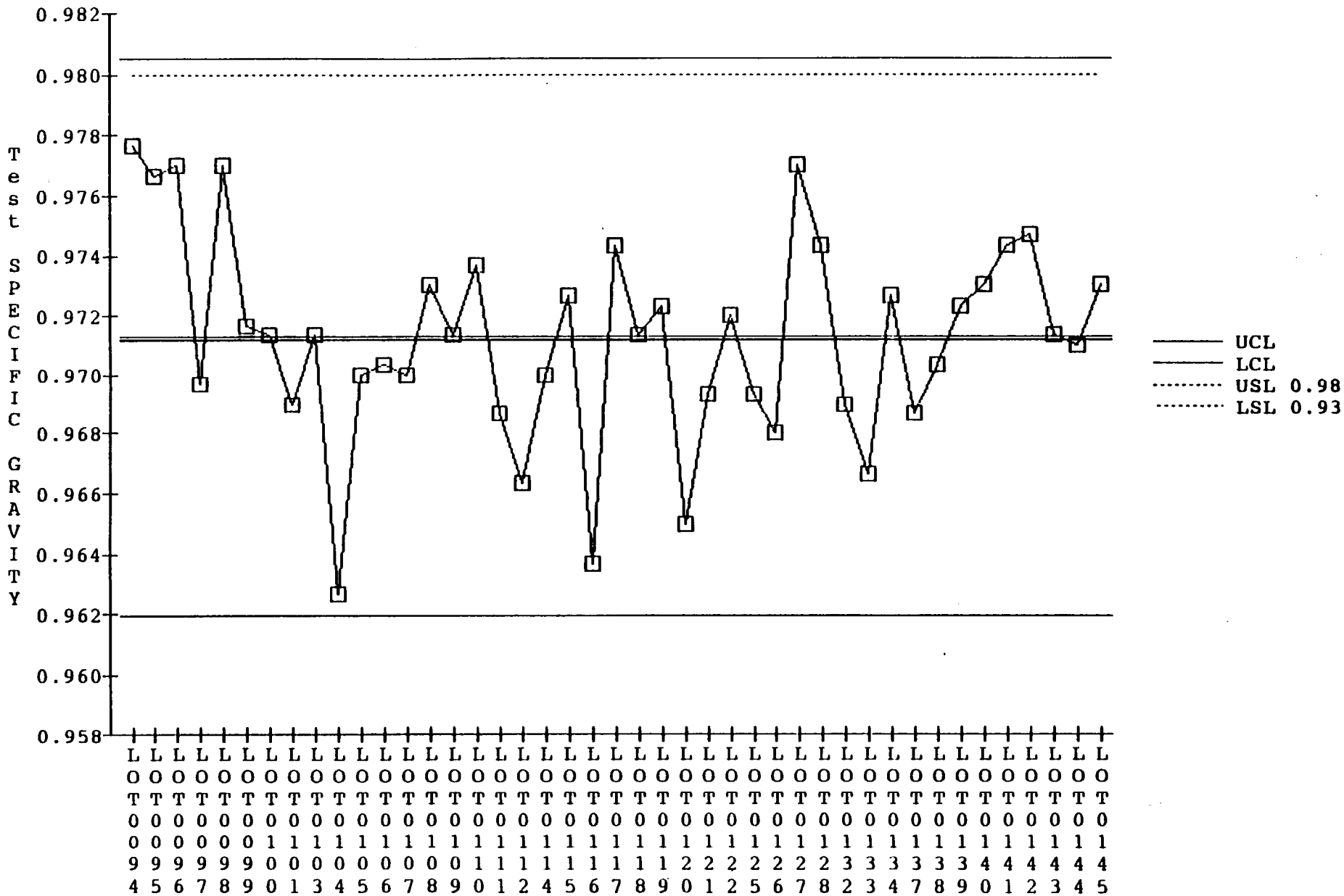

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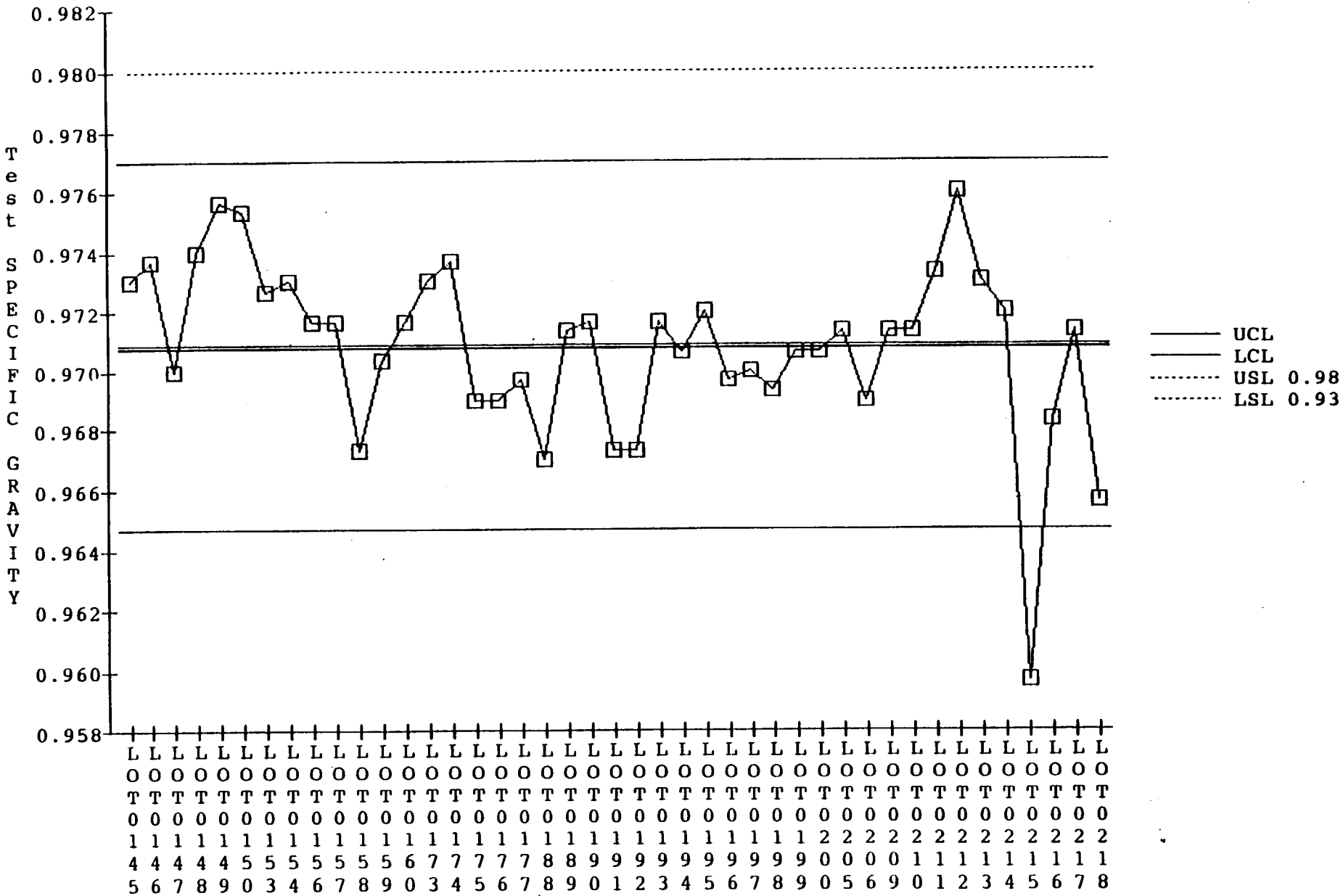

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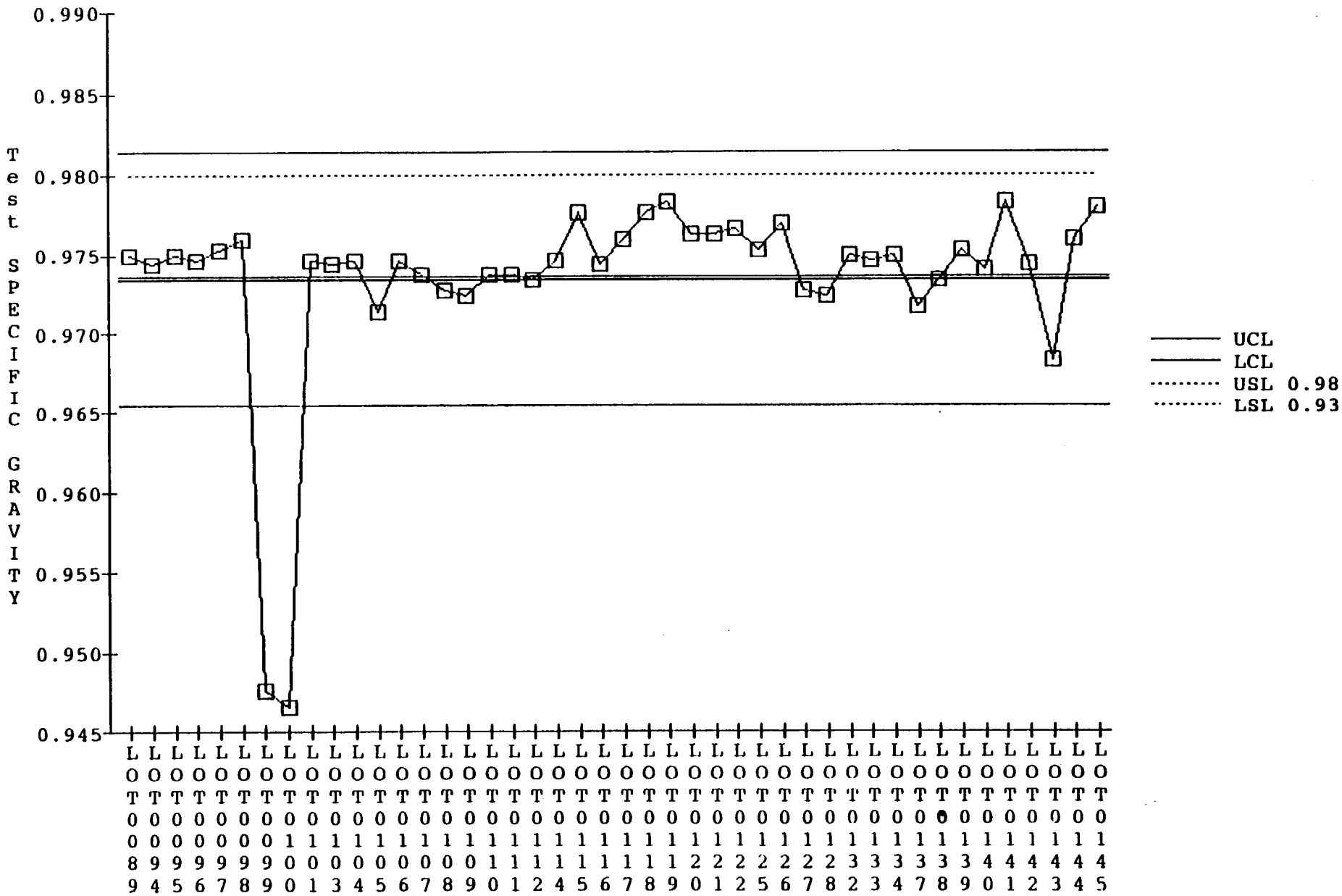

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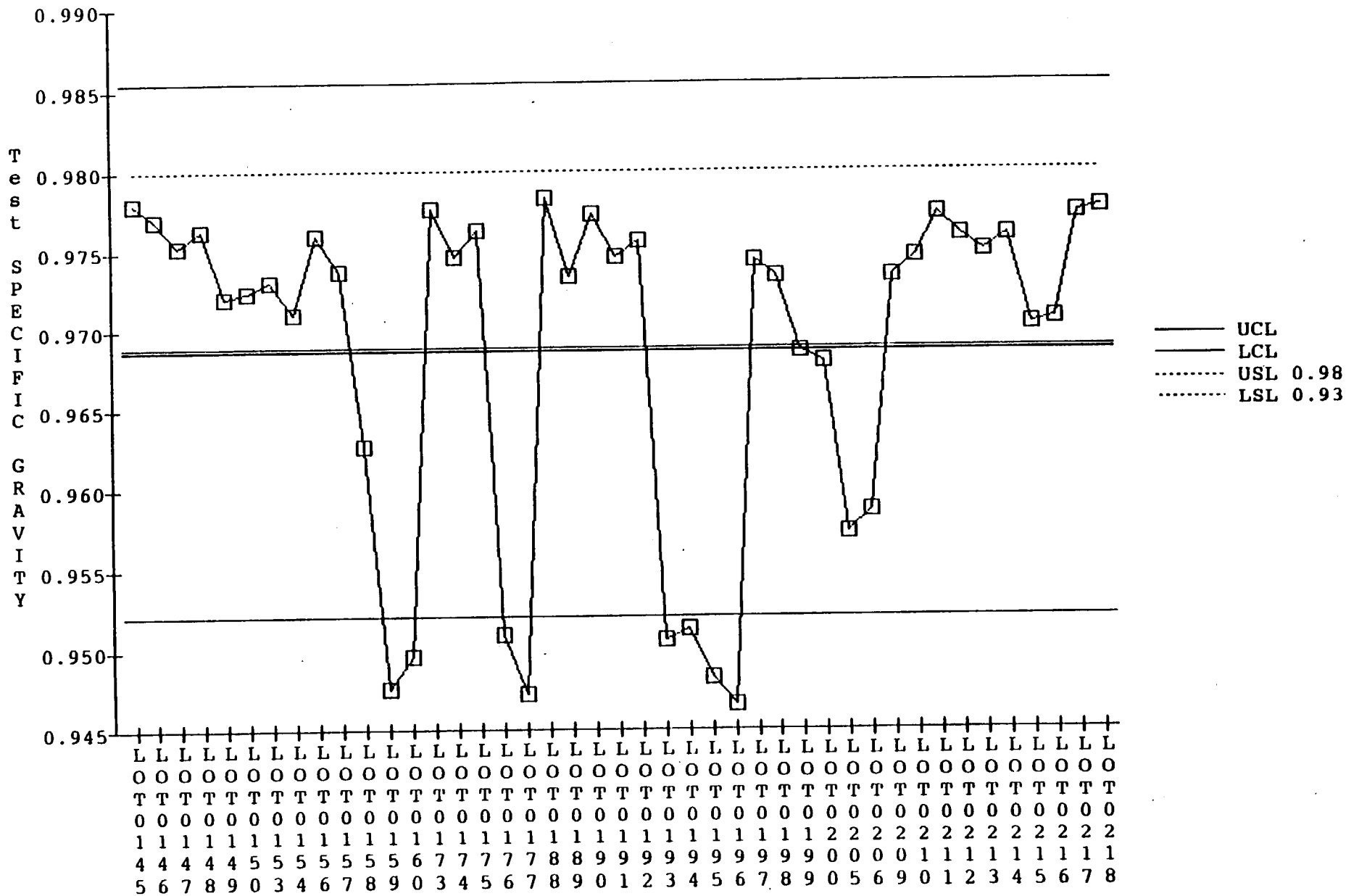

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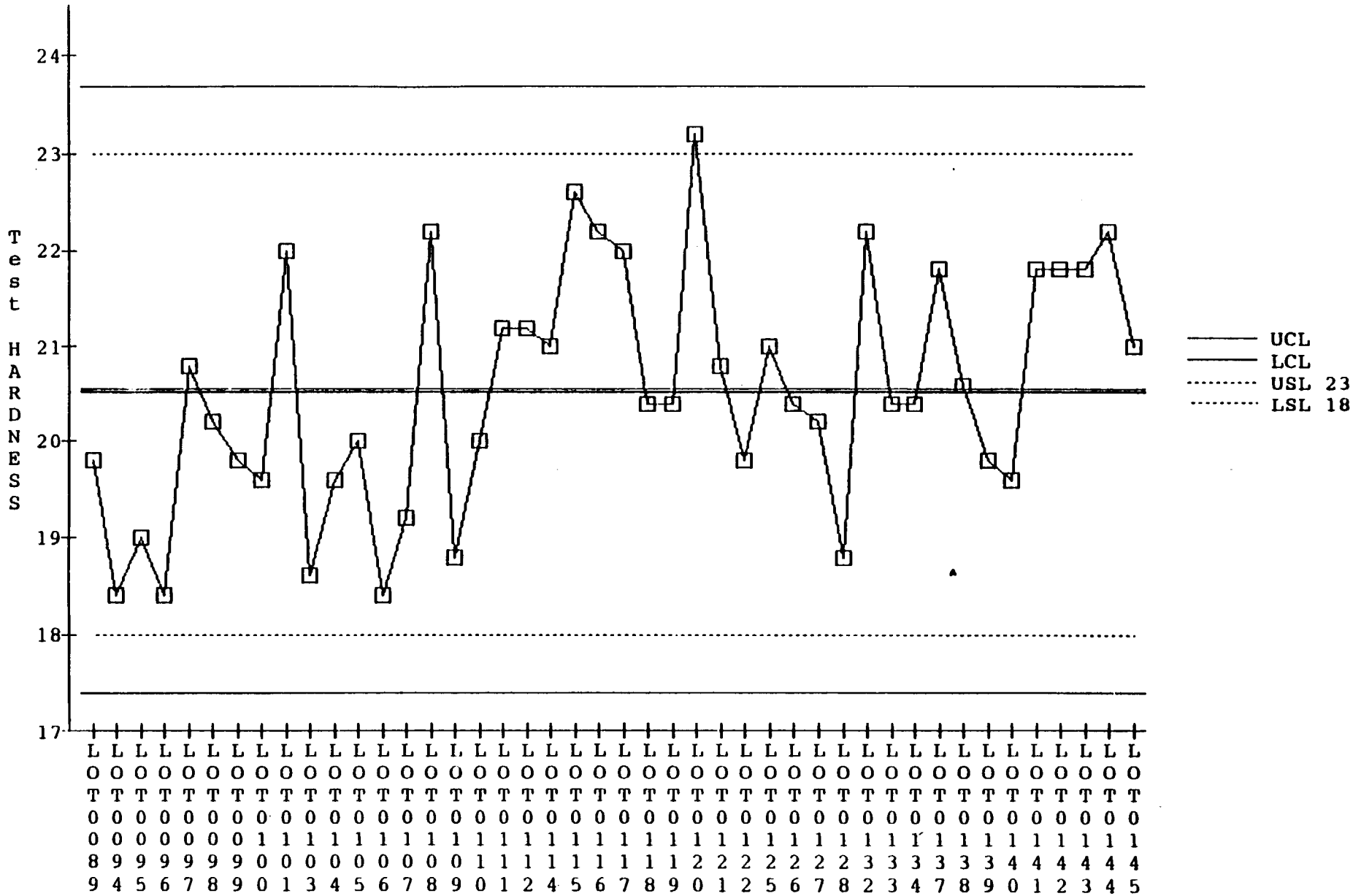

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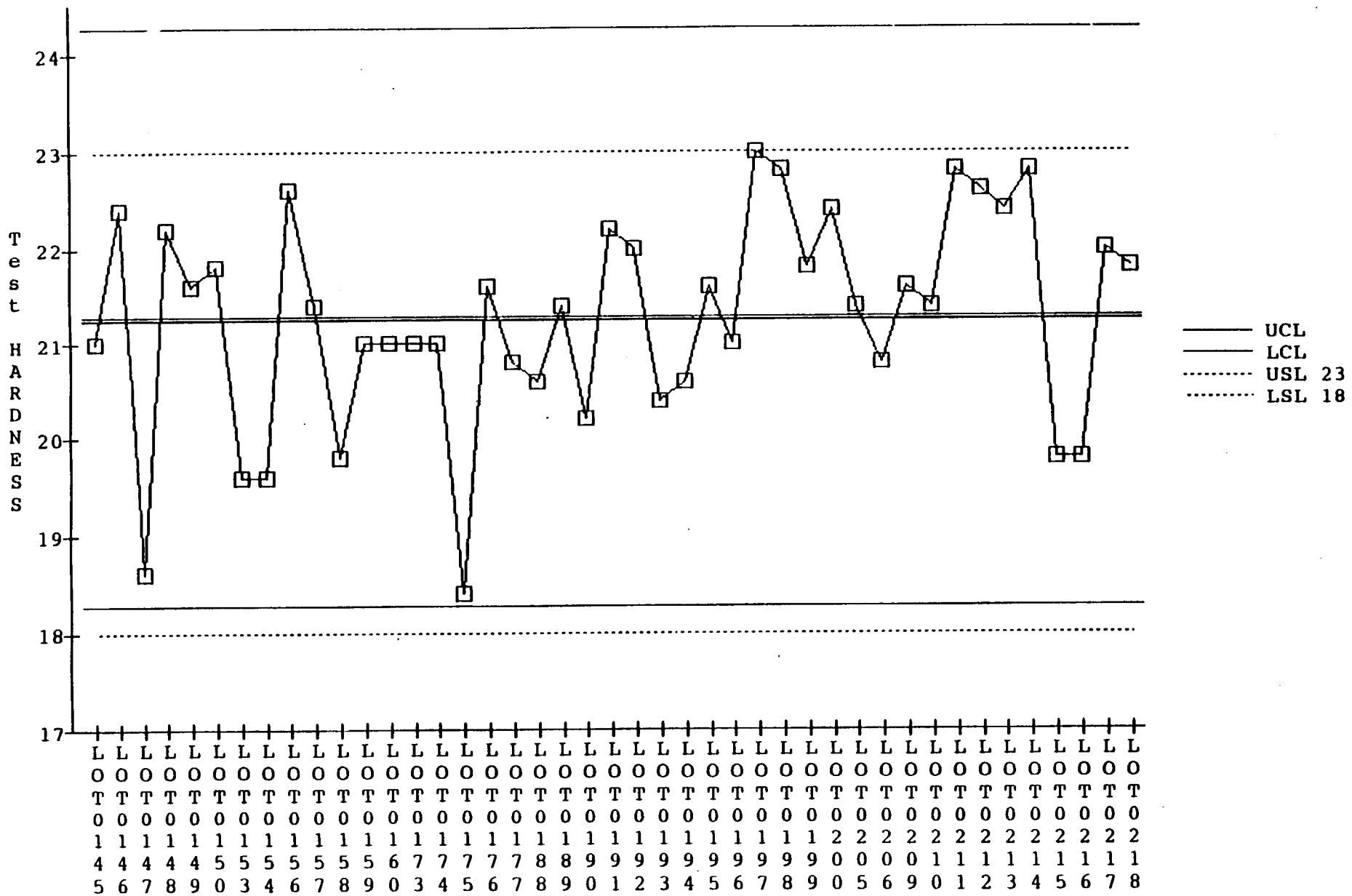

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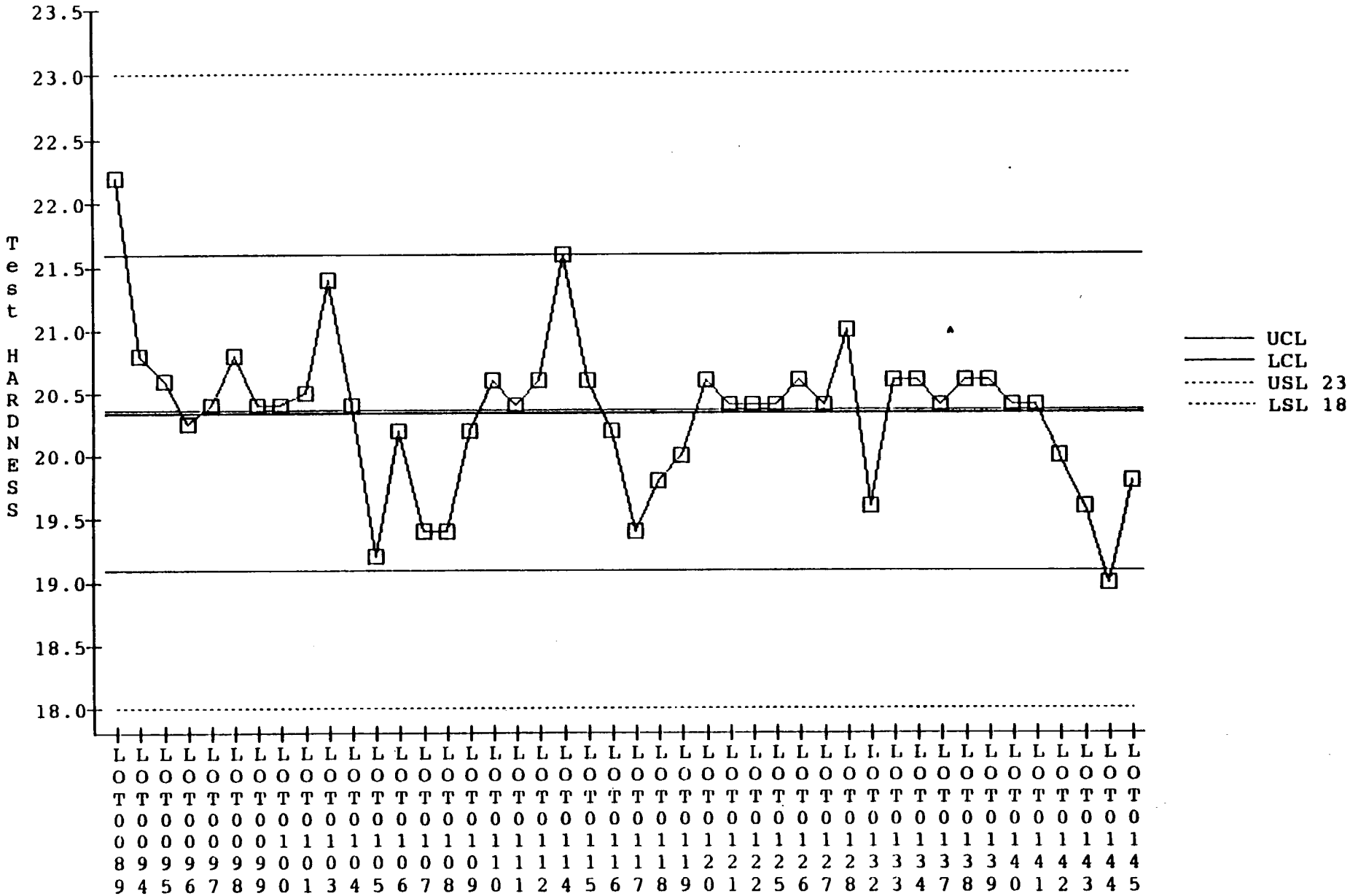

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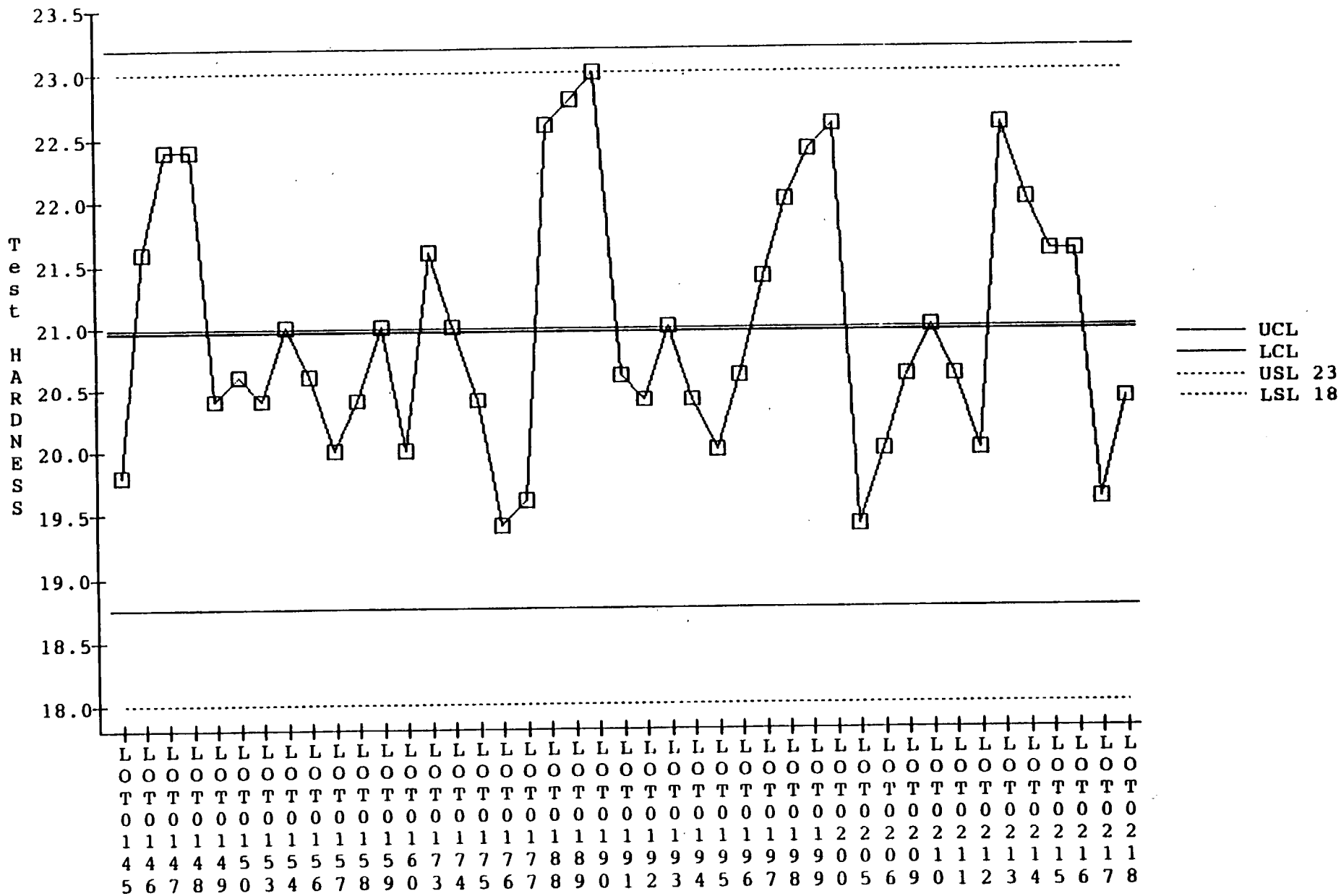
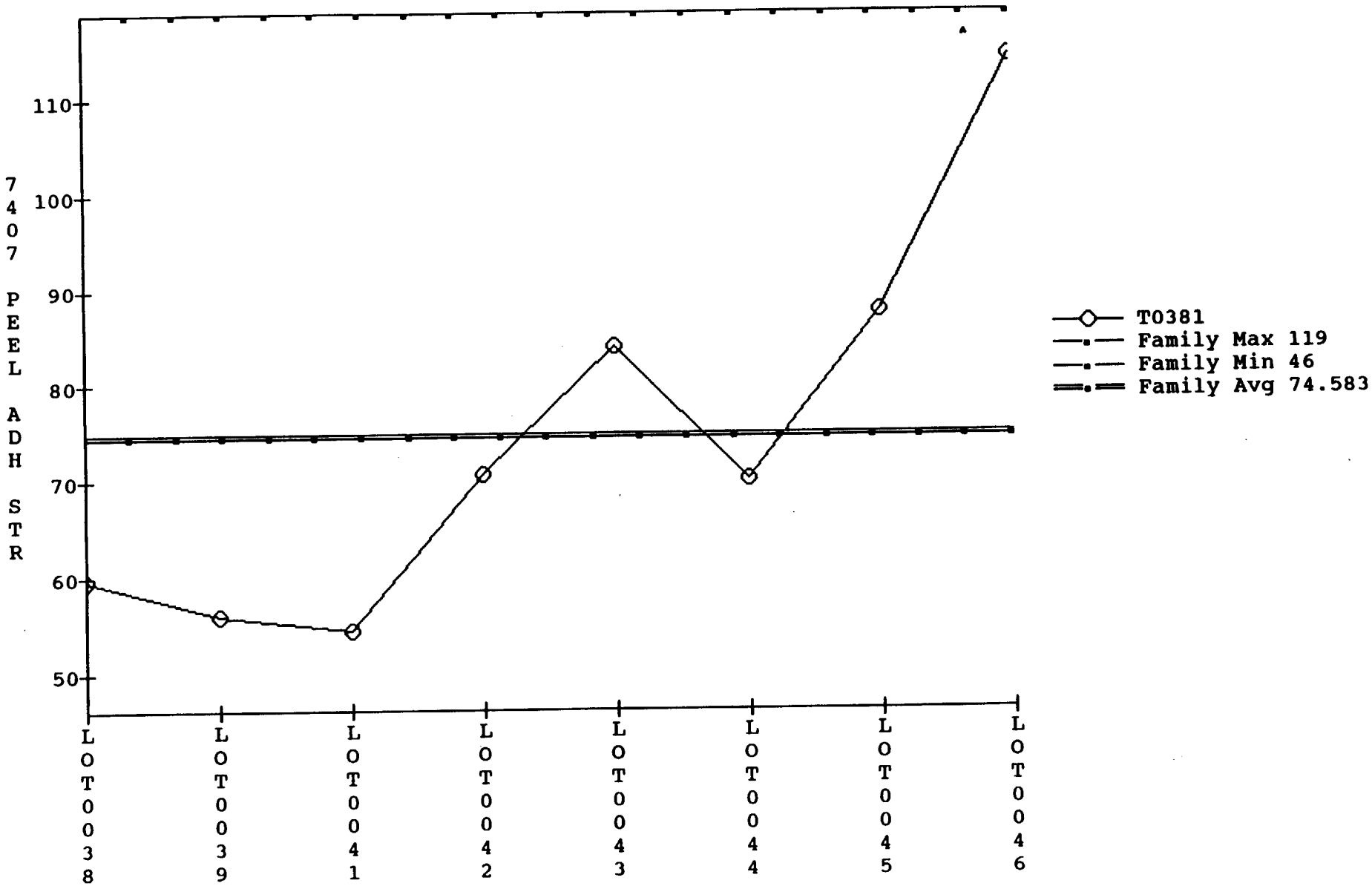


Prepared by Raw Materials PQE 25-FEB-93

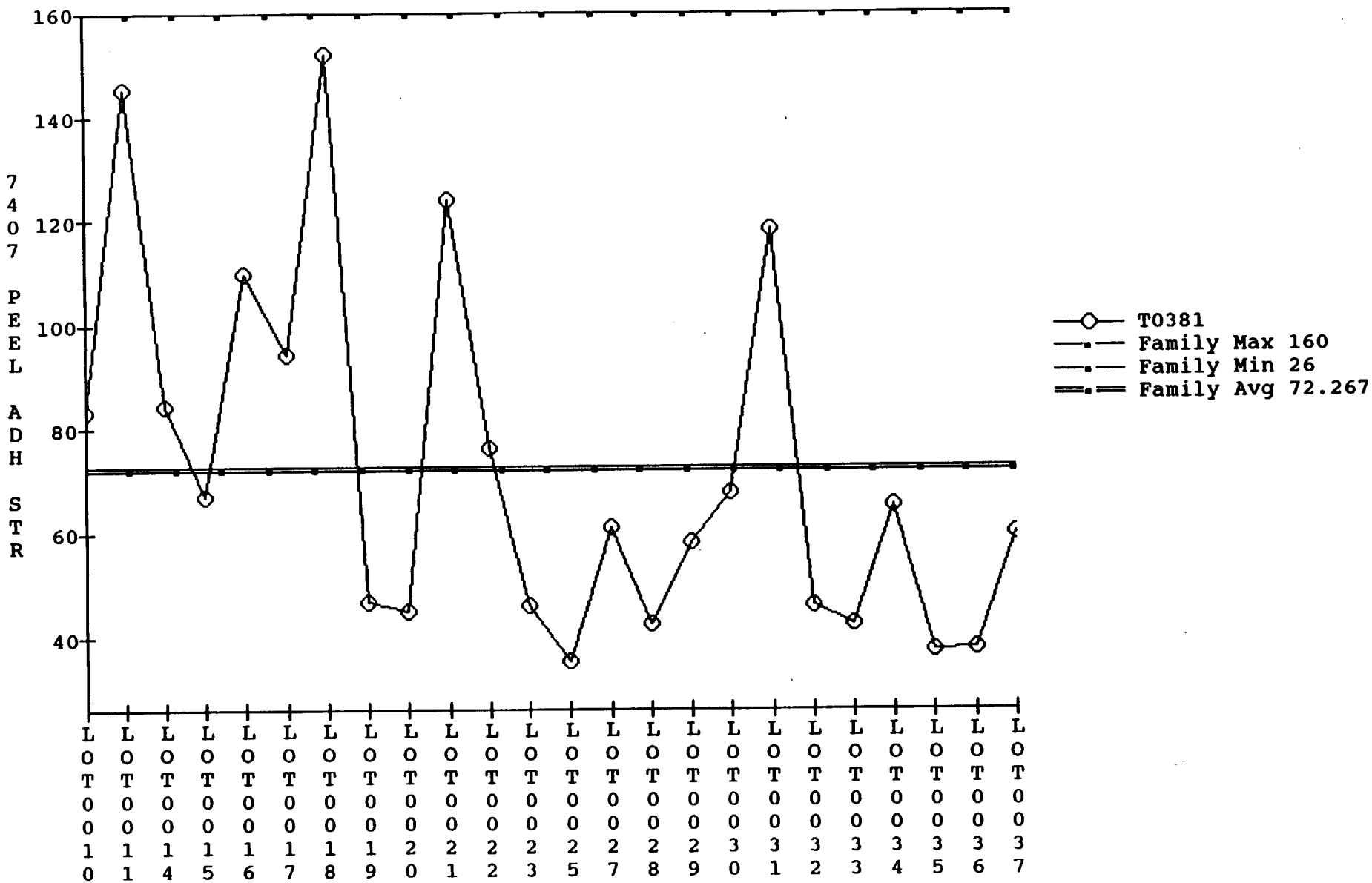
GXY7407_5_T0381 Stock # 7407 = Chemlok 205 primer for bond 15-FEB-93 15:12 Page 1

Trend Chart for gxy7407 5_T0381



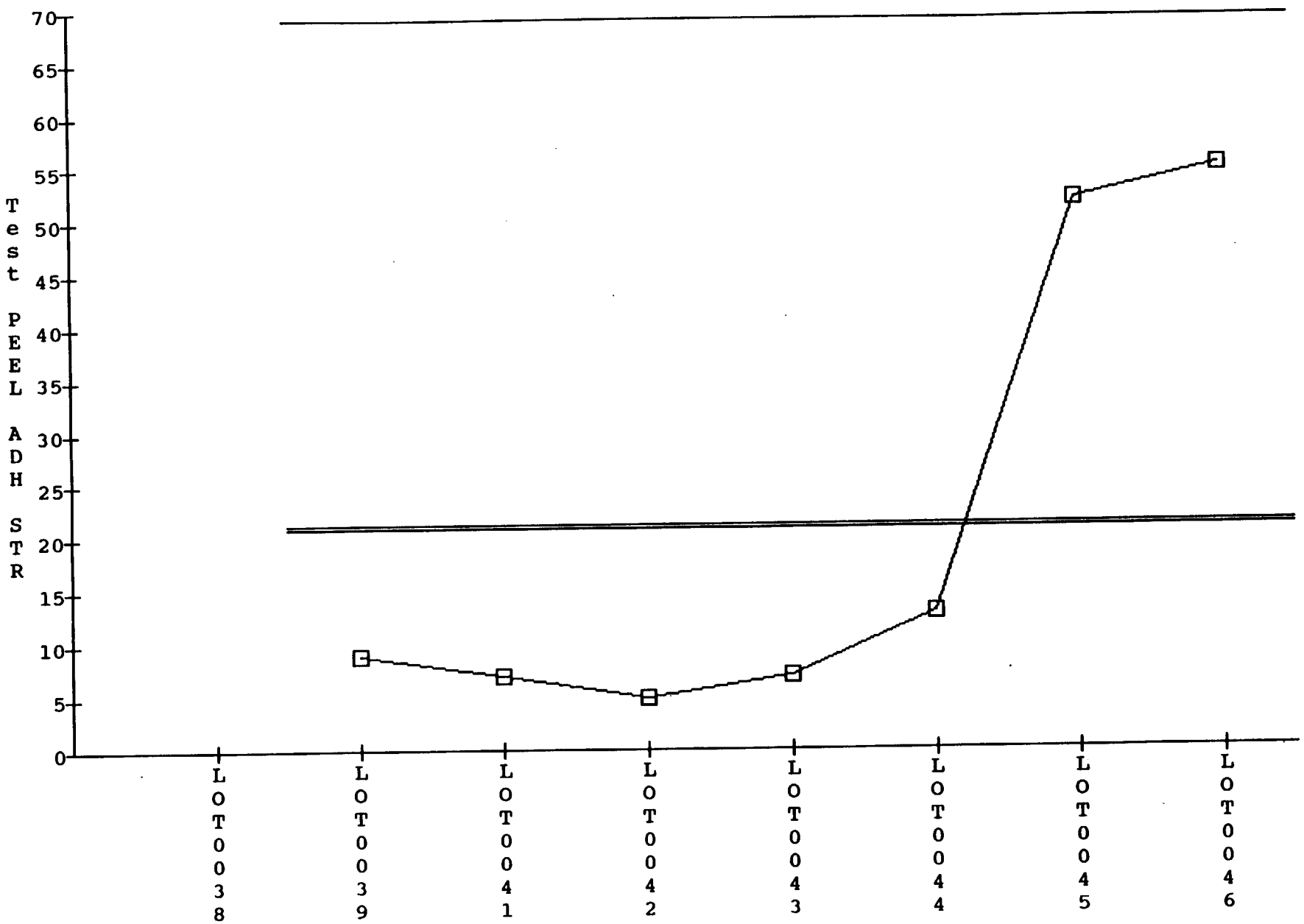
Prepared by Raw Materials PQE

Trend Chart for gxy7407 P_T0381



Prepared by Raw Materials PQE

R chart for 7407_5_T0381



Prepared by Raw Materials PQE 15-FEB-93

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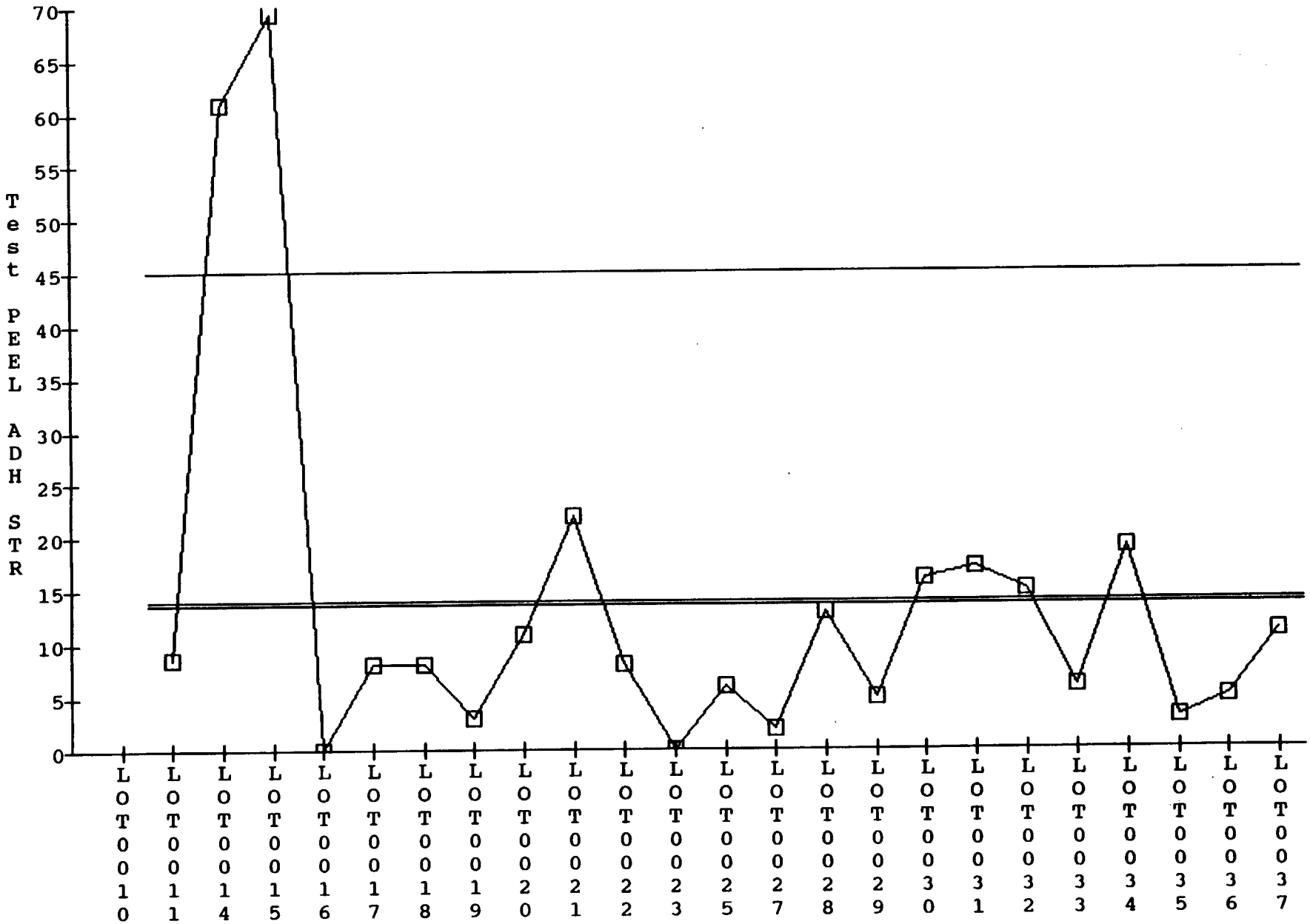
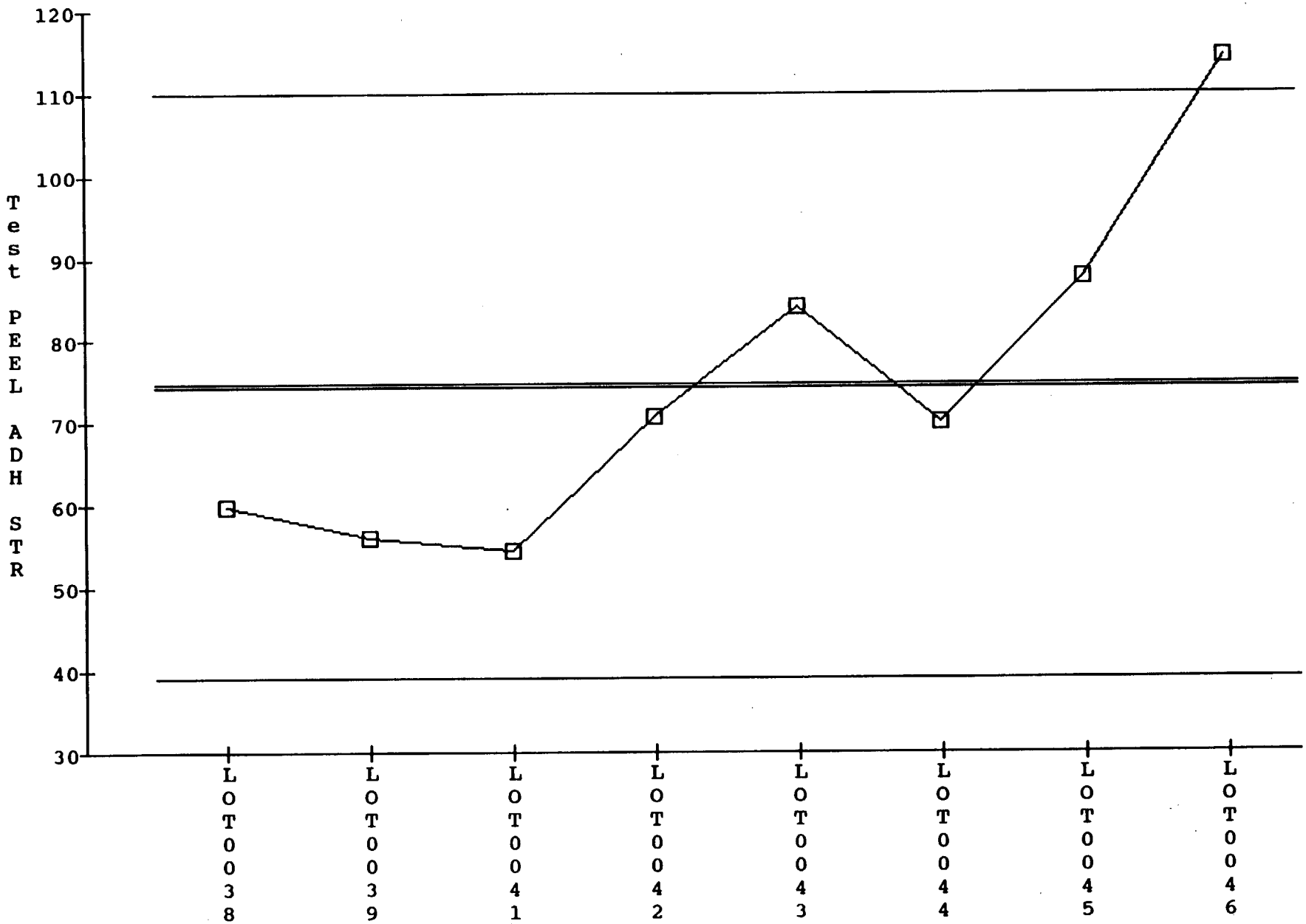


Prepared by Raw Materials PQE 15-FEB-93

Xbar chart for 7407_5_T0381



Prepared by Raw Materials PQE 15-FEB-93

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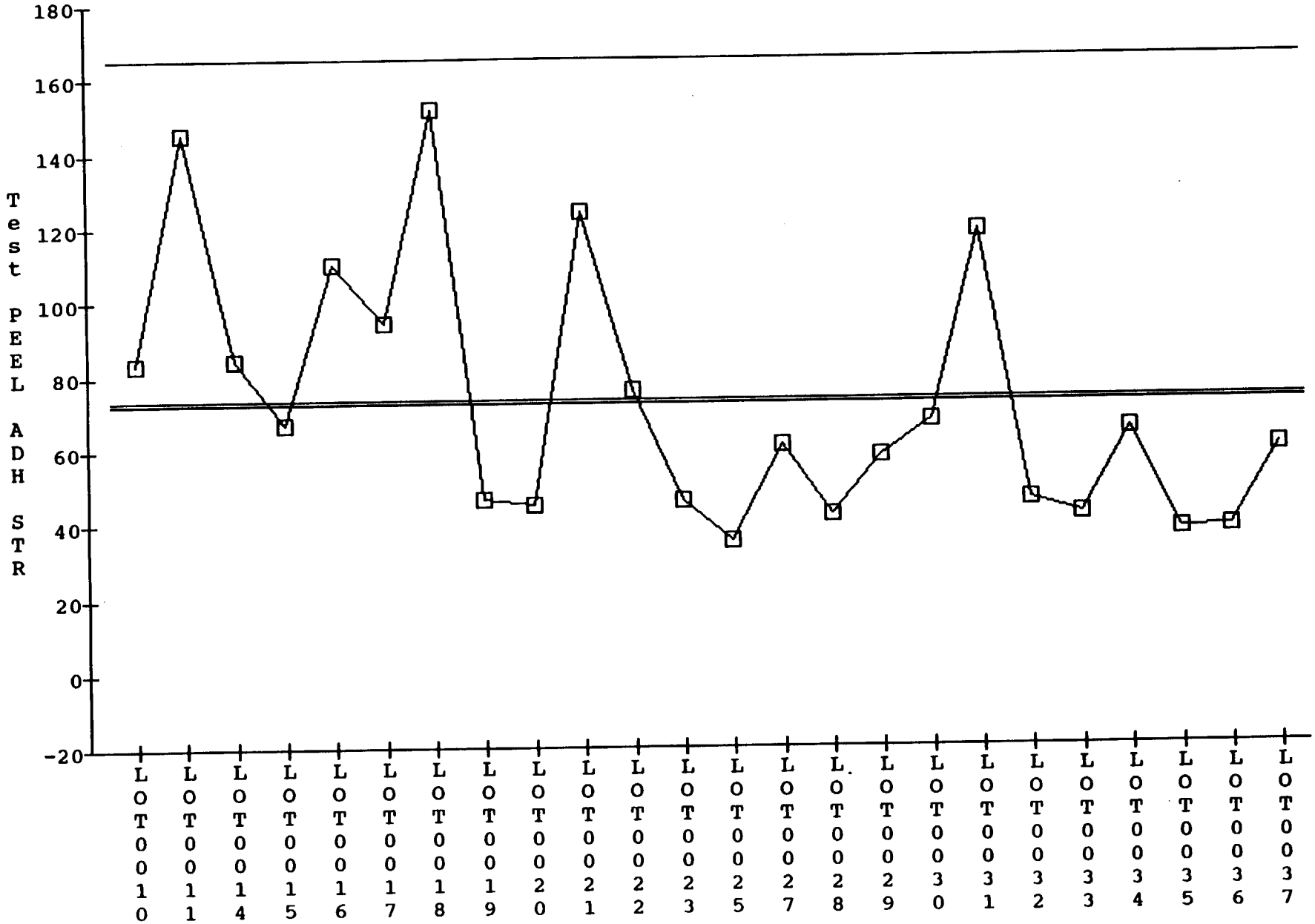
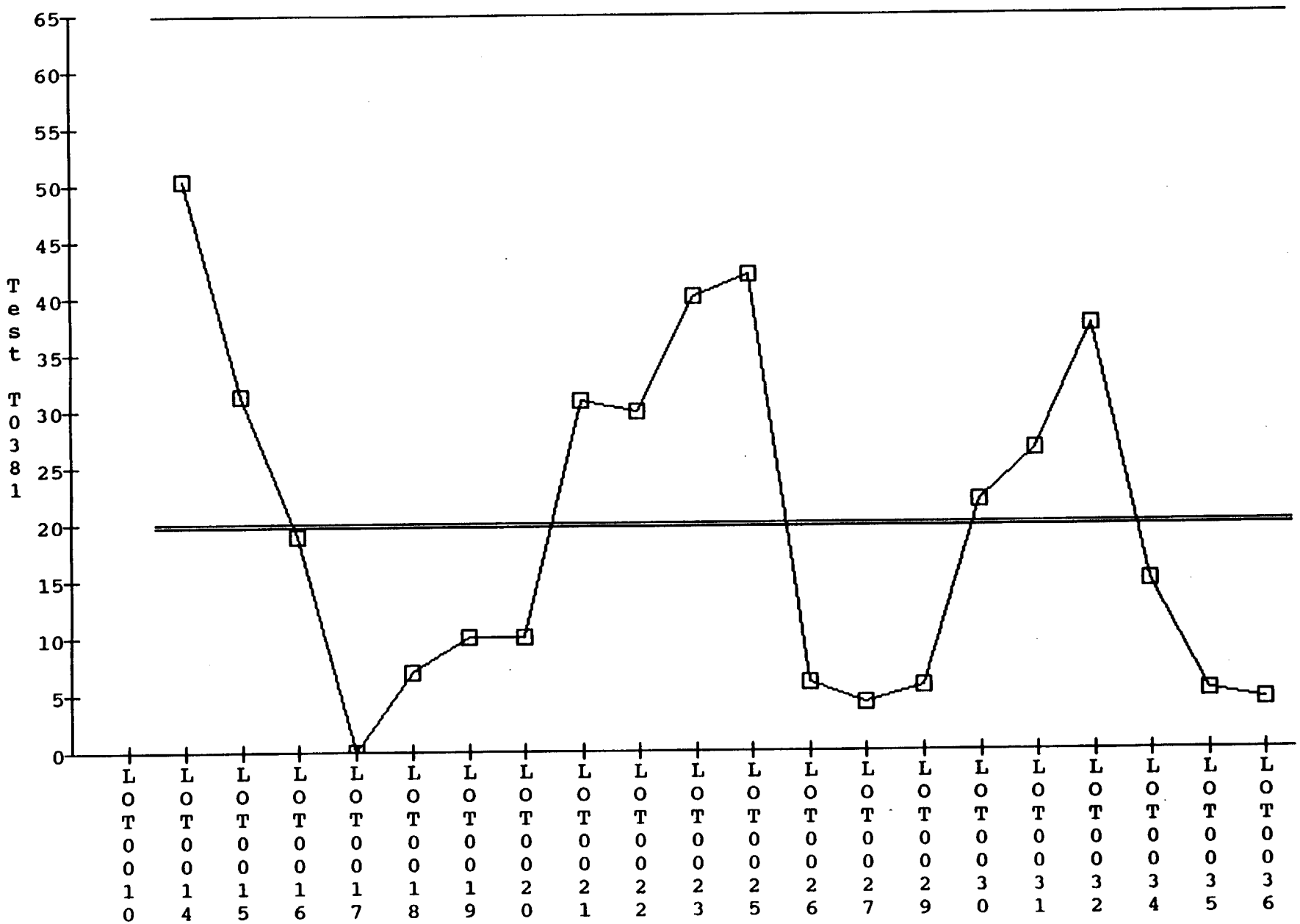


Prepared by Raw Materials PQE 15-FEB-93

Stock # 7408 = Chemlok 220 adhesive for bond

R chart for 7408_P_T0381



Prepared by Raw Materials PQE 16-FEB-93

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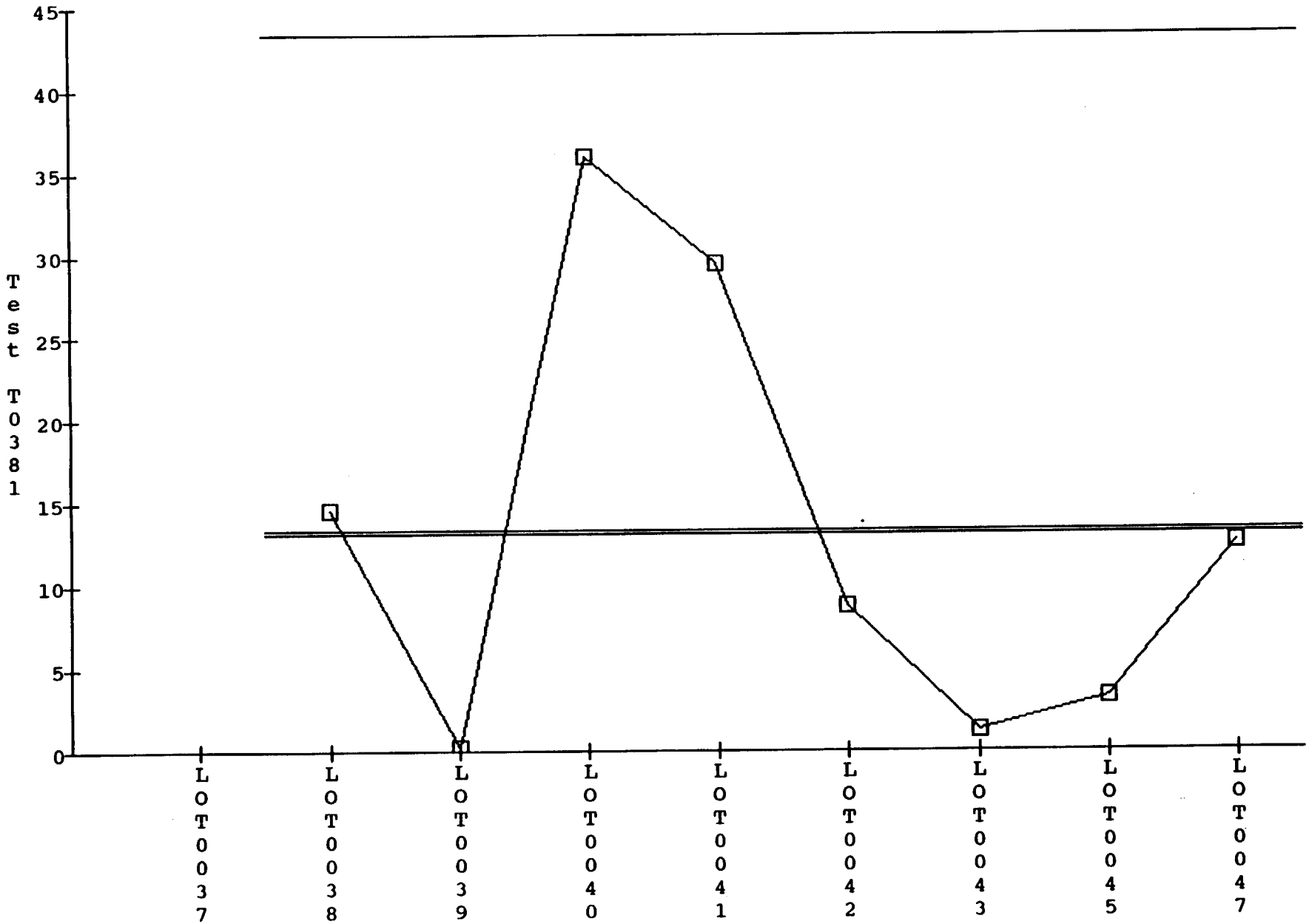

Prepared by Raw Materials PQE 16-FEB-93

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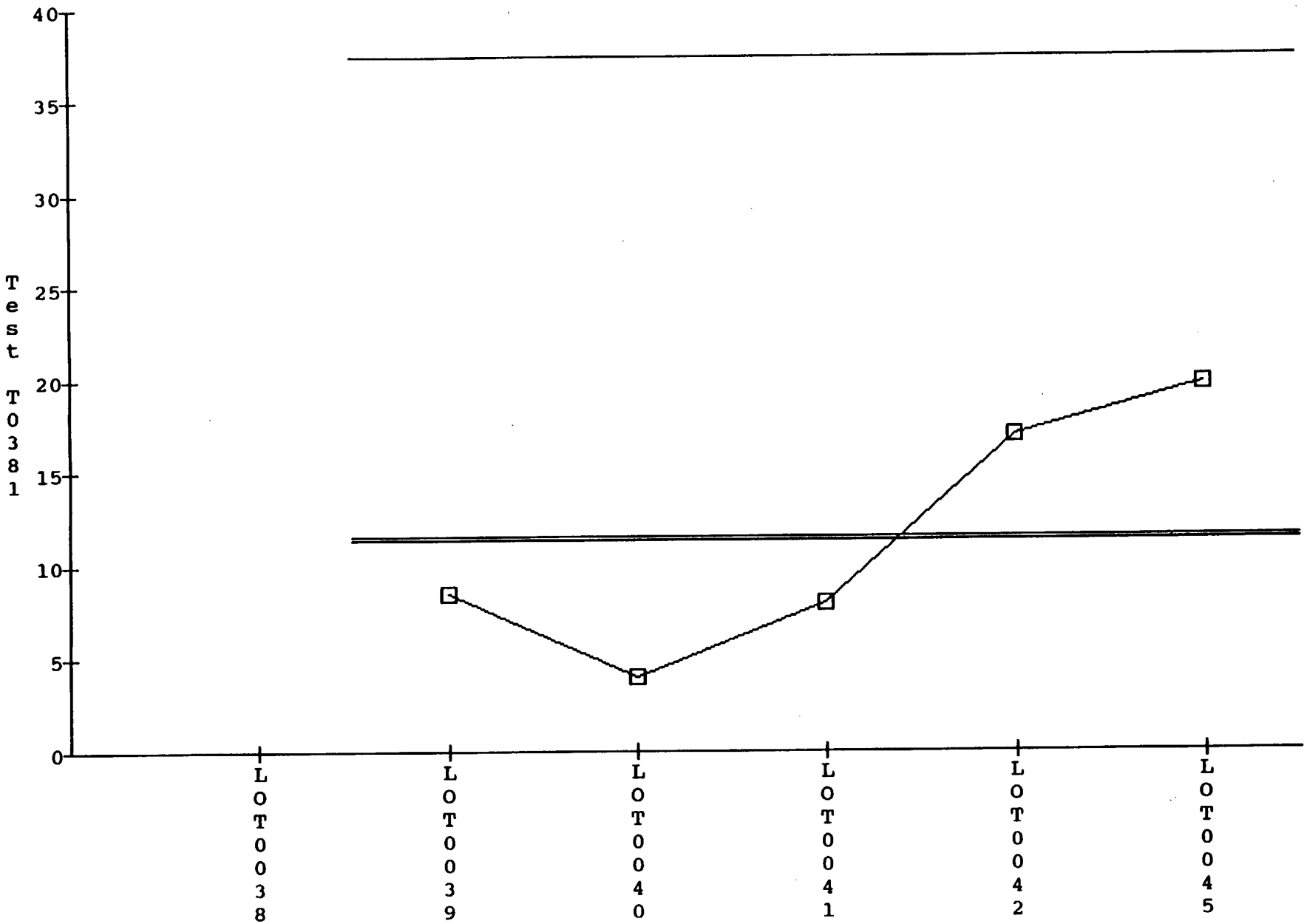
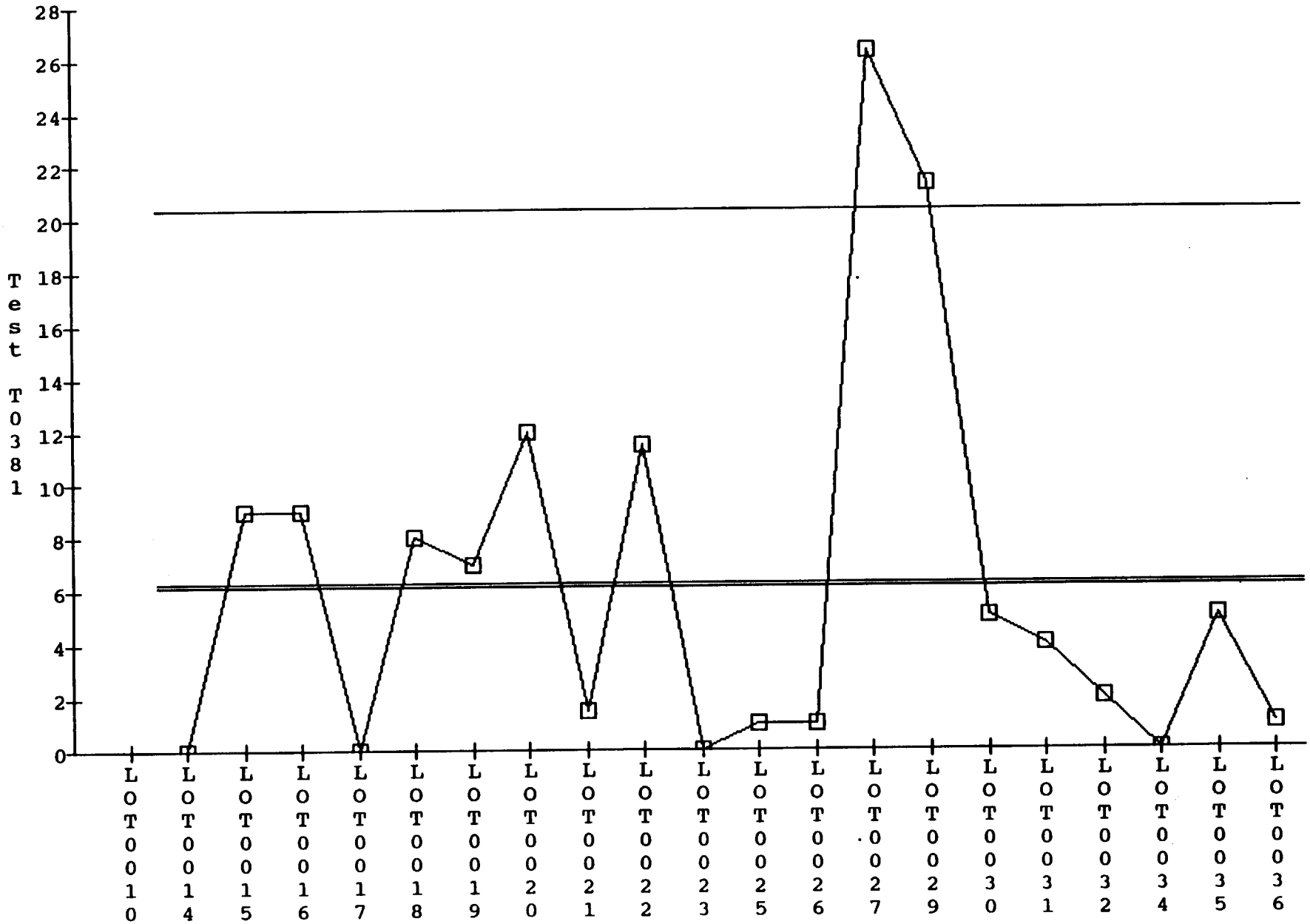


Prepared by Raw Materials PQE 16-FEB-93

R chart for 7408_P_T0419



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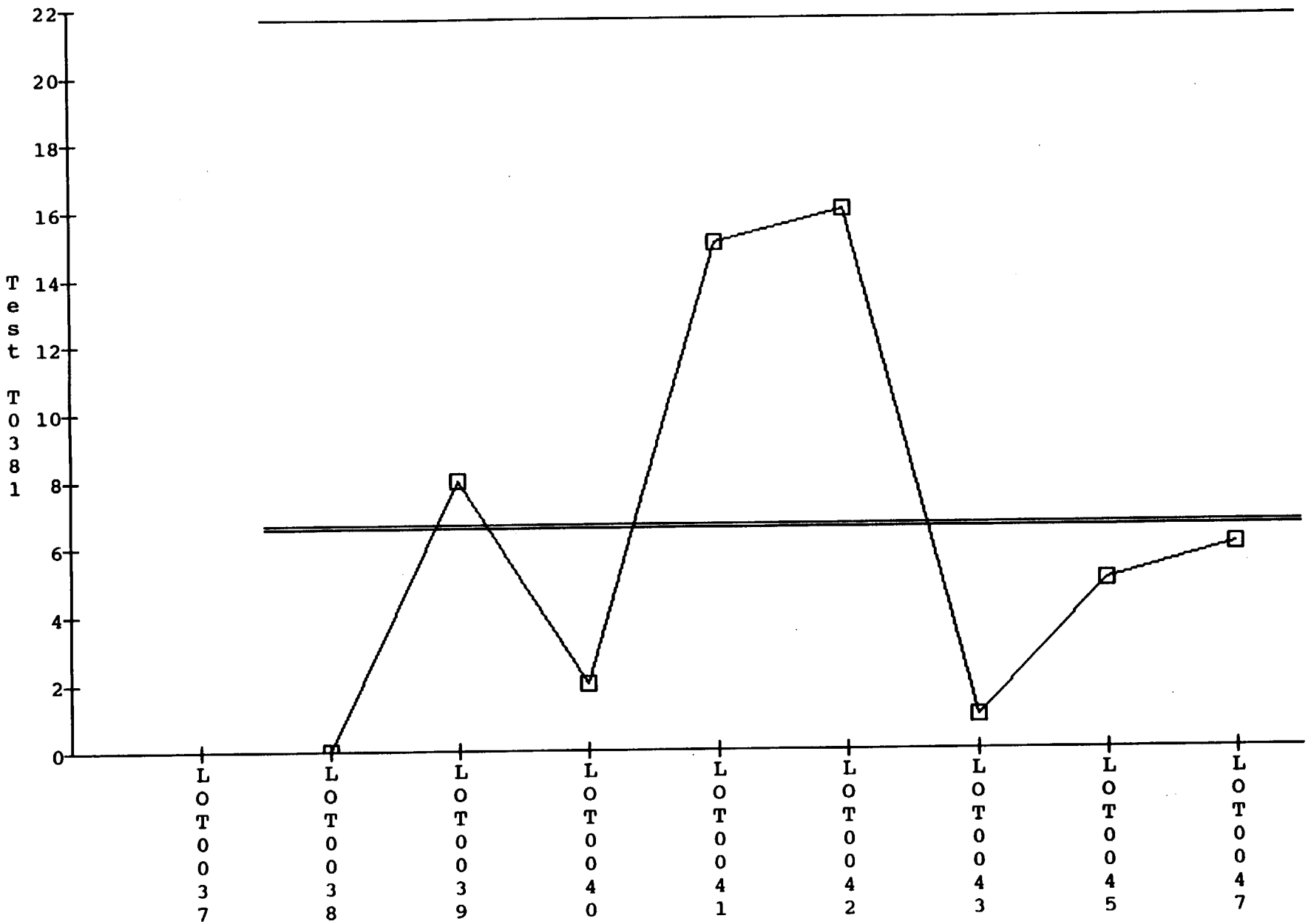

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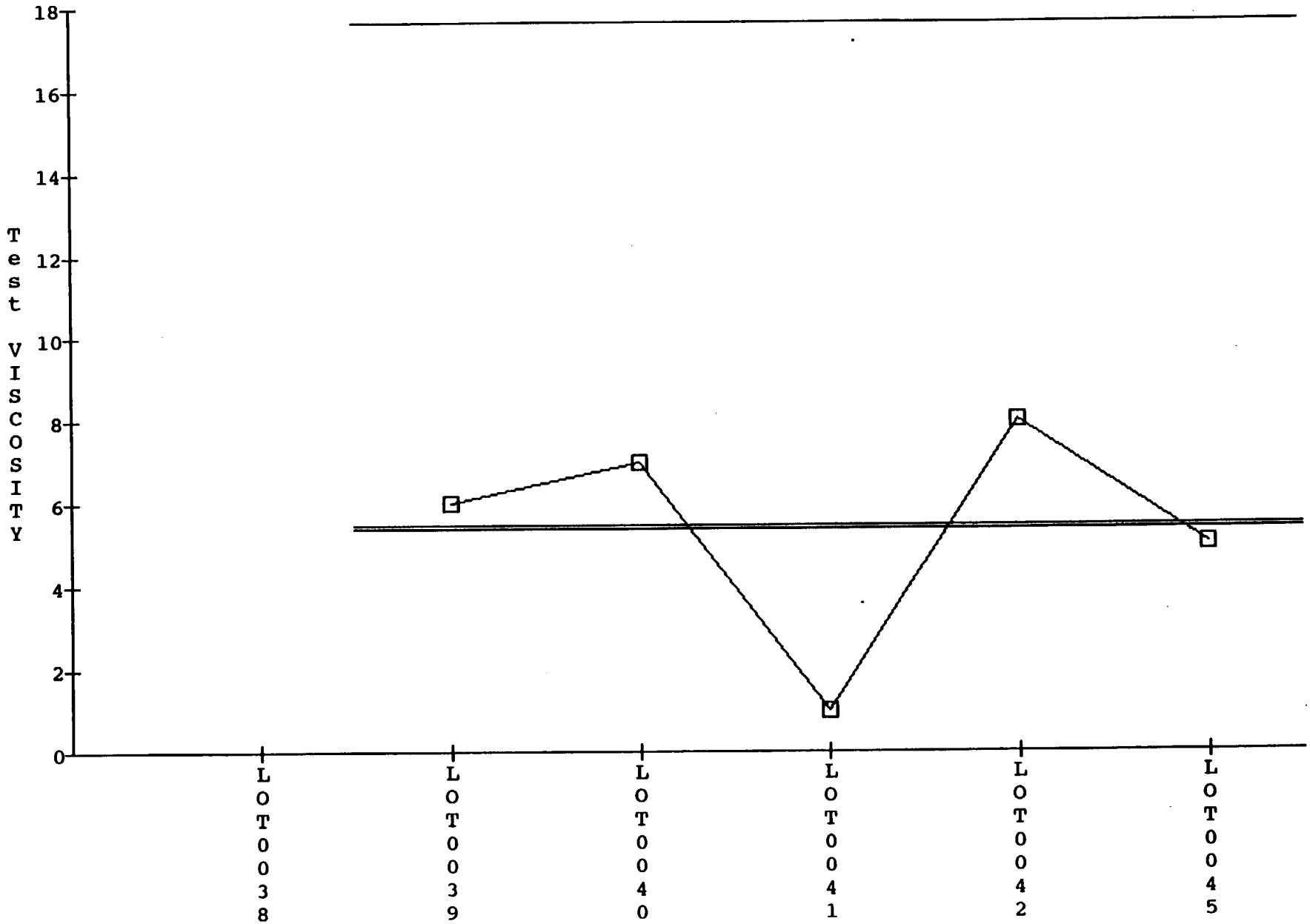

Prepared by Raw Materials PQE 16-FEB-93

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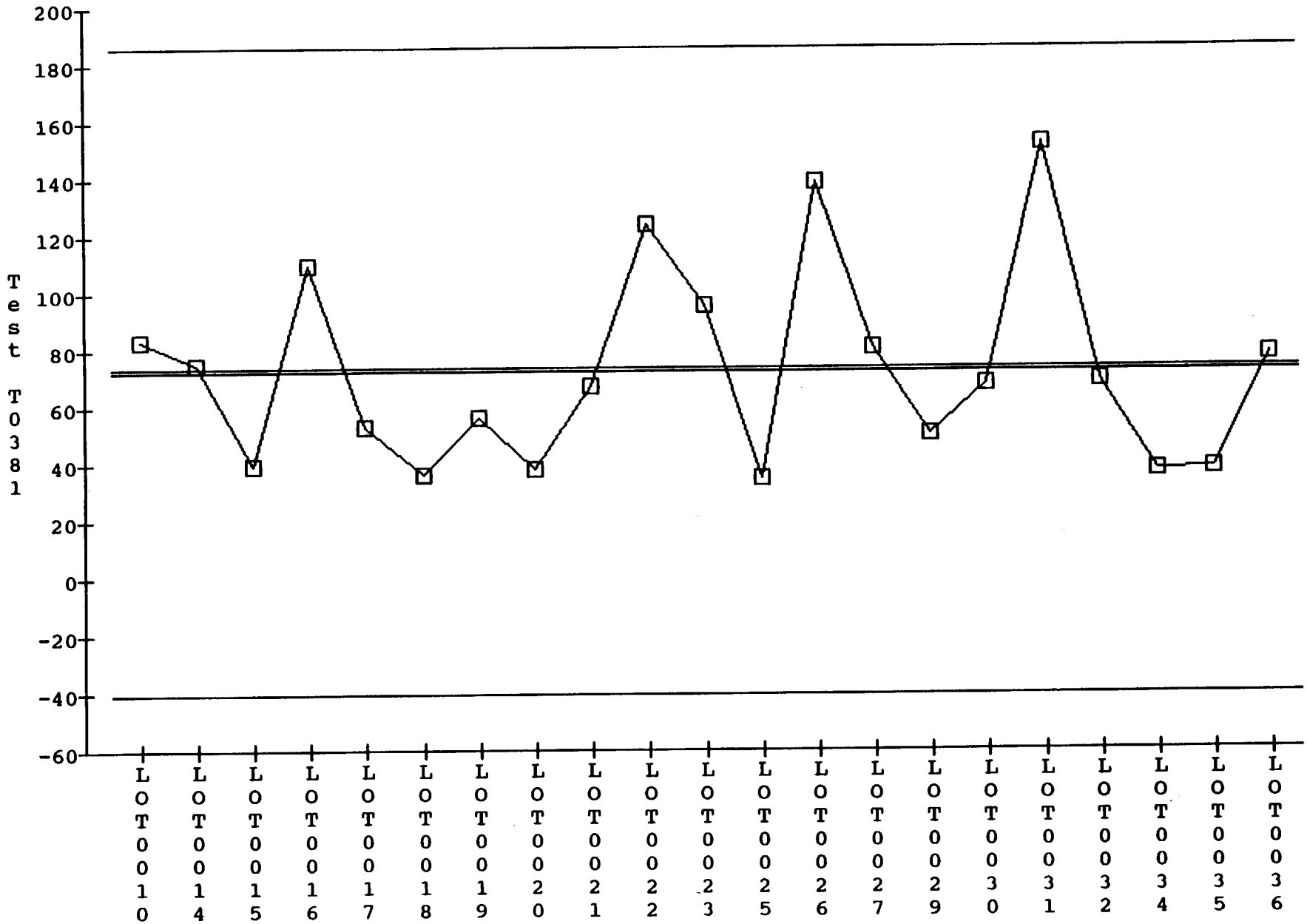
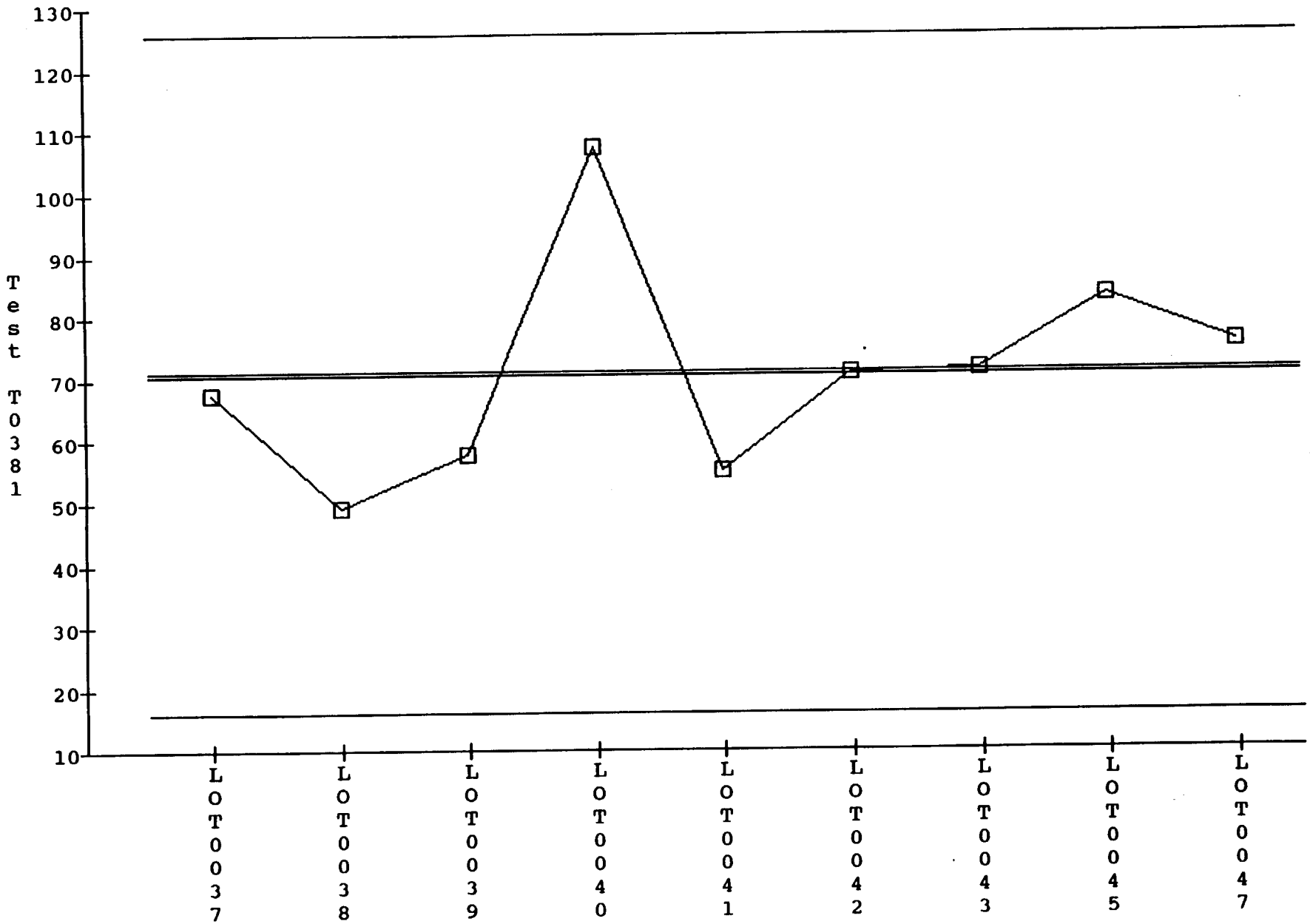


Prepared by Raw Materials PQE 16-FEB-93

Xbar chart for 7408_5_T0381



Prepared by Raw Materials PQE 16-FEB-93

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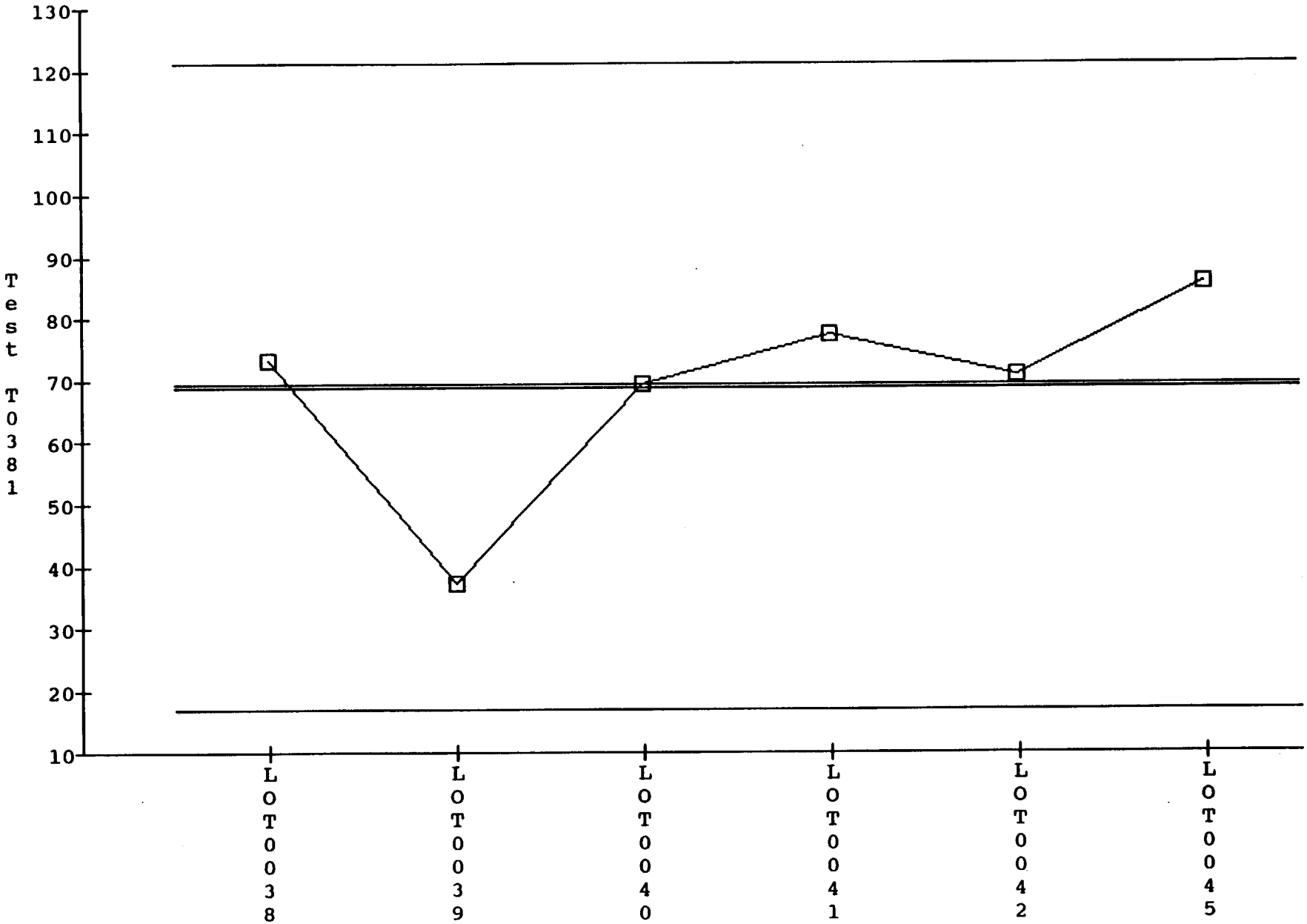
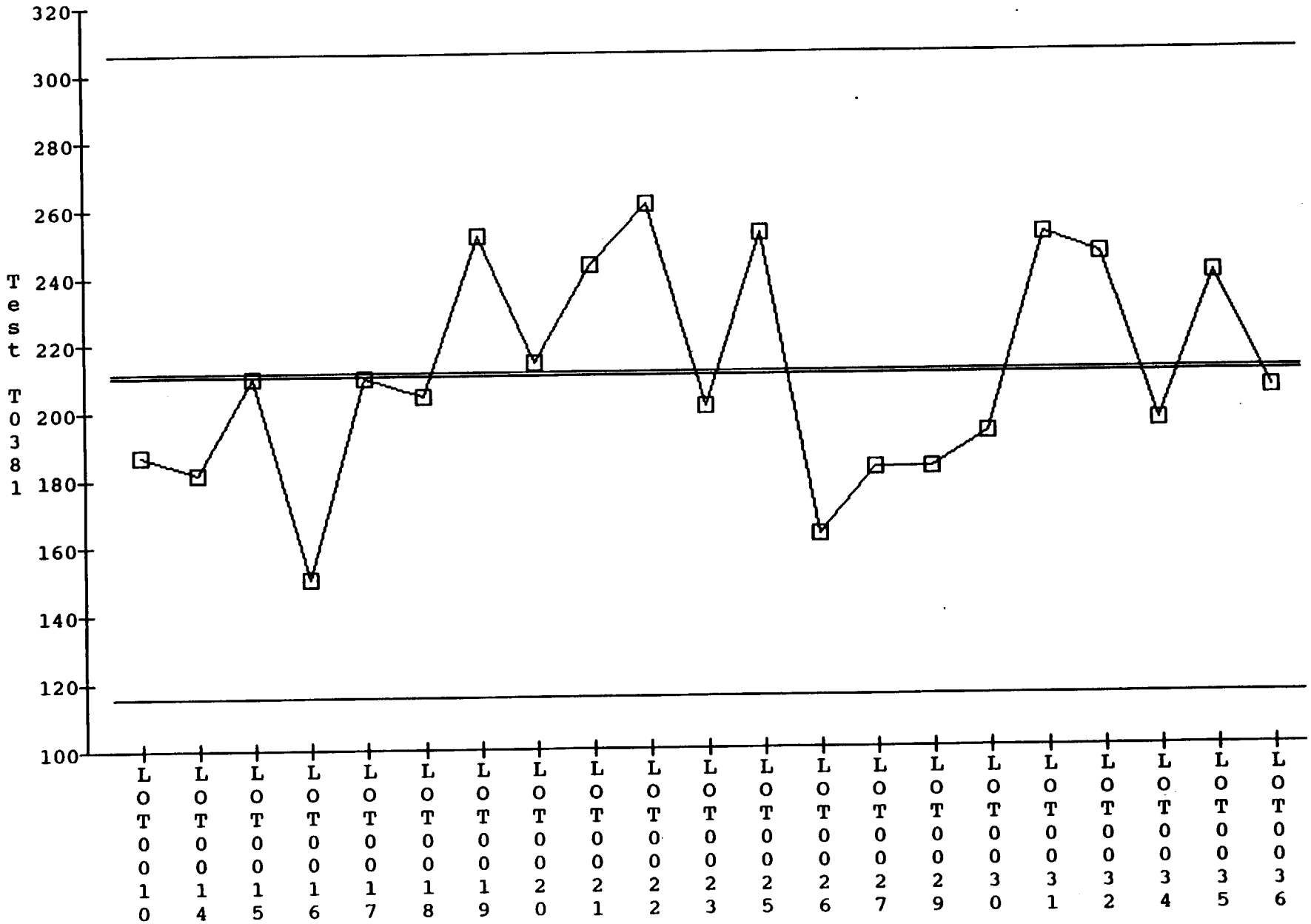


Prepared by Raw Materials PQE 16-FEB-93

Xbar chart for 7408_P_T0419



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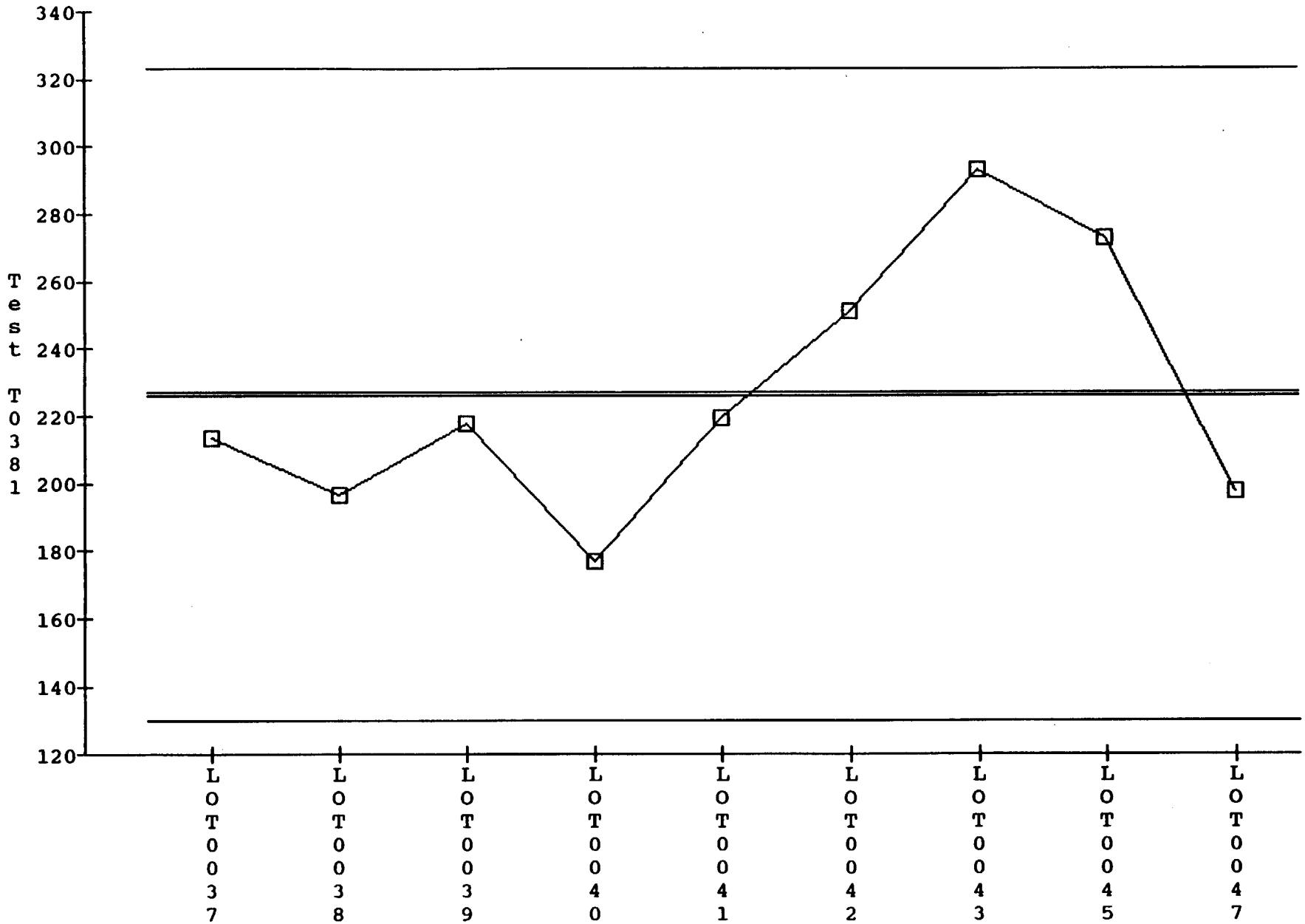

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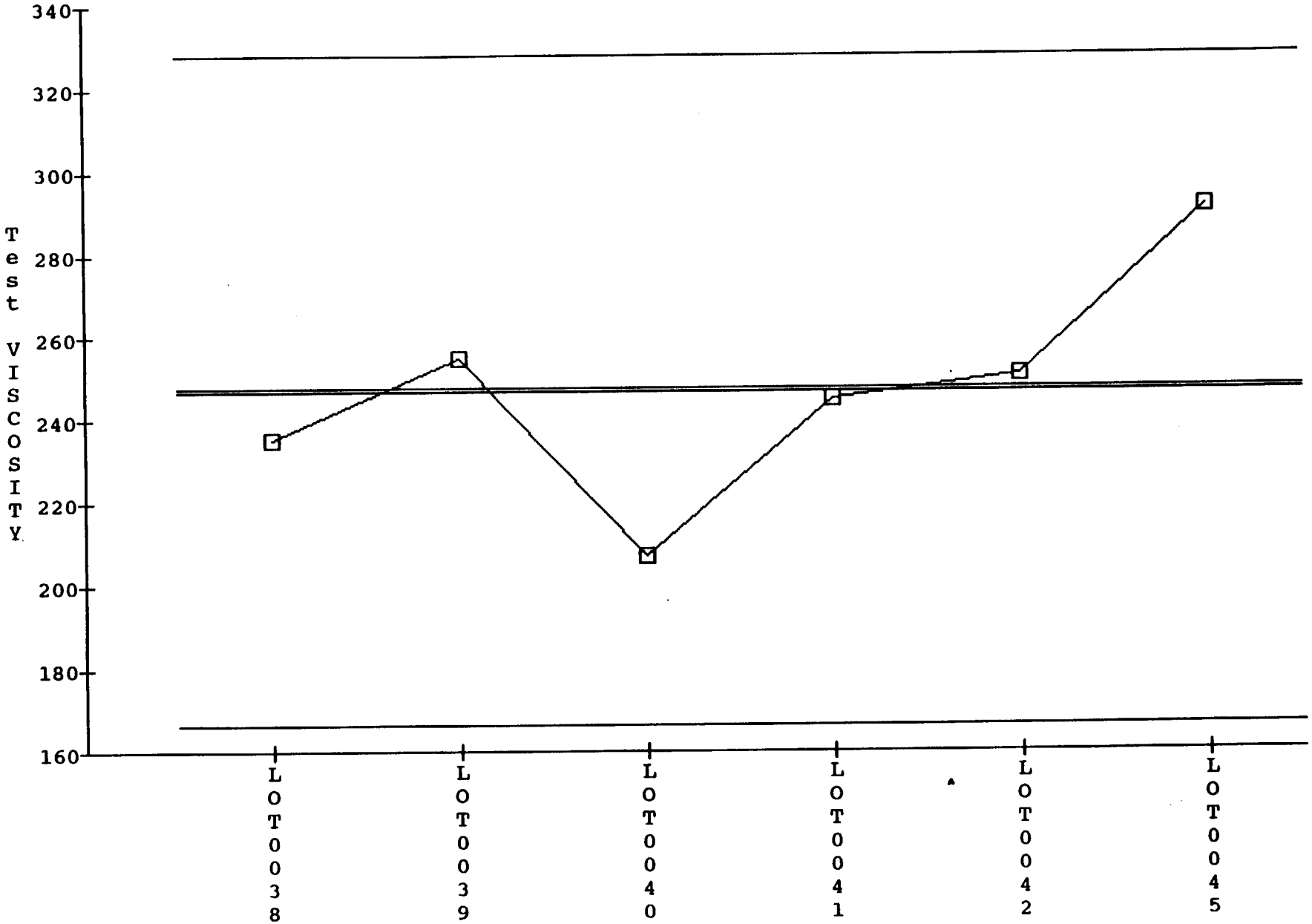
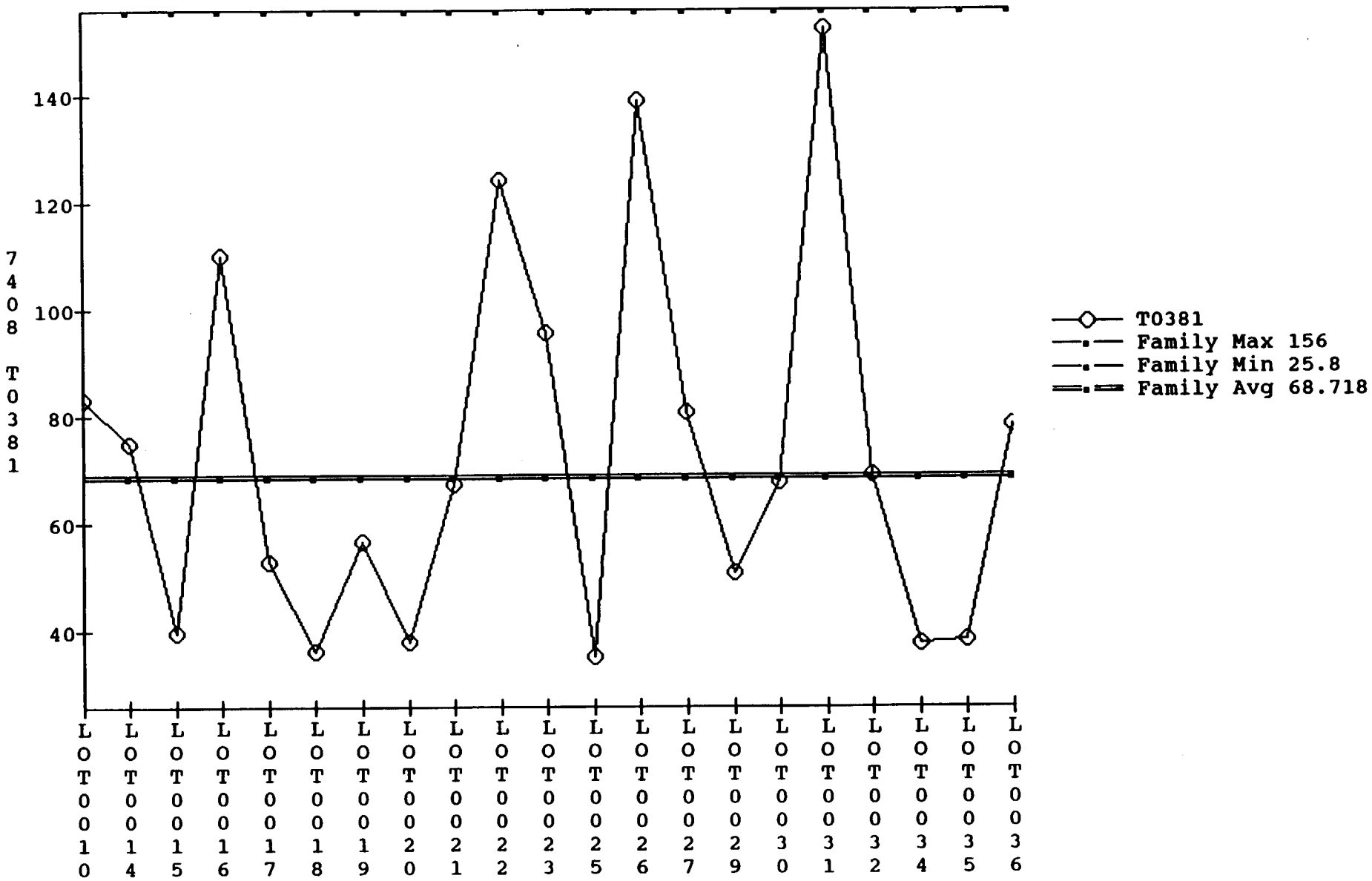


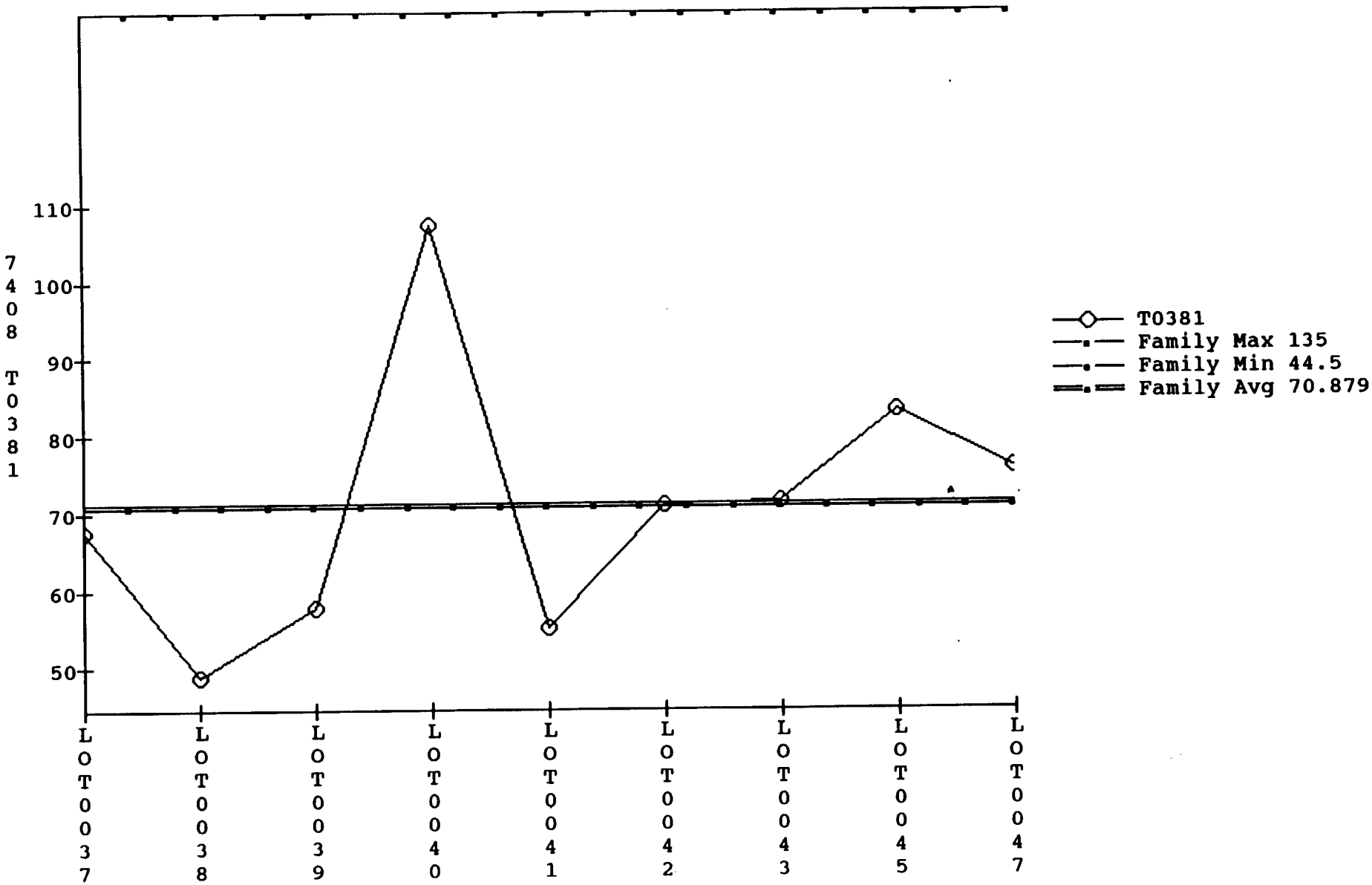
Prepared by Raw Materials PQE 16-FEB-93

Trend Chart for gxy7408 P_T0381



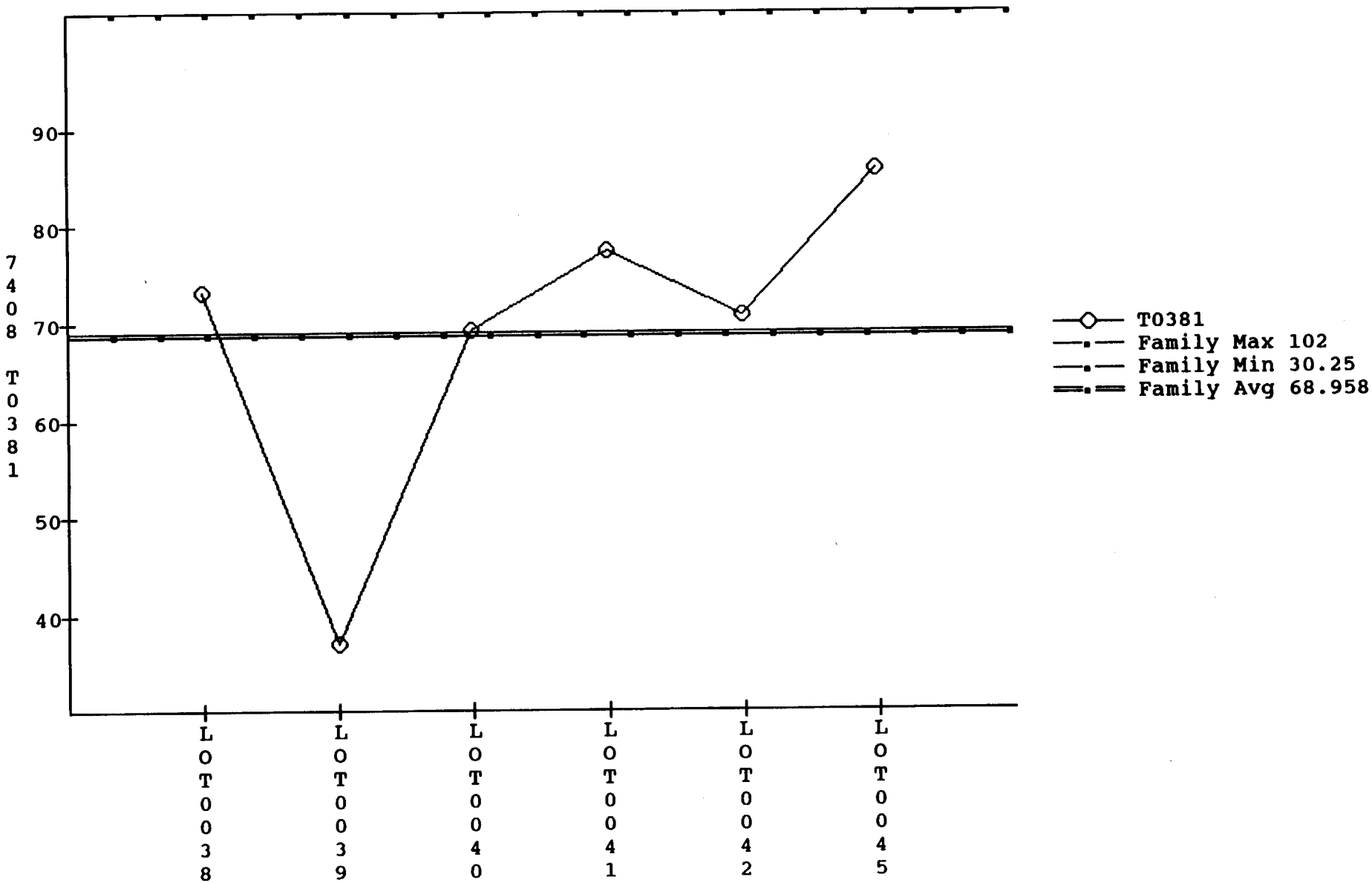
Prepared by Raw Materials PQE

Trend Chart for gxy7408 5_T0381



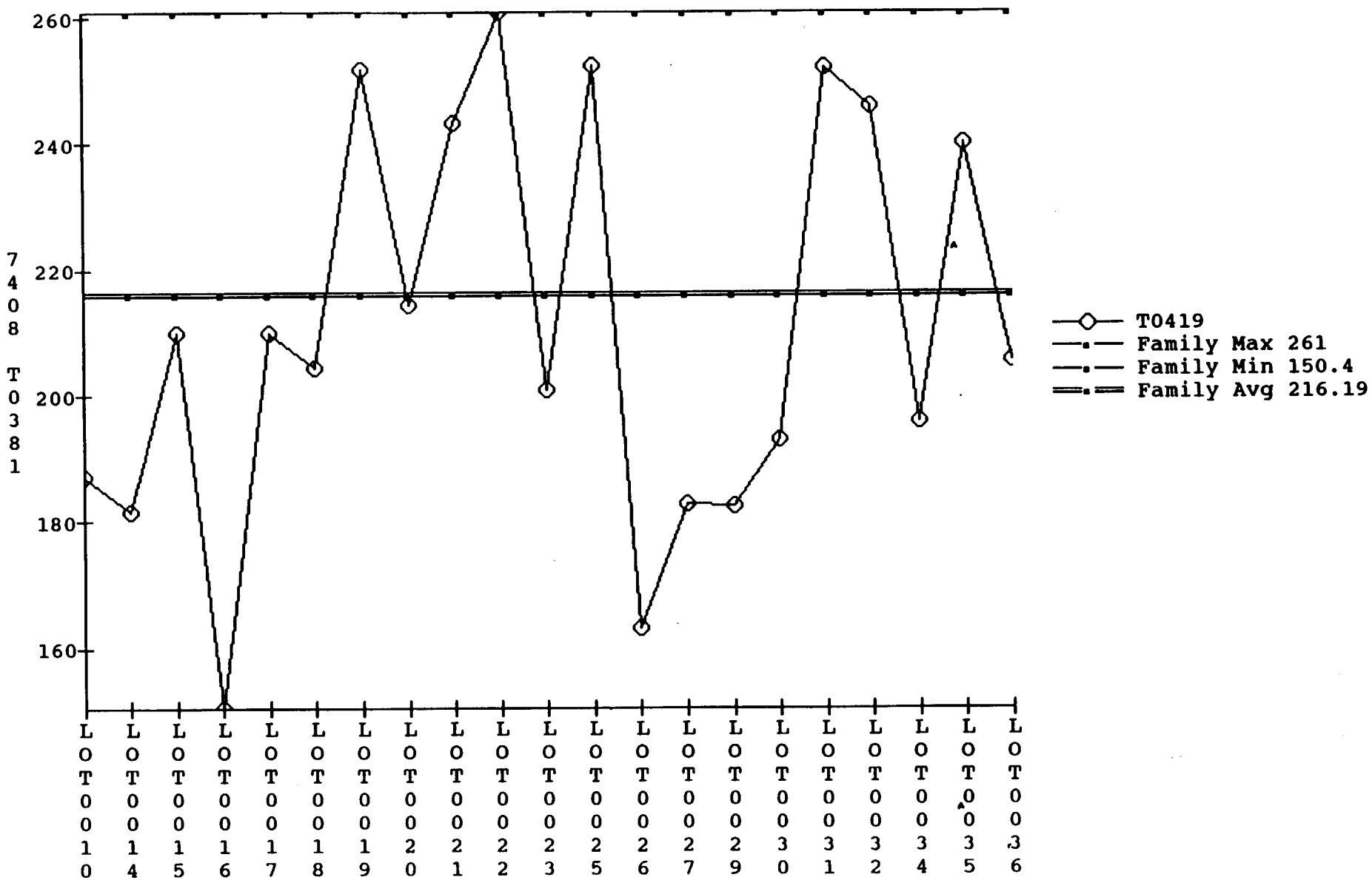
Prepared by Raw Materials PQE

Trend Chart for gxy7408 3_T0381



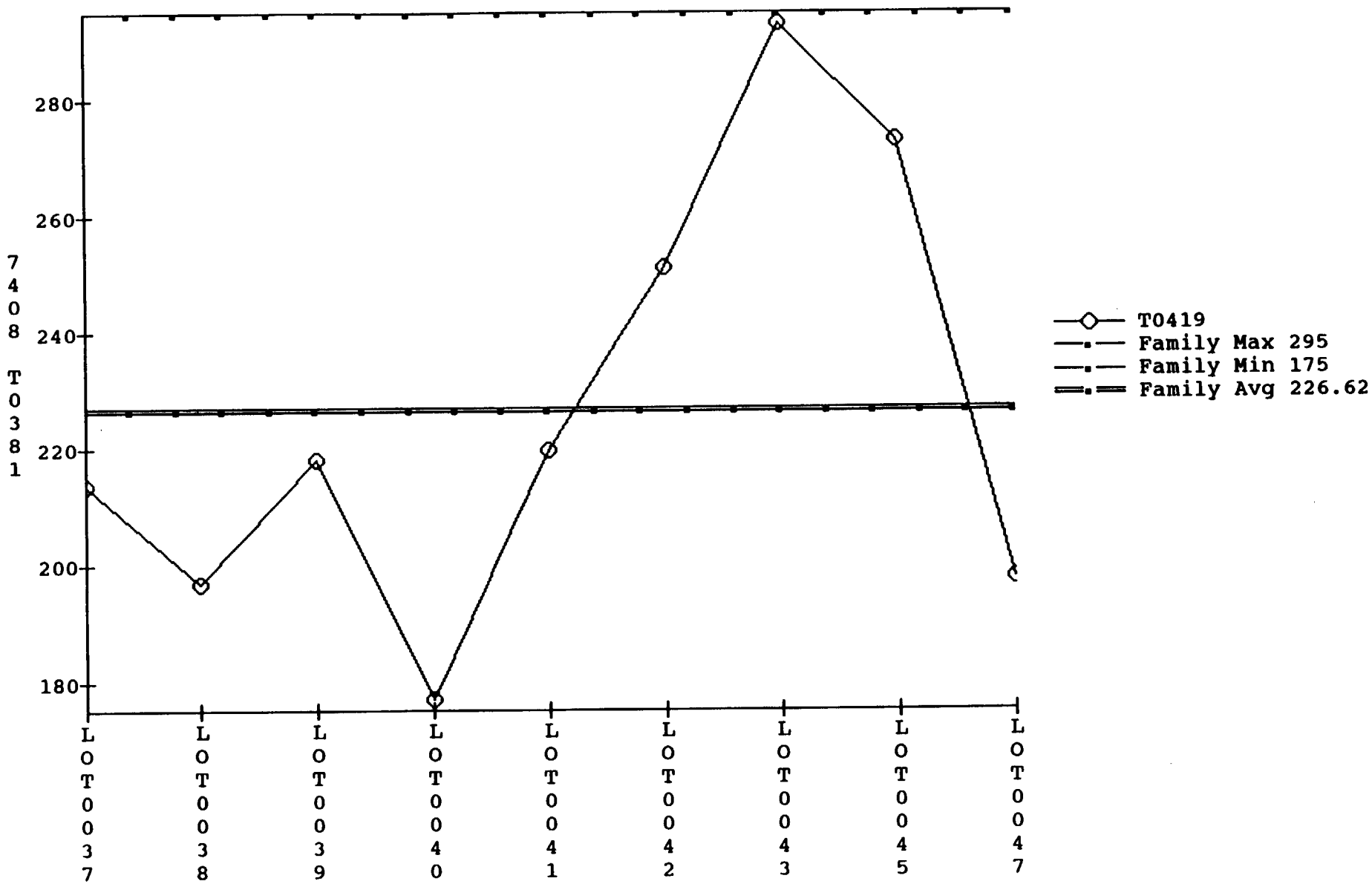
Prepared by Raw Materials PQE

Trend Chart for gxy7408 P_T0419



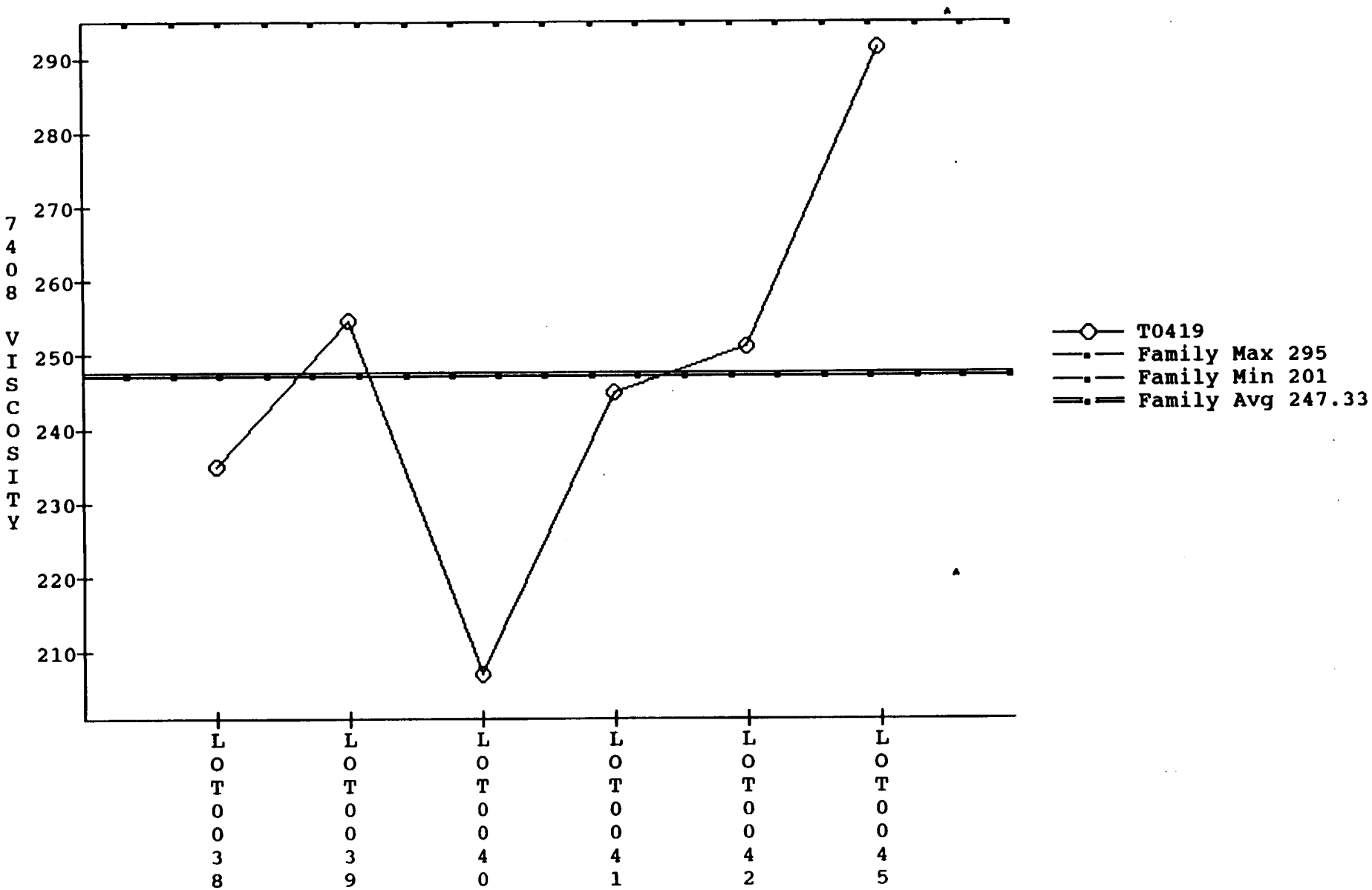
Prepared by Raw Materials PQE

Trend Chart for gxy7408 5_T0419



Prepared by Raw Materials PQE

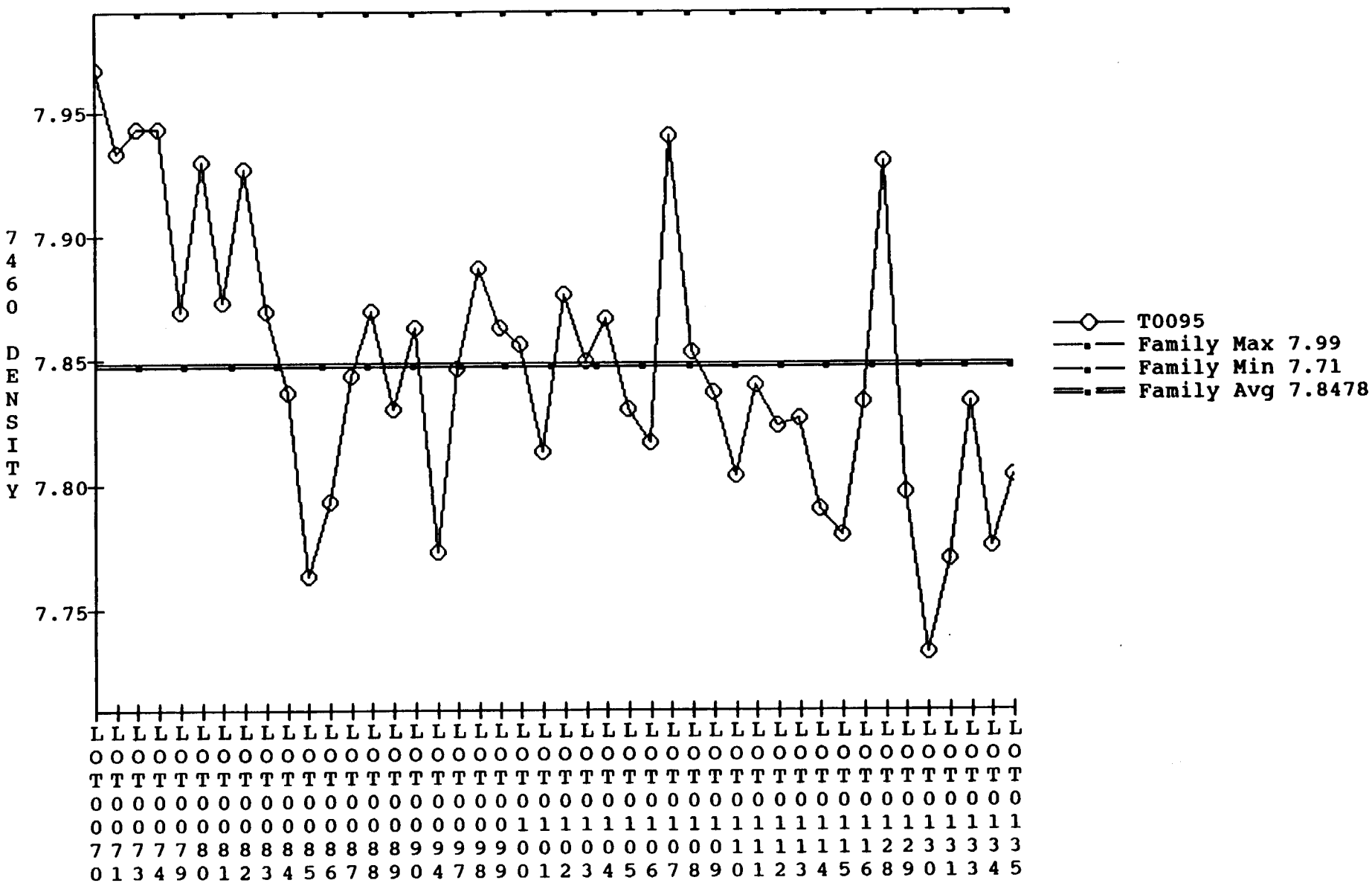
Trend Chart for gxy7408 3_T0419



Prepared by Raw Materials PQE

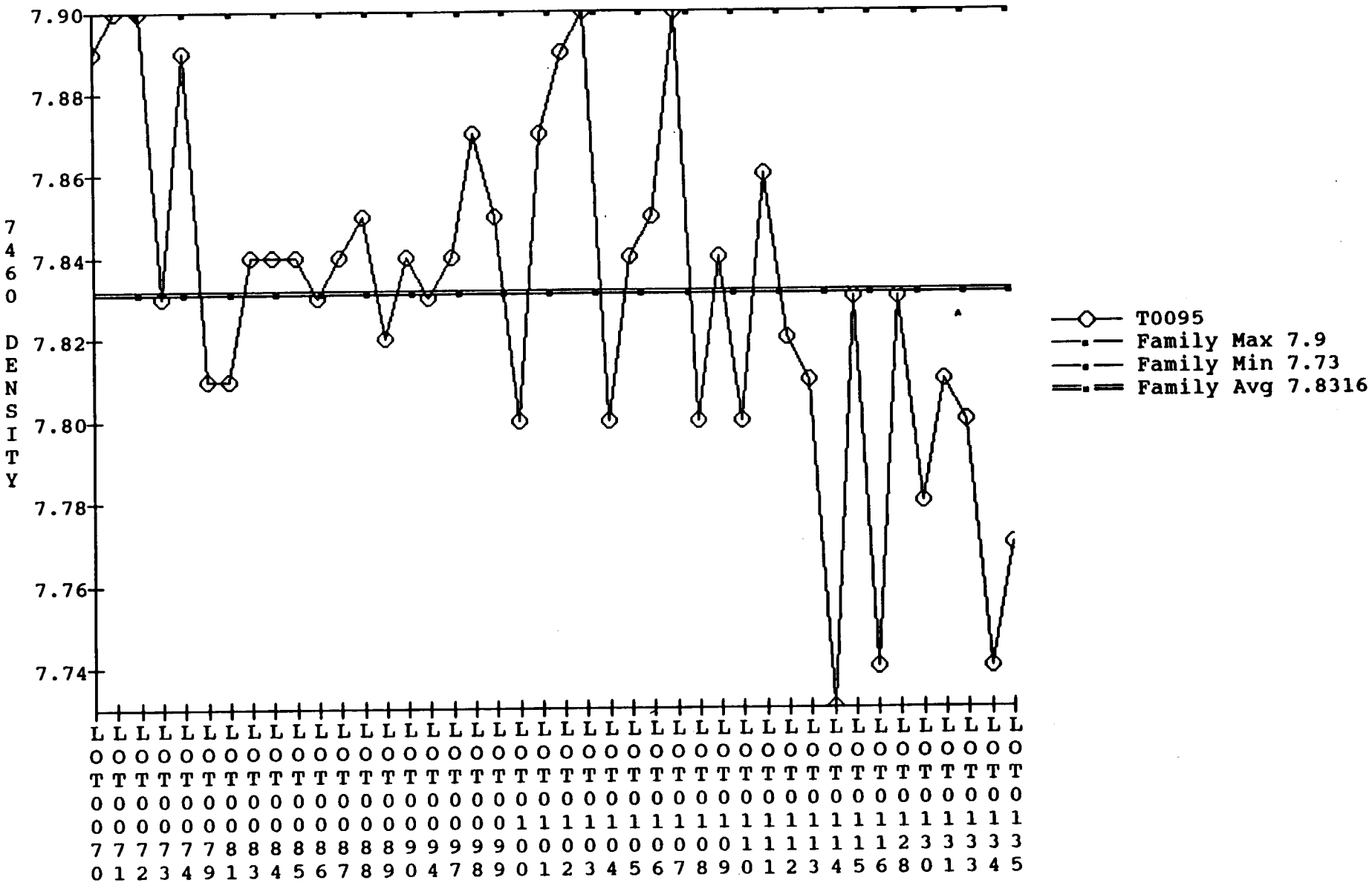
Stock # 7460 = Chemlok 220 adhesive for Protective coating

Trend Chart for gxy7460 R_T0095



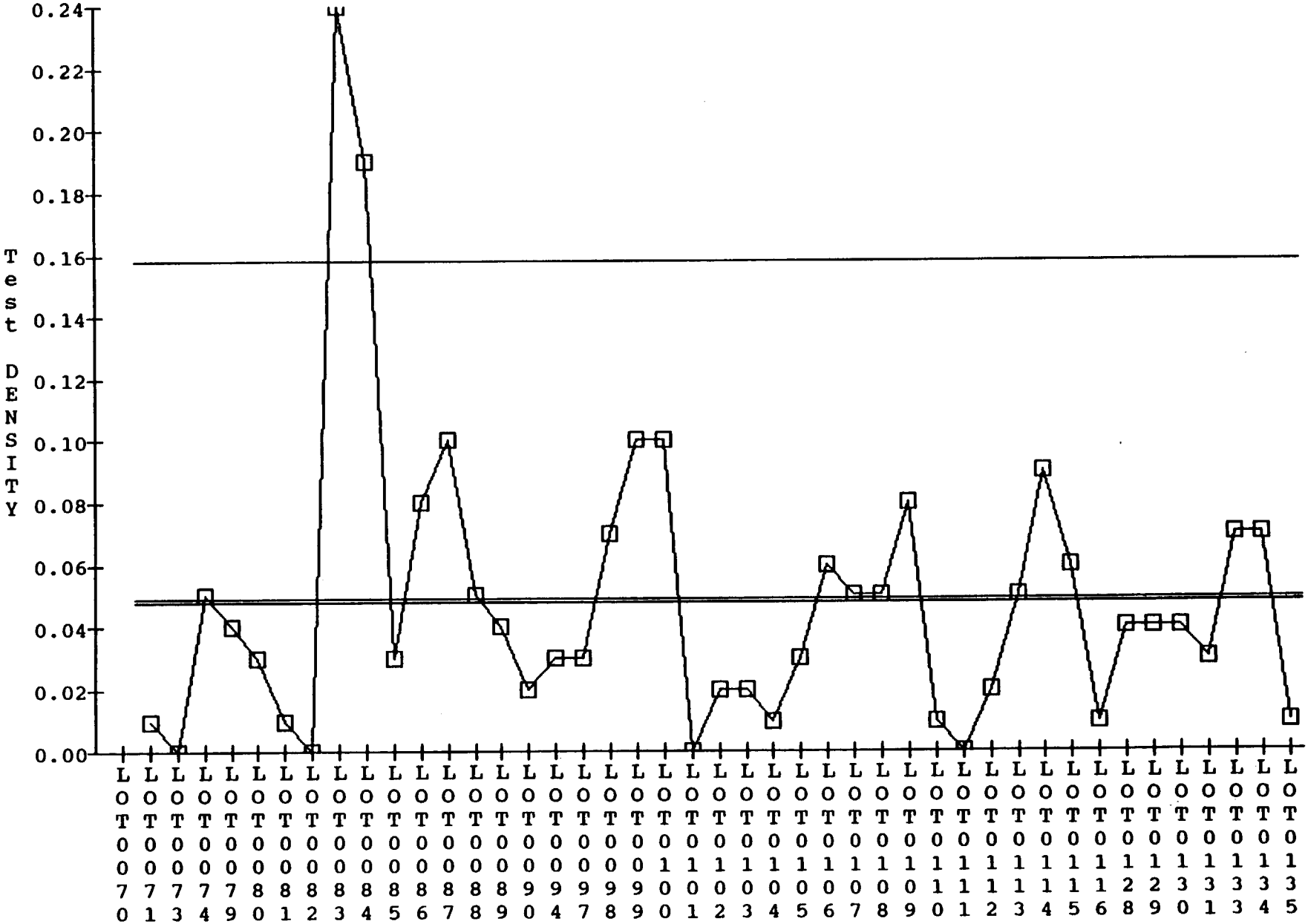
Prepared by Raw Materials PQE

Trend Chart for gxy7460 V_T0095



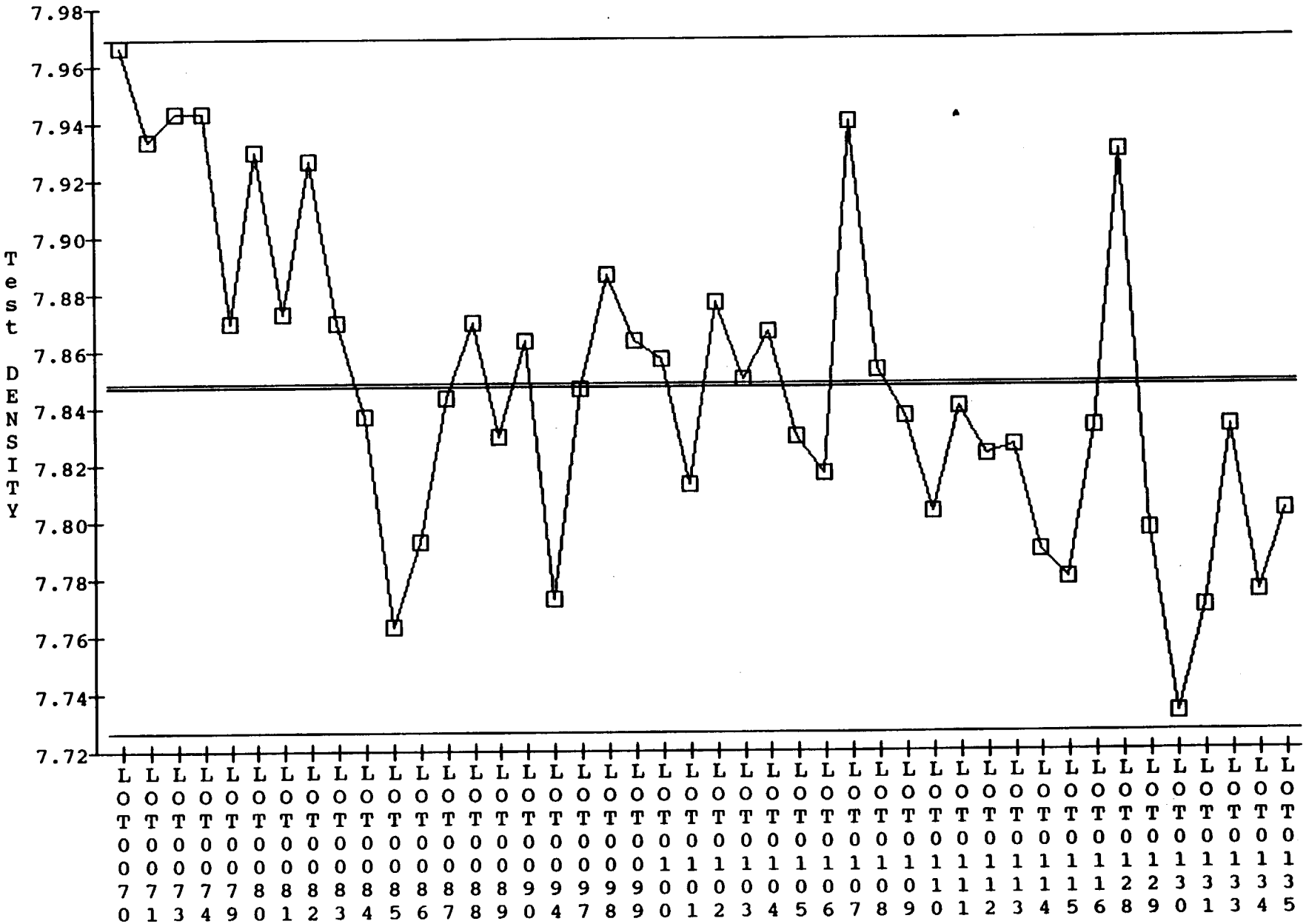
Prepared by Raw Materials PQE

R chart for 7460_R_T0095



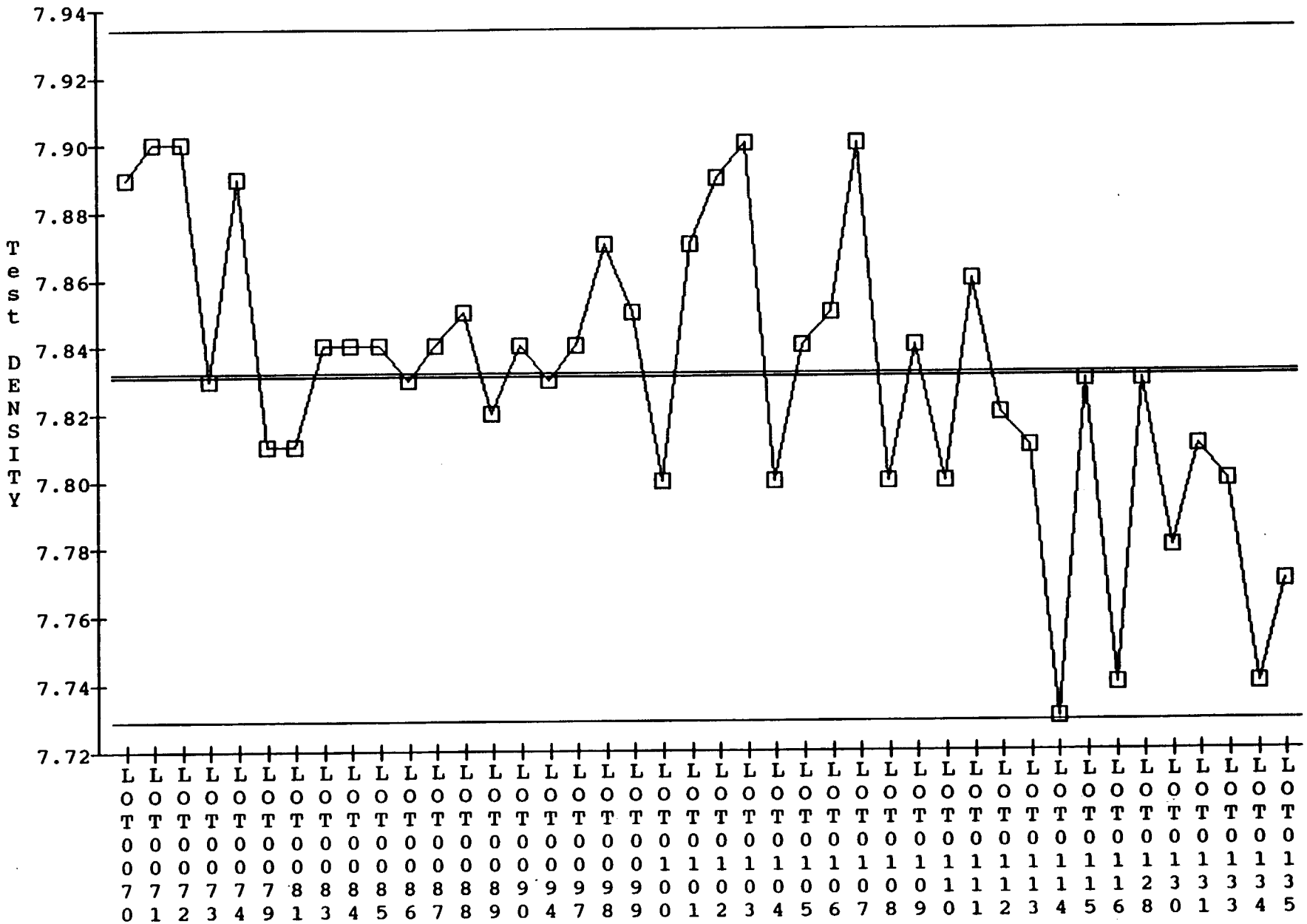
Prepared by Raw Materials PQE 18-FEB-93

Xbar chart for 7460_R_T0095



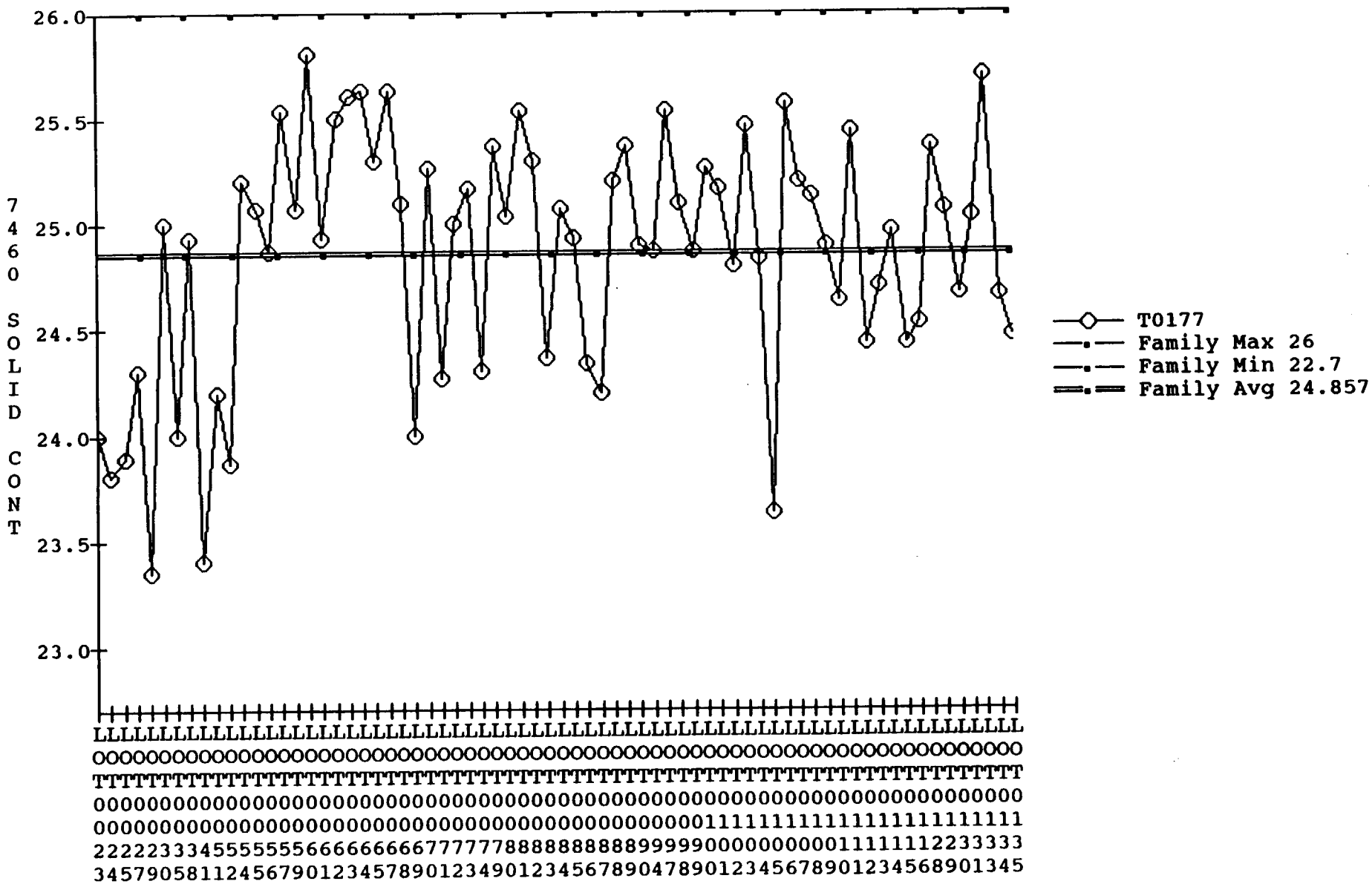
Prepared by Raw Materials PQE 18-FEB-93

Xbar chart for 7460_V_T0095



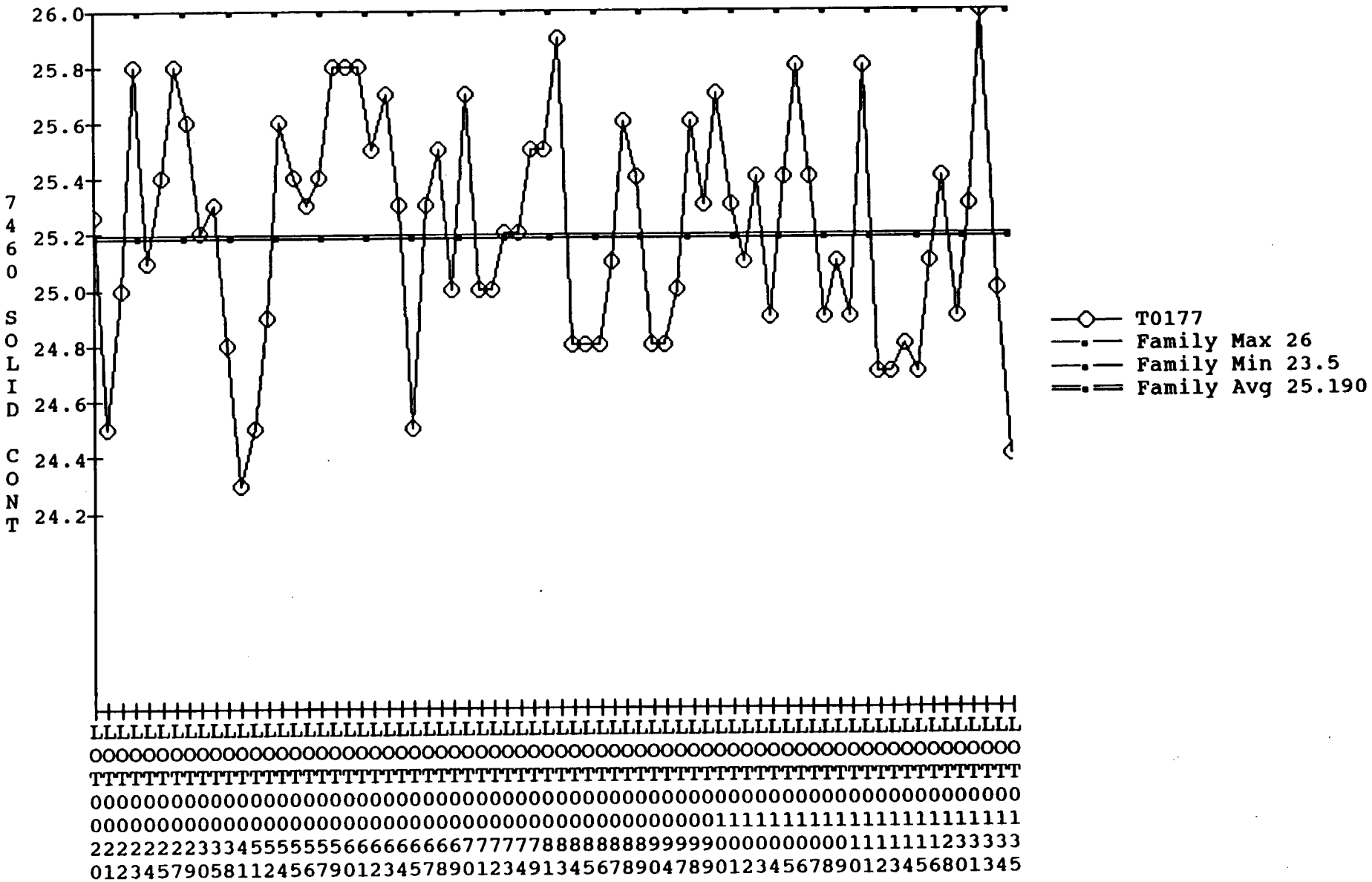
Prepared by Raw Materials PQE 18-FEB-93

Trend Chart for gxy7460 R_T0177



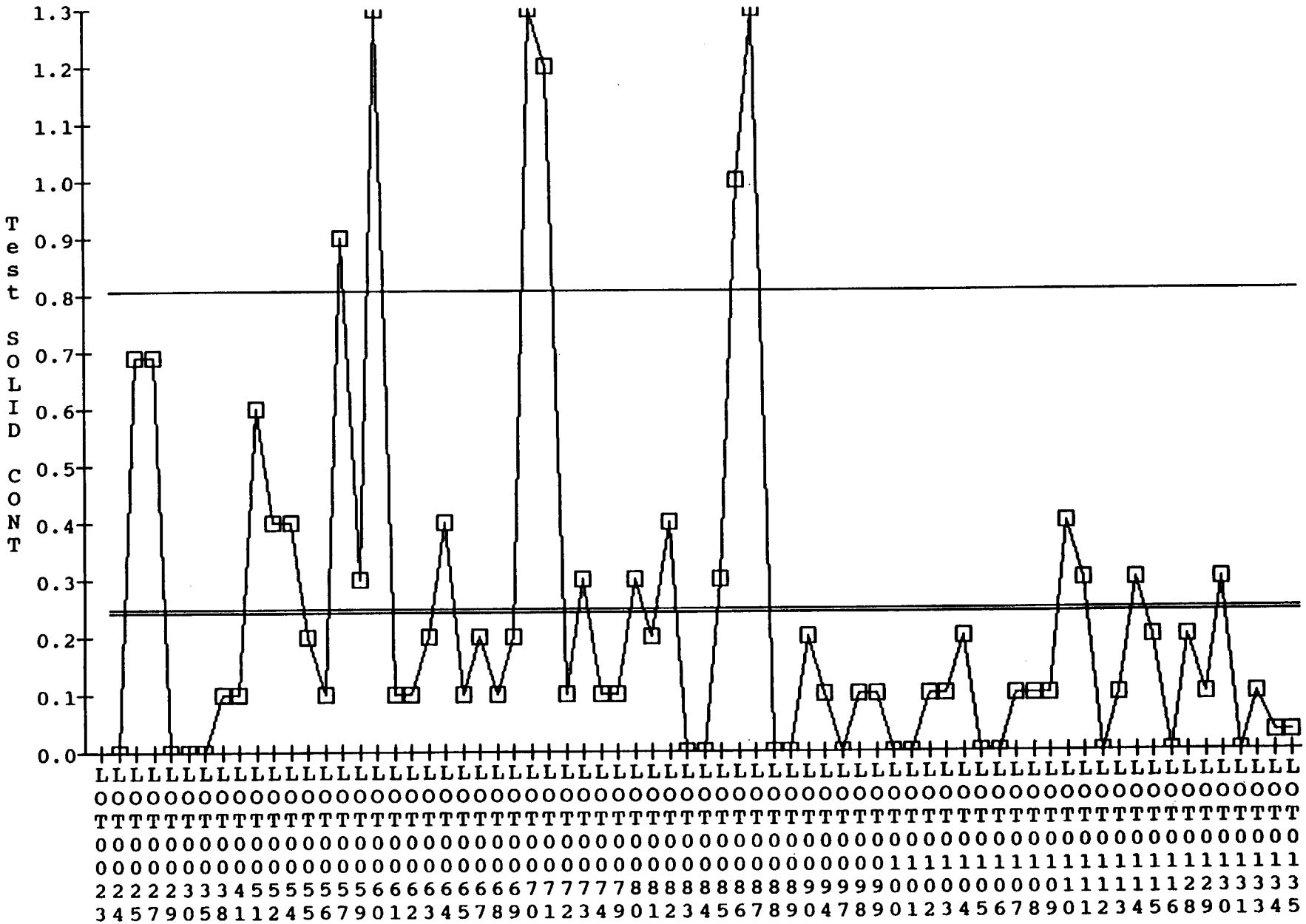
Prepared by Raw Materials PQE

Trend Chart for gxy7460 V_T0177



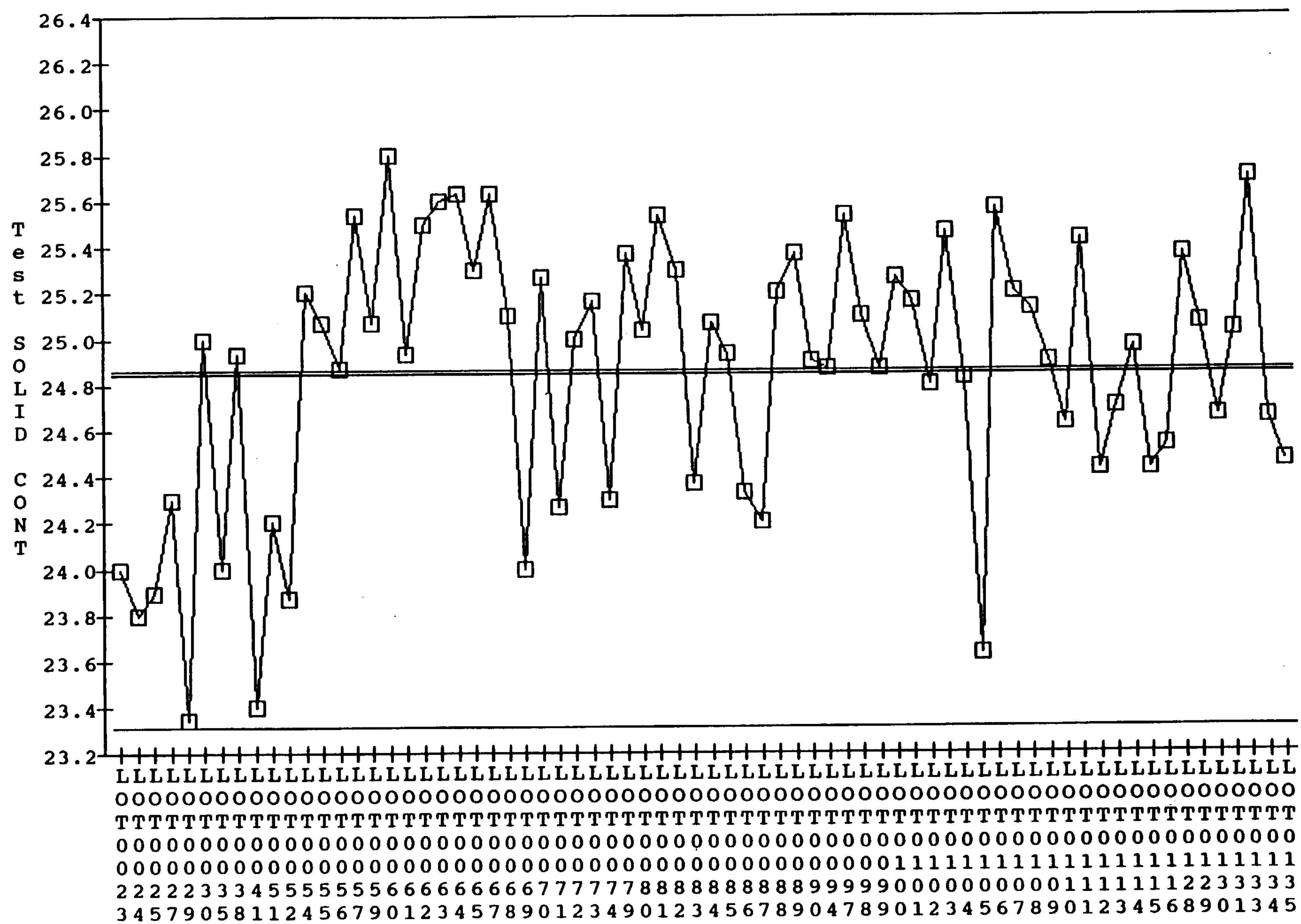
Prepared by Raw Materials PQE

R chart for 7460_R_T0177



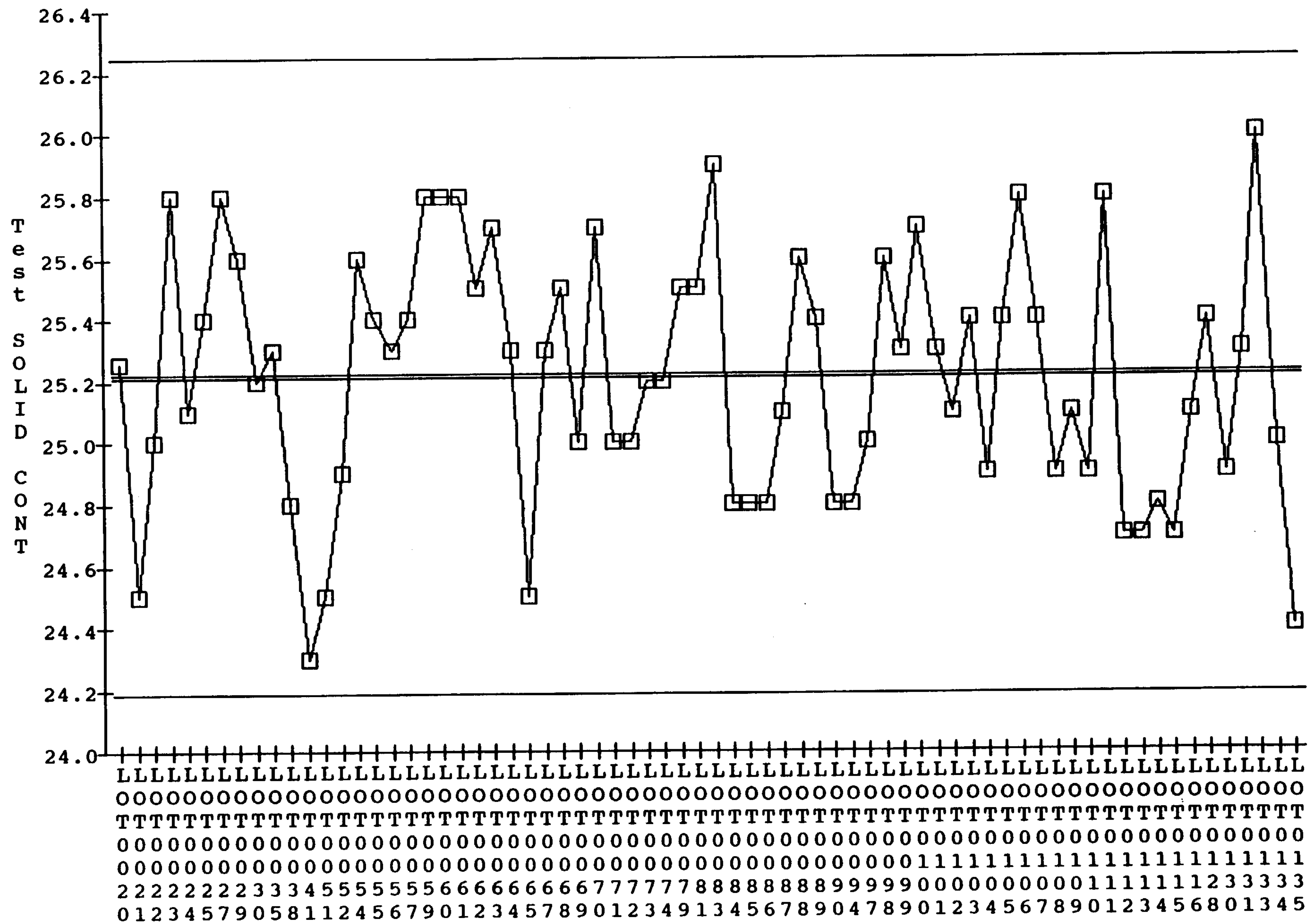
Prepared by Raw Materials PQE 18-FEB-93

Xbar chart for 7460_R_T0177



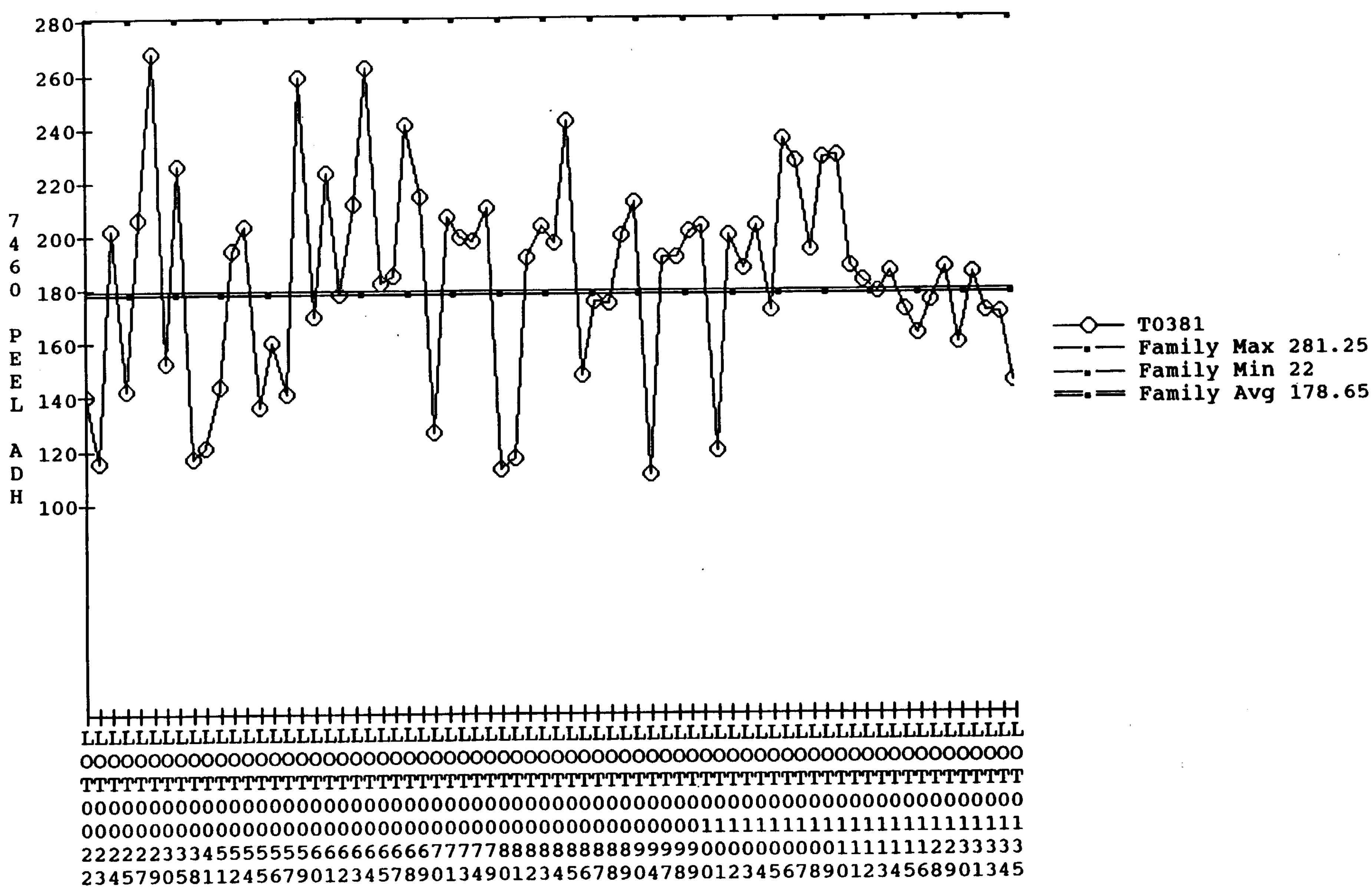
Prepared by Raw Materials PQE 18-FEB-93

Xbar chart for 7460_V_T0177



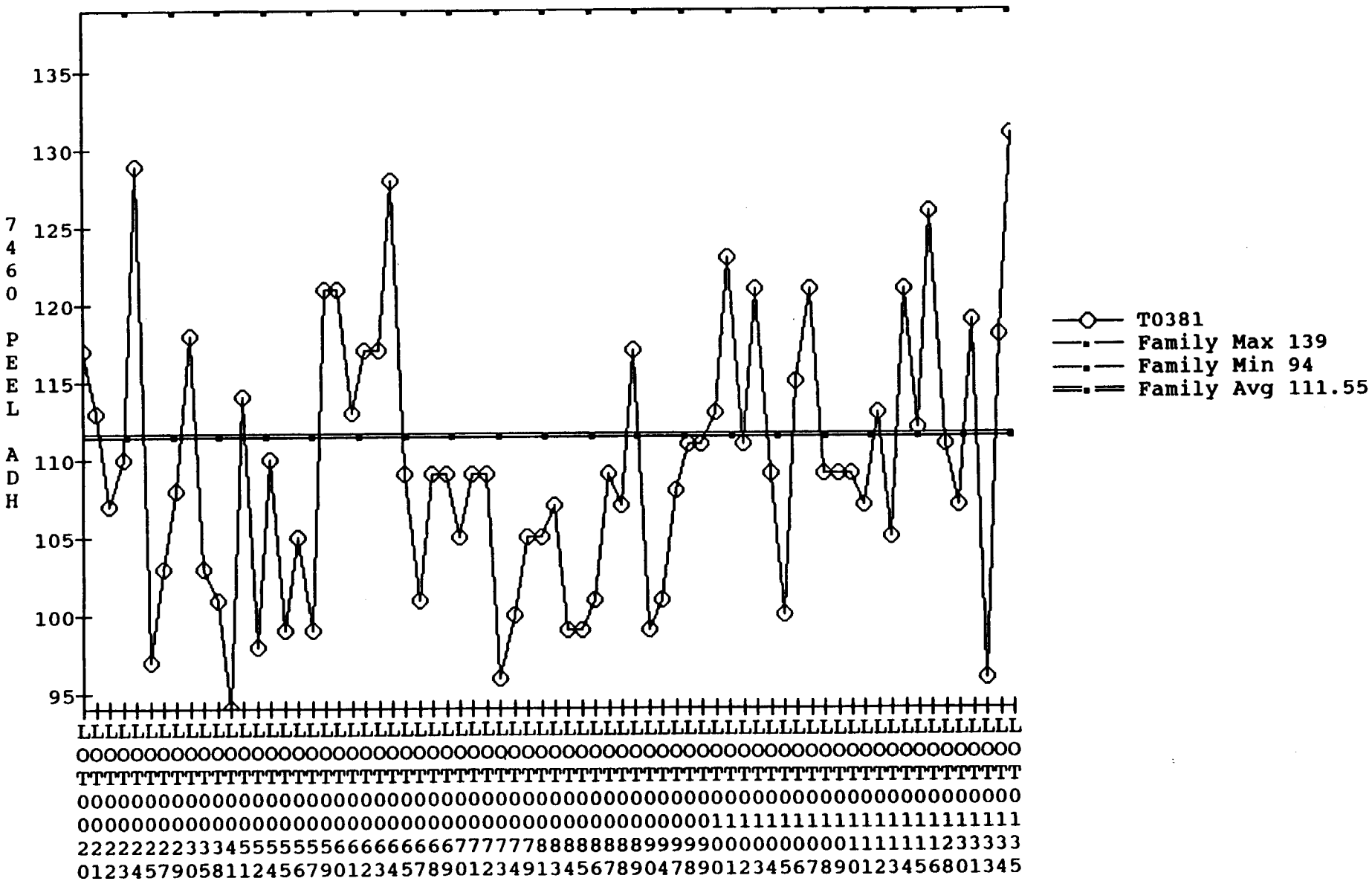
Prepared by Raw Materials PQE 18-FEB-93

Trend Chart for gxy7460 R_T0381



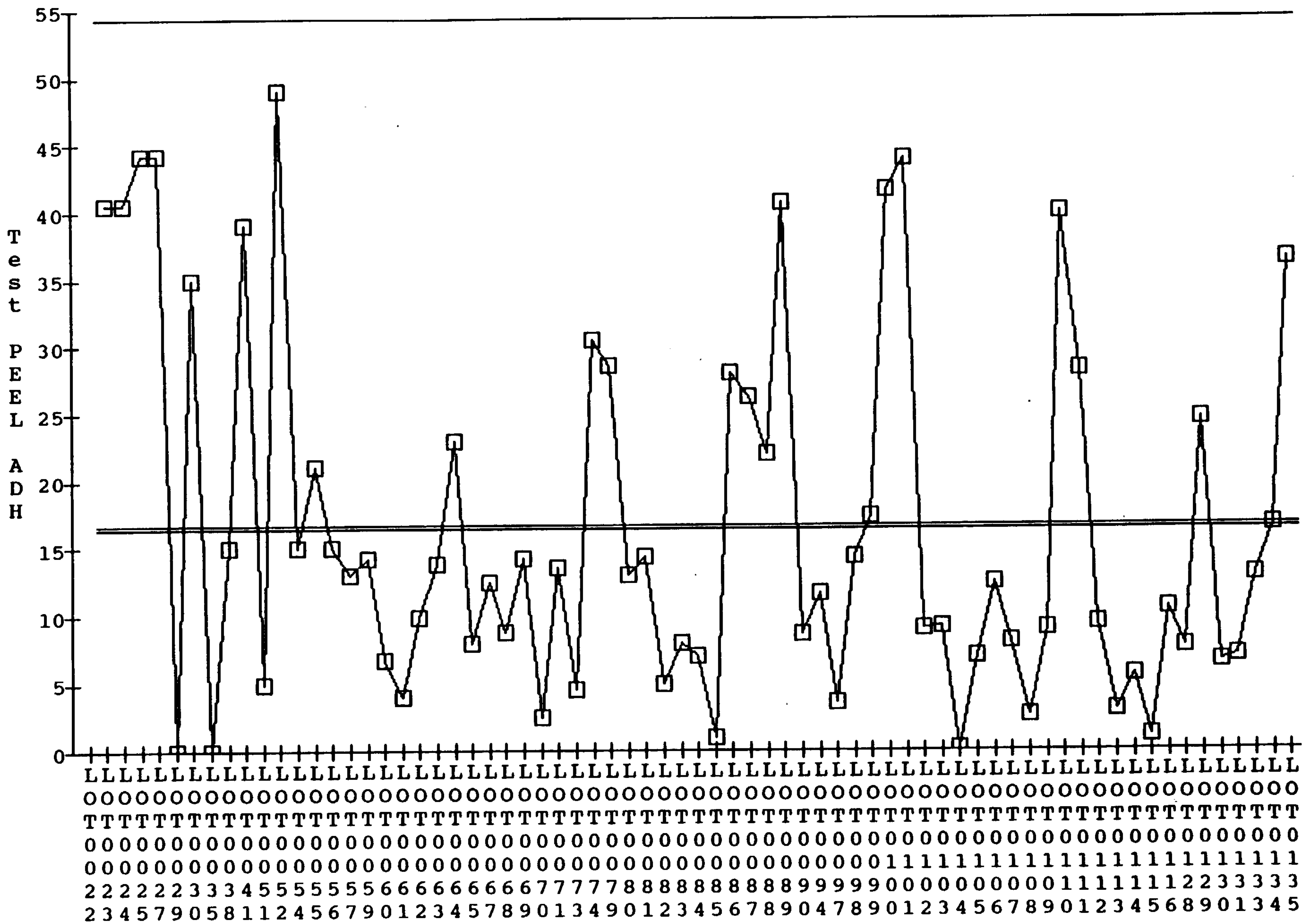
Prepared by Raw Materials PQE

Trend Chart for gxy7460 V_T0381



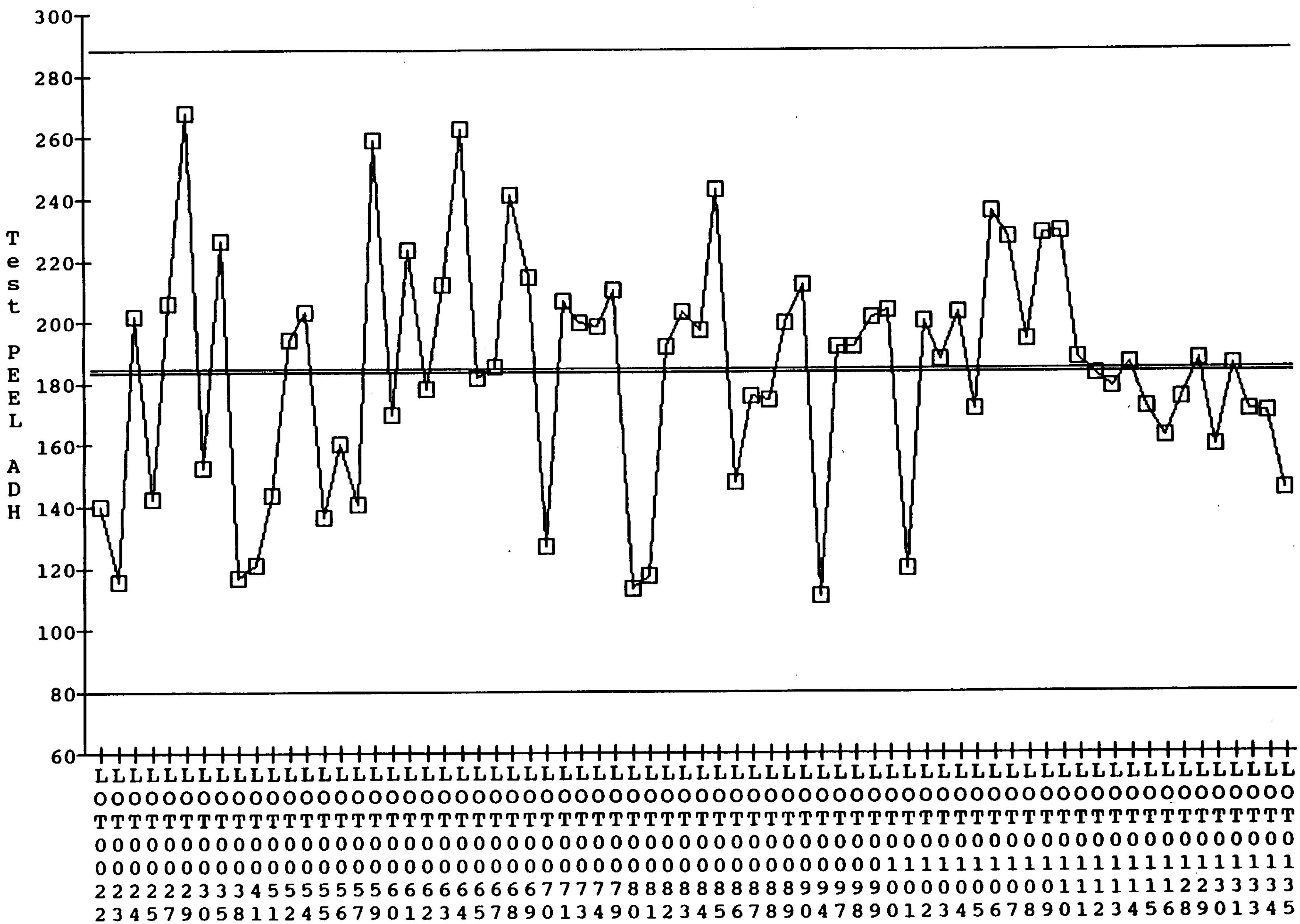
Prepared by Raw Materials PQE

R chart for 7460_R_T0381



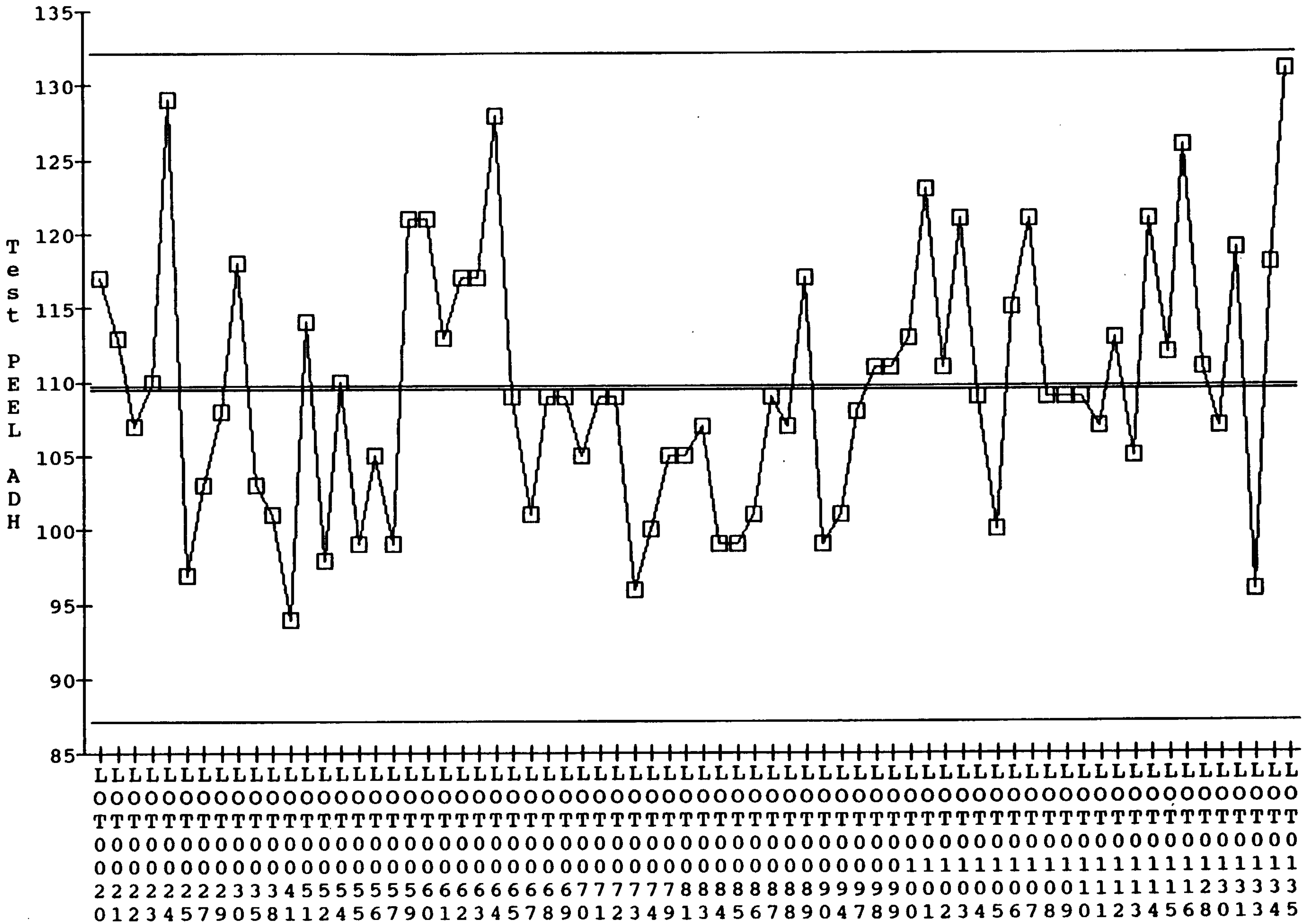
Prepared by Raw Materials PQE 18-FEB-93

Xbar chart for 7460_R_T0381



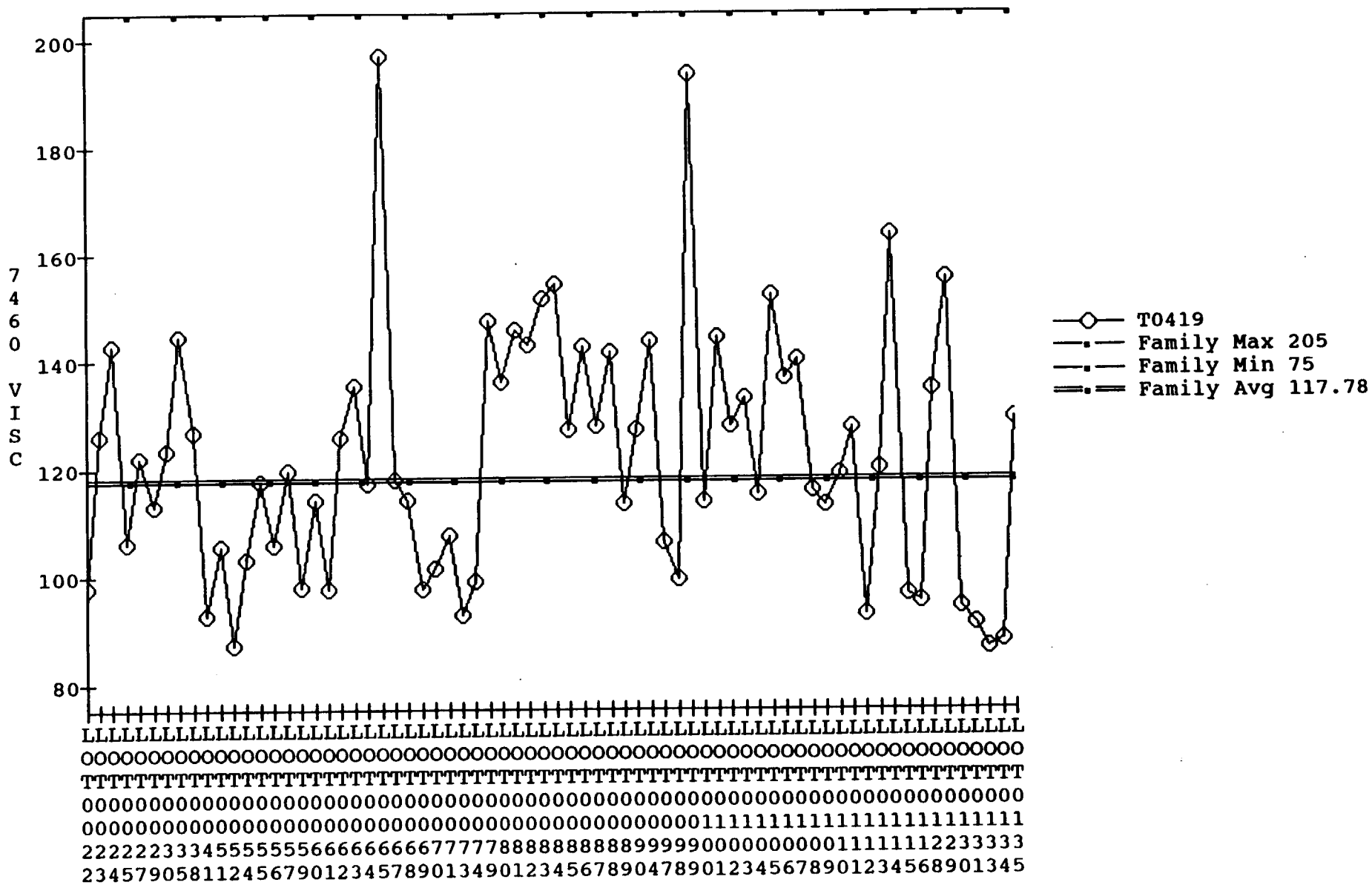
Prepared by Raw Materials PQE 18-FEB-93

Xbar chart for 7460_V_T0381



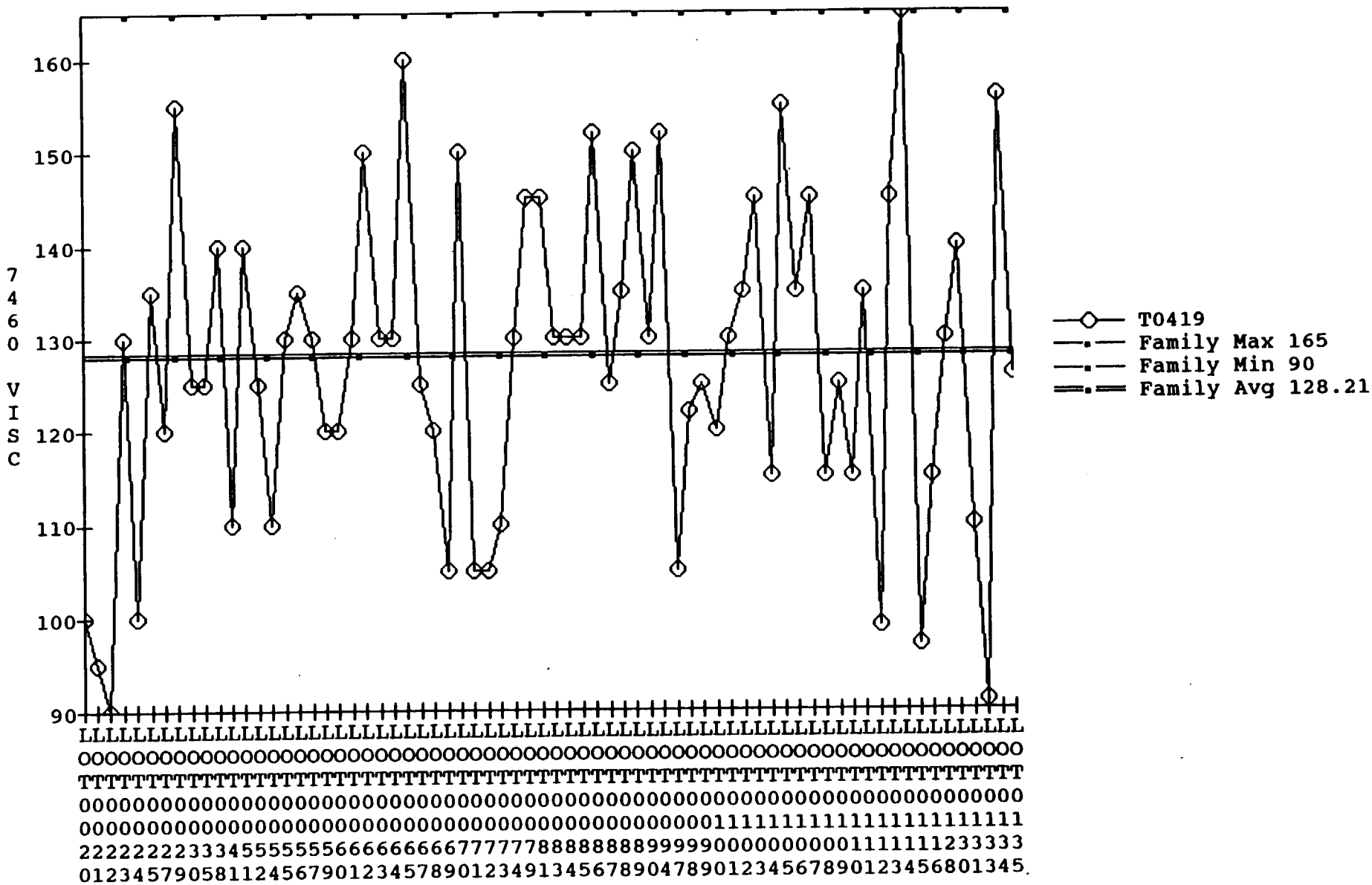
Prepared by Raw Materials PQE 18-FEB-93

Trend Chart for gxy7460 R_T0419



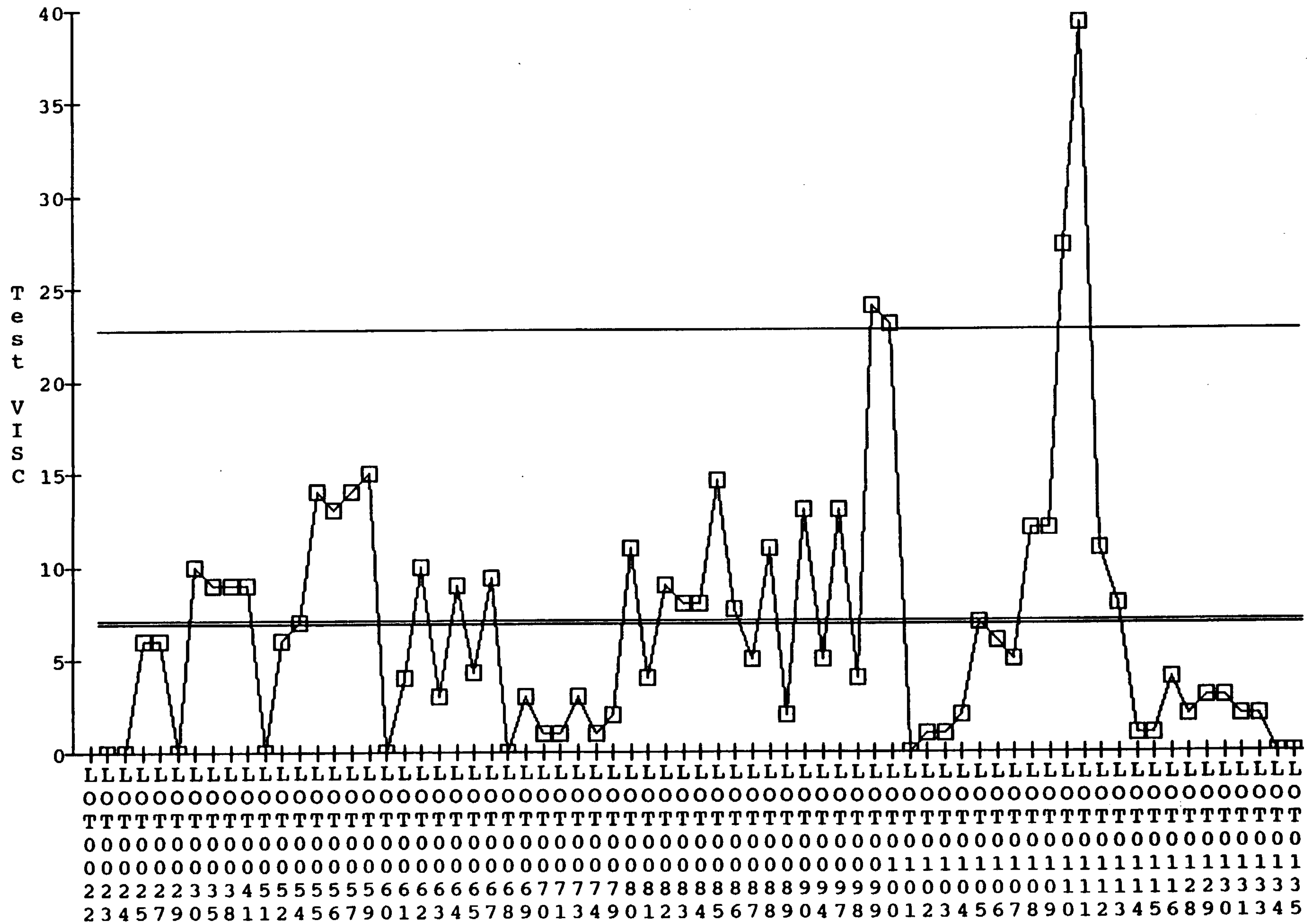
Prepared by Raw Materials PQE

Trend Chart for gxy7460 V_T0419



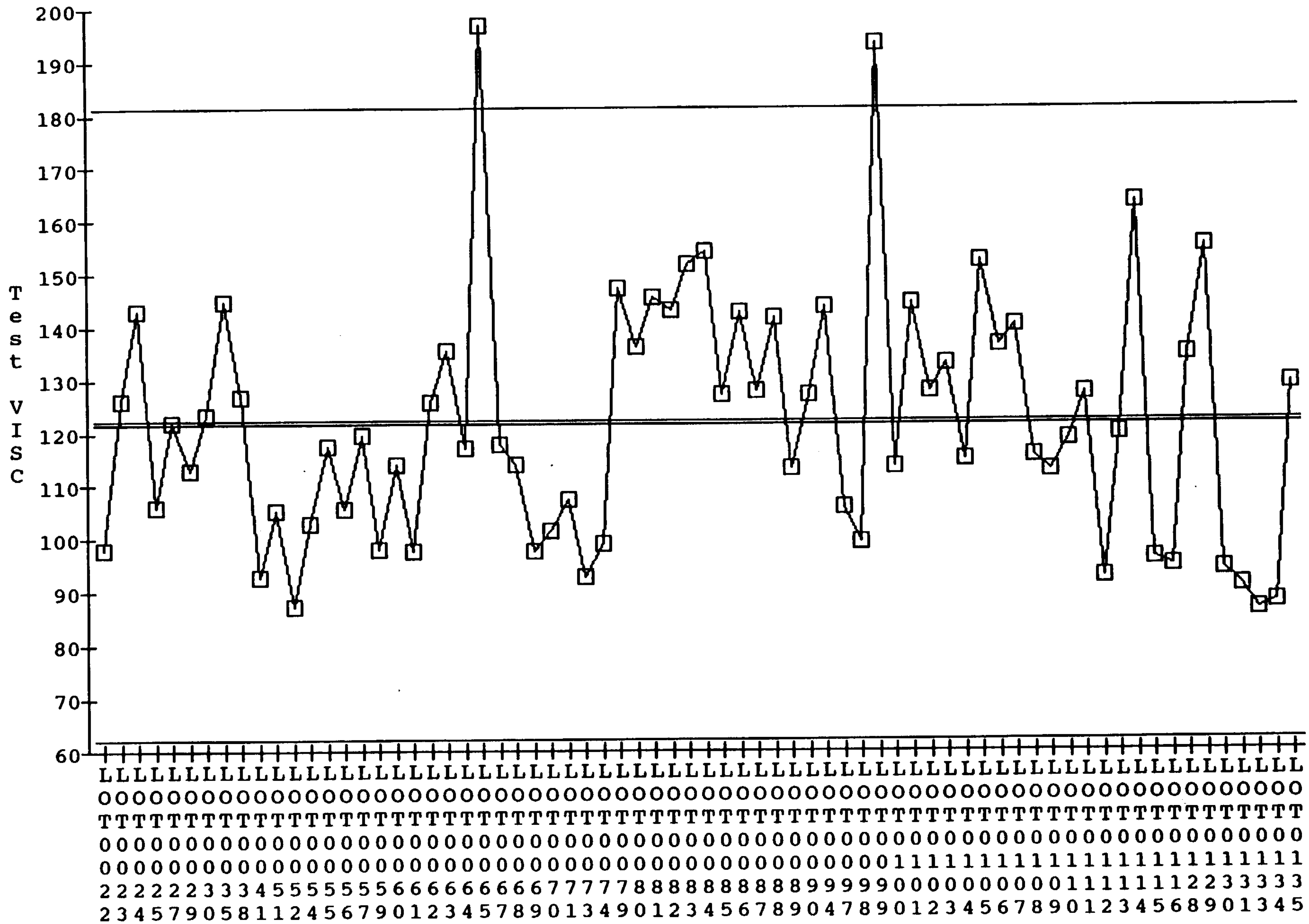
Prepared by Raw Materials PQE

R chart for 7460_R_T0419



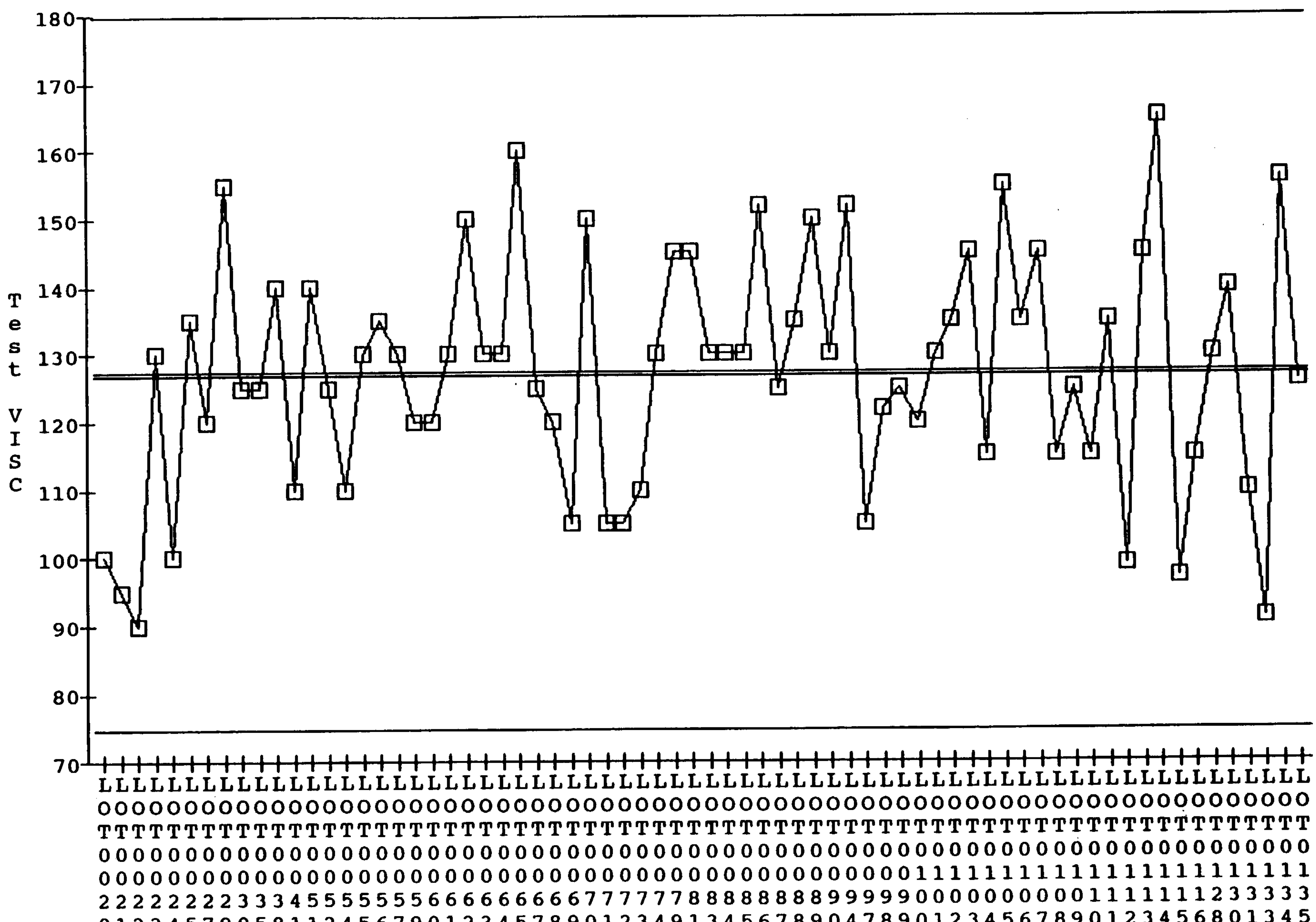
Prepared by Raw Materials PQE 18-FEB-93

Xbar chart for 7460_R_T0419



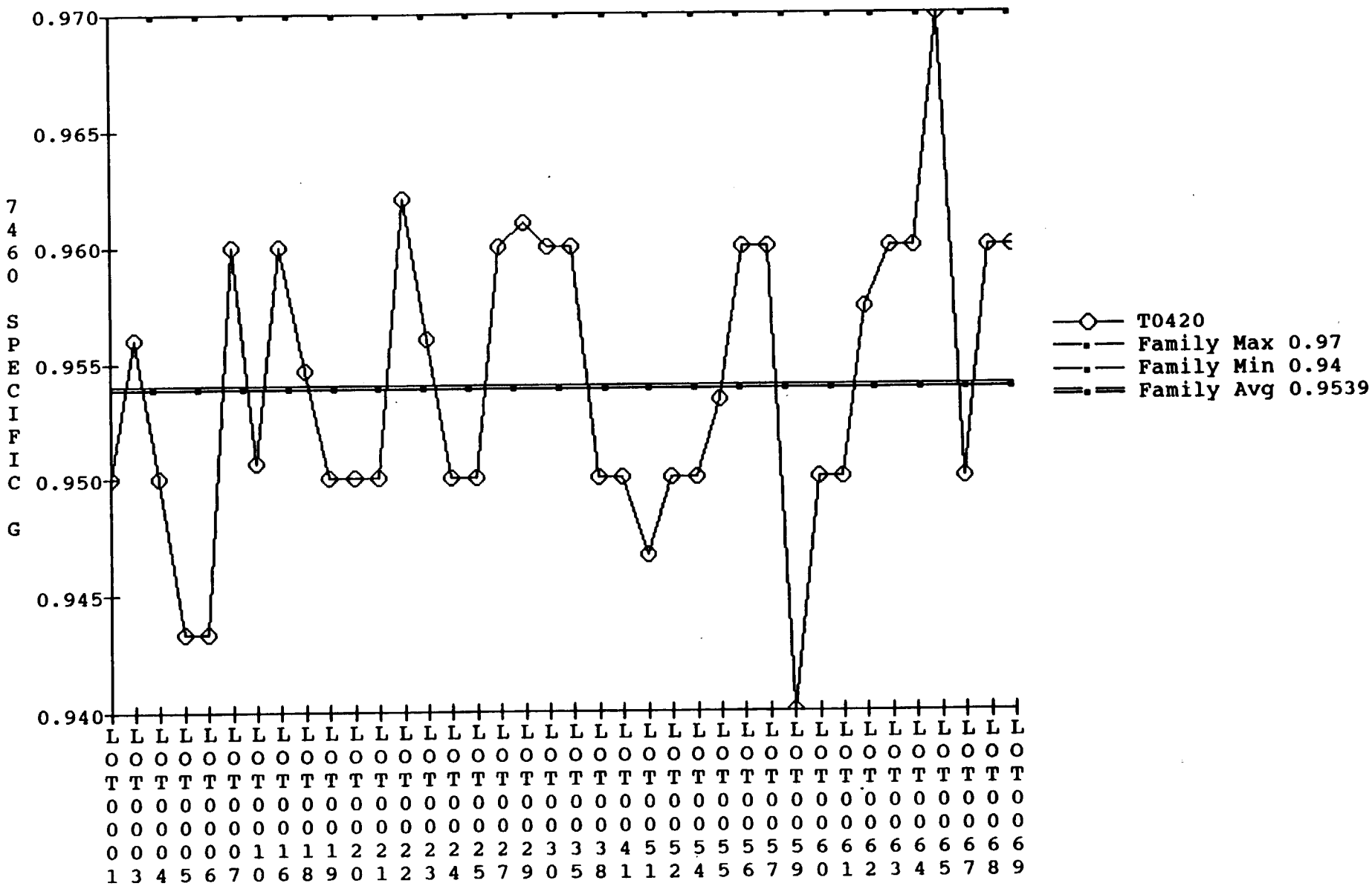
Prepared by Raw Materials PQE 18-FEB-93

Xbar chart for 7460_V_T0419



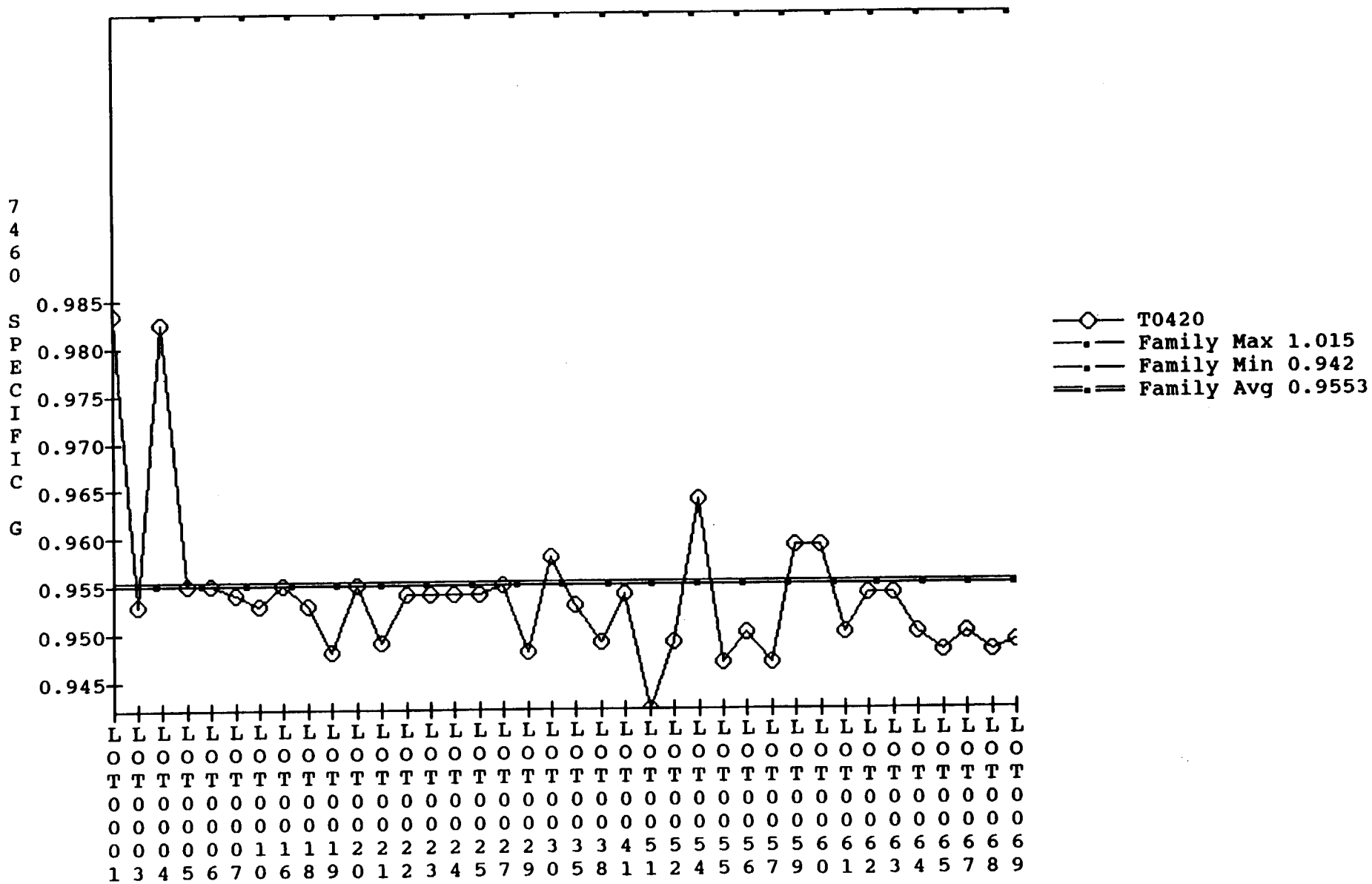
Prepared by Raw Materials PQE 18-FEB-93

Trend Chart for gxy7460 R_T0420



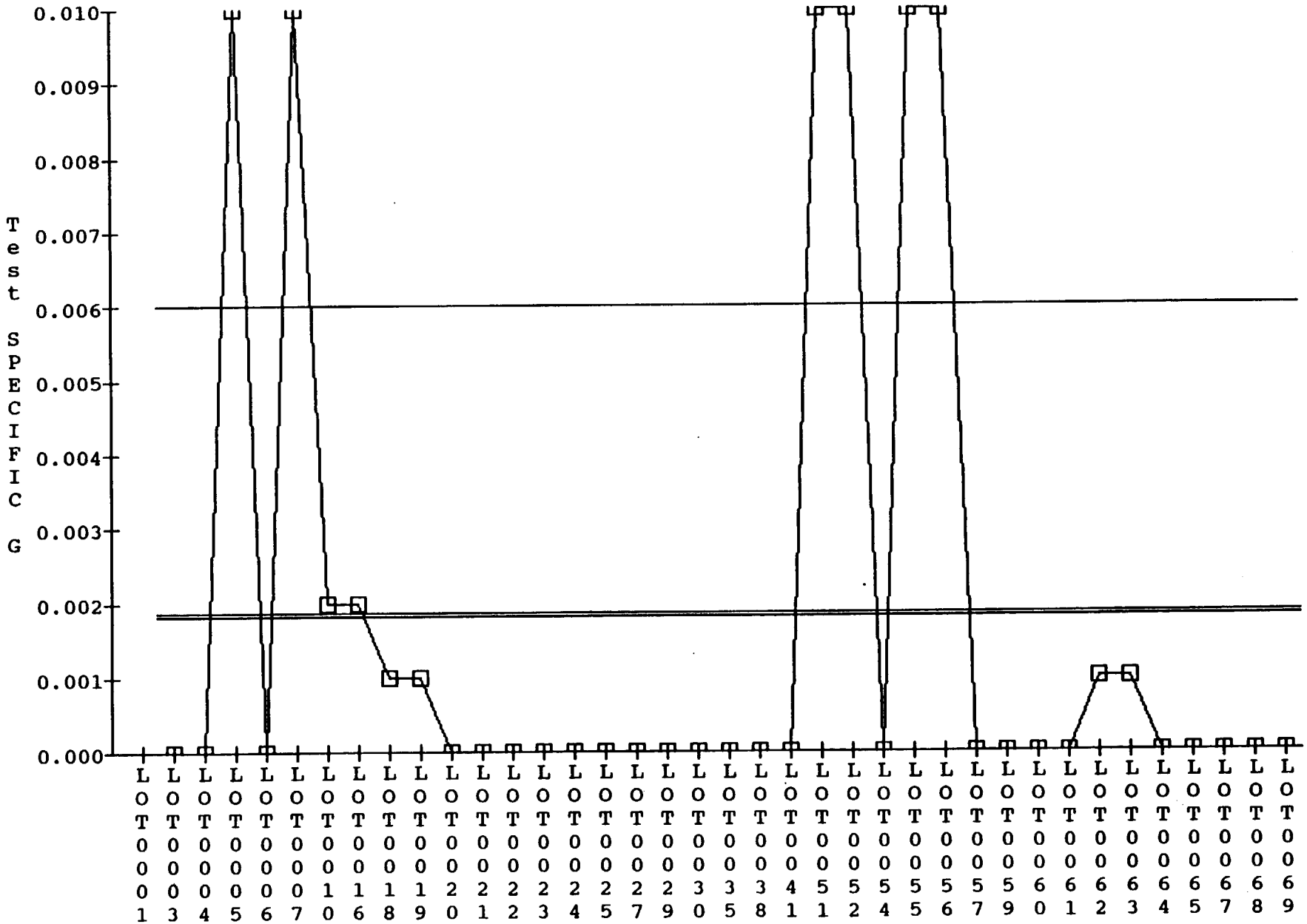
Prepared by Raw Materials PQE

Trend Chart for gxy7460 V_T0420



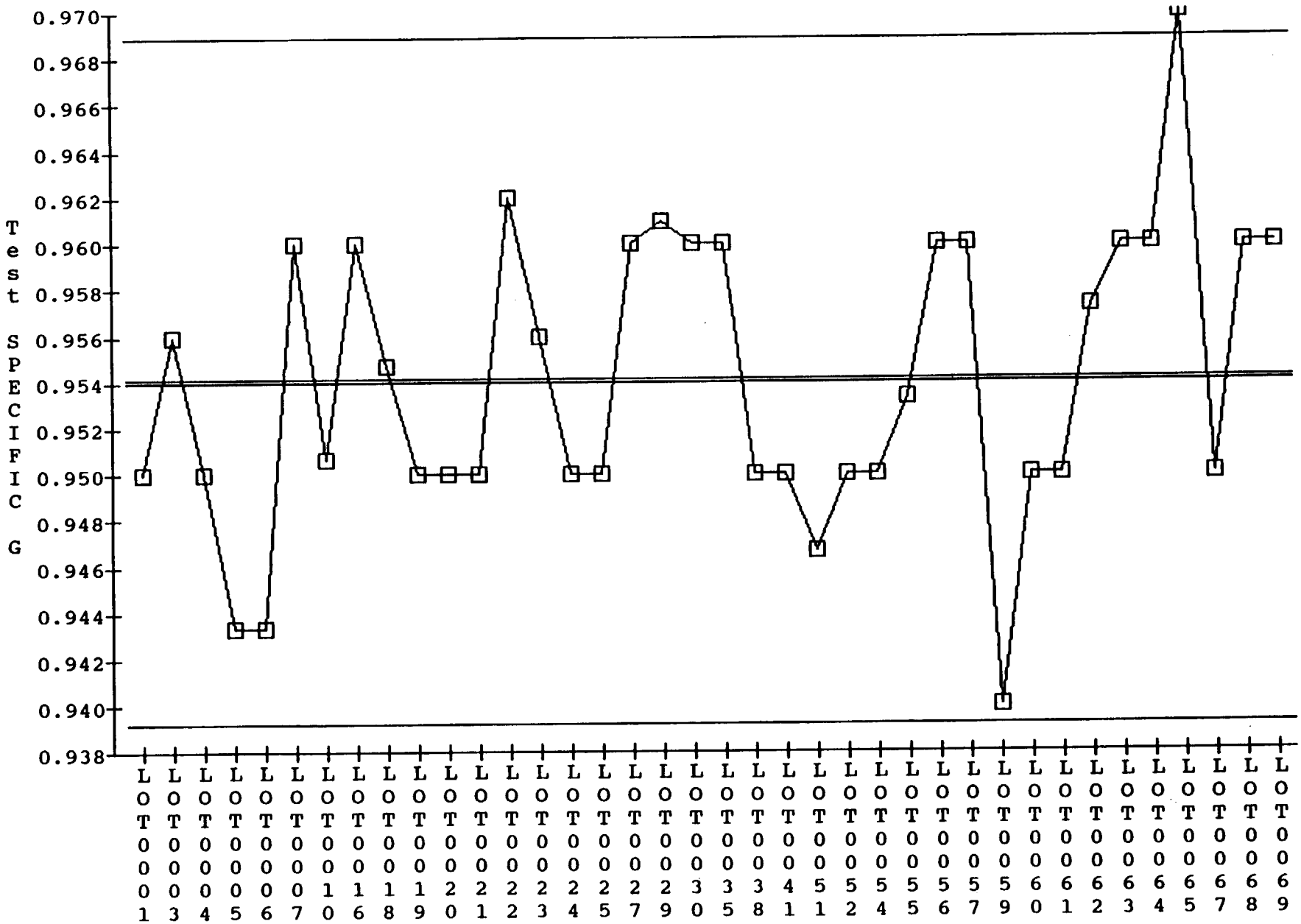
Prepared by Raw Materials PQE

R chart for 7460_R_T0420



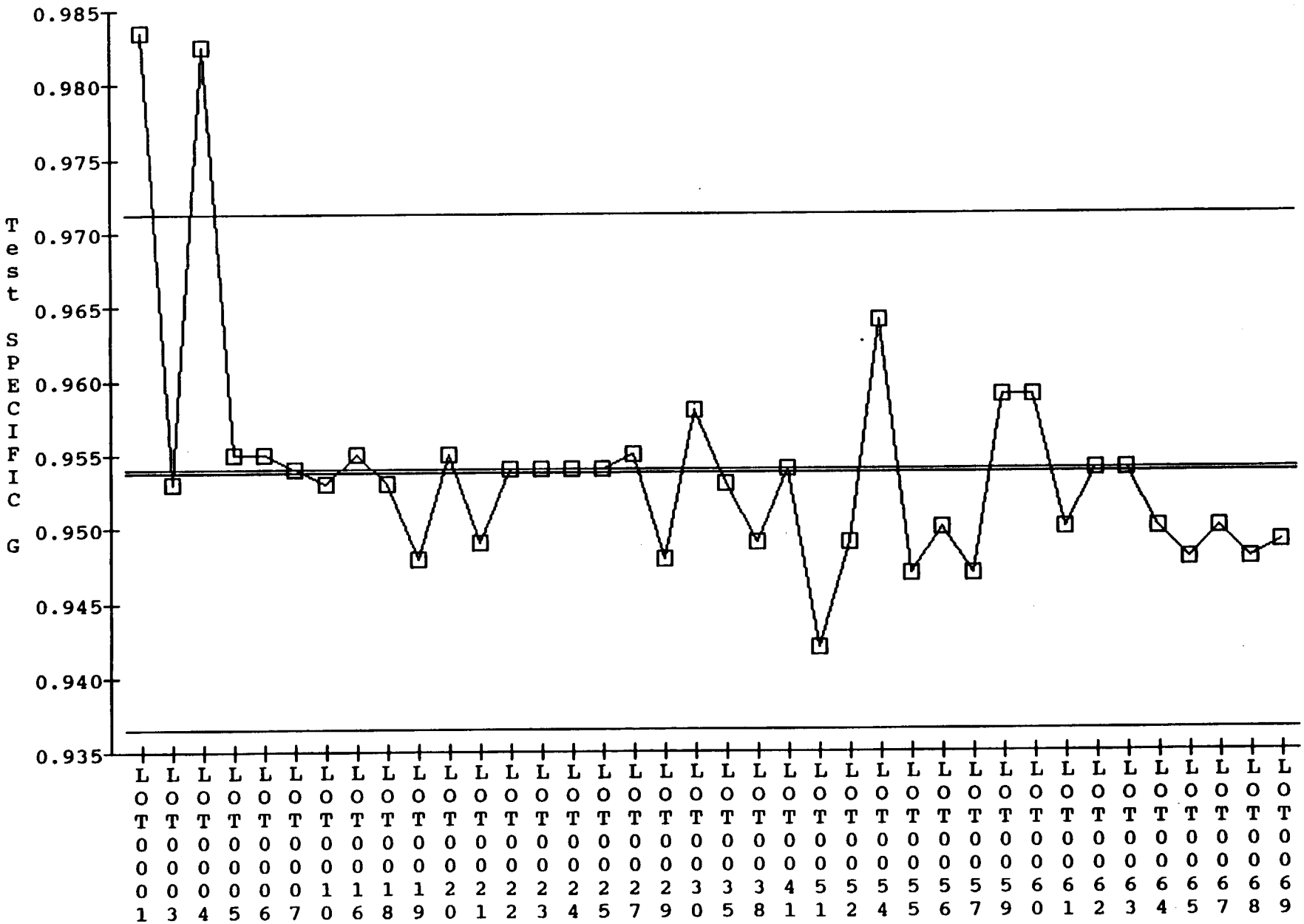
Prepared by Raw Materials PQE 18-FEB-93

Xbar chart for 7460_R_T0420



Prepared by Raw Materials PQE 18-FEB-93

Xbar chart for 7460_V_T0420



Prepared by Raw Materials PQE 18-FEB-93

JUDY'S SUPER JOB SAVING REPORT - FILE > D7460.DAT 2/17/1993

LOT NO.	T	ITEM	DATE	MATRIX	DATA 00 01	02 ...
LOT0001	R	0140		*0000177		24.5 24.5 24.7
LOT0001	R	0150		*0000420		.95 .95 .95
LOT0001	R	0160		*0000419		96 97 96
LOT0001	V	0140		*0000177		24.84 24.03
LOT0001	V	0150		*0000420		.952 1.015
LOT0001	V	0160		*0000419		160 144
LOT0003	3	0250	930216	*0000177		23.42 23.37 23.34
LOT0003	3	0260	930216	*0000420		.950 .956 .957
LOT0003	3	0270	930216	*0000419		90 90 95
LOT0003	R	0140		*0000177		25.9 25.9 25.9
LOT0003	R	0150		*0000420		.956 .956 .956
LOT0003	R	0160		*0000419		86 87 92
LOT0003	V	0140		*0000177		25.49
LOT0003	V	0150		*0000420		.953
LOT0003	V	0160		*0000419		110
LOT0003	V	0165		*0000381		122
LOT0004	R	0140		*0000177		25.7 25.4 25.5
LOT0004	R	0150		*0000420		0.95 0.95 0.95
LOT0004	R	0160		*0000419		75 77 84 85 80 83
LOT0004	V	0140		*0000177		25.70 23.50
LOT0004	V	0150		*0000420		.955 1.010
LOT0004	V	0165		*0000381		106 127
LOT0004	V	0165		*0000419		110 140
LOT0005	R	0140		*0000177		24.6 24.3 24.4
LOT0005	R	0150		*0000420		.95 .94 .94
LOT0005	R	0160		*0000419		91 86 86
LOT0005	V	0140		*0000177		25.56
LOT0005	V	0150		*0000420		.955
LOT0005	V	0160		*0000419		110
LOT0005	V	0165		*0000381		134
LOT0006	R	0140		*0000177		24.6 24.3 24.4
LOT0006	R	0150		*0000420		.95 .94 .94
LOT0006	R	0160		*0000419		91 86 86
LOT0006	V	0140		*0000177		25.56
LOT0006	V	0150		*0000420		.955
LOT0006	V	0160		*0000419		110
LOT0006	V	0165		*0000381		134
LOT0007	R	0140		*0000177		25.2 25.1 25.0
LOT0007	R	0150		*0000420		0.96 0.96 0.96
LOT0007	R	0160		*0000419		85 86 85
LOT0007	V	0140		*0000177		25.91
LOT0007	V	0150		*0000420		.954
LOT0007	V	0160		*0000419		125
LOT0007	V	0165		*0000381		127
LOT0010	R	0140		*0000177		24.9 24.7 25.2
LOT0010	R	0150		*0000420		.952 .950 .950
LOT0010	R	0160		*0000419		101 100 128
LOT0010	V	0140		*0000177		24.94
LOT0010	V	0150		*0000420		.953
LOT0010	V	0160		*0000419		160
LOT0010	V	0165		*0000381		125
LOT0016	R	0140		*0000177		24.9 24.8 24.8

LOT NO.	T	ITEM	DATE	MATRIX	DATA 00 01	02 ...
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LOT0016	R	0160		*0000419		118 118 118
LOT0016	V	0140		*0000177		25.5
LOT0016	V	0150		*0000420		.955
LOT0016	V	0160		*0000419		120
LOT0016	V	0165		*0000381		112
LOT0018	R	0140		*0000177		24.62 24.66 24.52
LOT0018	R	0150		*0000420		0.955 0.954 0.955
LOT0018	R	0160		*0000419		109.6 117.4 117.4 #99-> 114.8
LOT0018	R	0165		*0000381		49.5 47.5 88.0
LOT0018	V	0140		*0000177		24.8
LOT0018	V	0150		*0000420		.953
LOT0018	V	0160		*0000419		160
LOT0018	V	0165		*0000381		139
LOT0019	R	0140		*0000177		24.3
LOT0019	R	0150		*0000420		.95
LOT0019	R	0160		*0000419		94
LOT0019	R	0165		*0000381		120
LOT0019	V	0140		*0000177		24.7
LOT0019	V	0150		*0000420		.948
LOT0019	V	0160		*0000419		160
LOT0019	V	0165		*0000381		124
LOT0020	R	0140		*0000177		23.70 23.01 23.12
LOT0020	R	0150		*0000420		.95 .95 .95
LOT0020	R	0160		*0000419		95 100 100
LOT0020	R	0165		*0000381		22 28 26
LOT0020	V	0140		*0000177		25.26
LOT0020	V	0150		*0000420		.955
LOT0020	V	0160		*0000419		100
LOT0020	V	0165		*0000381		117
LOT0021	R	0140		*0000177		22.7
LOT0021	R	0150		*0000420		.95
LOT0021	R	0160		*0000419		93
LOT0021	R	0165		*0000381		151
LOT0021	V	0140		*0000177		24.5
LOT0021	V	0150		*0000420		.949
LOT0021	V	0160		*0000419		95
LOT0021	V	0165		*0000381		113
LOT0022	R	0140		*0000177		23.2
LOT0022	R	0150		*0000420		.962
LOT0022	R	0160		*0000419		98
LOT0022	R	0165		*0000381		140
LOT0022	V	0140		*0000177		25.0
LOT0022	V	0150		*0000420		.954
LOT0022	V	0160		*0000419		90
LOT0022	V	0165		*0000381		107
LOT0023	R	0140		*0000177		24.0
LOT0023	R	0150		*0000420		.956
LOT0023	R	0160		*0000419		126
LOT0023	R	0165		*0000381		107 99.5 140
LOT0023	V	0140		*0000177		25.8
LOT0023	V	0150		*0000420		.954

LOT NO.	T	ITEM DATE	MATRIX	DATA 00 01	02 ...
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LOT0023	V	0165	*0000381		110
LOT0024	R	0140	*0000177		23.8
LOT0024	R	0150	*0000420		.950
LOT0024	R	0160	*0000419		143
LOT0024	R	0165	*0000381		202
LOT0024	V	0140	*0000177		25.1
LOT0024	V	0150	*0000420		.954
LOT0024	V	0160	*0000419		100
LOT0024	V	0165	*0000381		129
LOT0025	R	0140	*0000177		24.16 24.04 23.47
LOT0025	R	0150	*0000420		0.95 0.95 0.95
LOT0025	R	0160	*0000419		104 110 104
LOT0025	R	0165	*0000381		113.8 158.0 154.6
LOT0025	V	0140	*0000177		25.4
LOT0025	V	0150	*0000420		.954
LOT0025	V	0160	*0000419		135
LOT0025	V	0165	*0000381		97
LOT0027	R	0140	*0000177		24.3
LOT0027	R	0150	*0000420		.96
LOT0027	R	0160	*0000419		122
LOT0027	R	0165	*0000381		206
LOT0027	V	0140	*0000177		25.8
LOT0027	V	0150	*0000420		.955
LOT0027	V	0160	*0000419		120
LOT0027	V	0165	*0000381		103
LOT0029	R	0140	*0000177		23.35
LOT0029	R	0150	*0000420		.961
LOT0029	R	0160	*0000419		113
LOT0029	R	0165	*0000381		268
LOT0029	V	0140	*0000177		25.6
LOT0029	V	0150	*0000420		.948
LOT0029	V	0160	*0000419		155
LOT0029	V	0165	*0000381		108
LOT0030	R	0140	*0000177		25.0 25.0 25.0
LOT0030	R	0150	*0000420		.96 .96 .96
LOT0030	R	0160	*0000419		120 120 130
LOT0030	R	0165	*0000381		174 144 139
LOT0030	V	0140	*0000177		25.2
LOT0030	V	0150	*0000420		.958
LOT0030	V	0160	*0000419		125
LOT0030	V	0165	*0000381		118
LOT0035	R	0140	*0000177		24.0 24.0 24.0
LOT0035	R	0150	*0000420		.96 .96 .96
LOT0035	R	0160	*0000419		145 144 145
LOT0035	R	0165	*0000381		235 225 205 240 #99-> 226
LOT0035	V	0140	*0000177		25.3
LOT0035	V	0150	*0000420		.953
LOT0035	V	0160	*0000419		125
LOT0035	V	0165	*0000381		103
LOT0038	R	0140	*0000177		24.9 24.9 25.0
LOT0038	R	0150	*0000420		.95 .95 .95

LOT NO.	T	ITEM	DATE	MATRIX	DATA 00 01	02 ...
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LOT0038	R	0165		*0000381		126 118 106
LOT0038	V	0140		*0000177		24.8
LOT0038	V	0150		*0000420		.949
LOT0038	V	0160		*0000419		140
LOT0038	V	0165		*0000381		101
LOT0041	R	0140		*0000177		23.4 23.5 23.3 #99-> 23.4
LOT0041	R	0150		*0000420		.95 .95 .95 #99-> .95
LOT0041	R	0160		*0000419		93 92 93 #99-> 93
LOT0041	R	0165		*0000381		104 159 100 #99-> 121
LOT0041	V	0140		*0000177		24.3
LOT0041	V	0150		*0000420		.954
LOT0041	V	0160		*0000419		110
LOT0041	V	0165		*0000381		94
LOT0051	R	0140		*0000177		23.8 24.6 24.2
LOT0051	R	0150		*0000420		.95 .95 .94
LOT0051	R	0160		*0000419		105 106 105
LOT0051	R	0165		*0000381		133 181 117
LOT0051	V	0140		*0000177		24.5
LOT0051	V	0150		*0000420		.942
LOT0051	V	0160		*0000419		140
LOT0051	V	0165		*0000381		114
LOT0052	R	0140		*0000177		23.7 23.8 24.1
LOT0052	R	0150		*0000420		.95 .95 .95
LOT0052	R	0160		*0000419		85 85 92
LOT0052	R	0165		*0000381		189 190 204
LOT0052	V	0140		*0000177		24.9
LOT0052	V	0150		*0000420		.949
LOT0052	V	0160		*0000419		125
LOT0052	V	0165		*0000381		98
LOT0054	R	0140		*0000177		25.2
LOT0054	R	0150		*0000420		.95
LOT0054	R	0160		*0000419		103
LOT0054	R	0165		*0000381		203.3
LOT0054	V	0140		*0000177		25.6
LOT0054	V	0150		*0000420		.964
LOT0054	V	0160		*0000419		110
LOT0054	V	0165		*0000381		110
LOT0055	R	0140		*0000177		25.0 25.2 25.0
LOT0055	R	0150		*0000420		.96 .95 .95
LOT0055	R	0160		*0000419		111 125 116
LOT0055	R	0165		*0000381		148 134 127
LOT0055	V	0140		*0000177		25.4
LOT0055	V	0150		*0000420		.947
LOT0055	V	0160		*0000419		130
LOT0055	V	0165		*0000381		99
LOT0056	R	0140		*0000177		24.7 25.0 24.9 #99-> 24.9
LOT0056	R	0150		*0000420		.96 .96 .96 #99-> .96
LOT0056	R	0160		*0000419		106 105 106 #99-> 106
LOT0056	R	0165		*0000381		146 182 153 #99-> 160
LOT0056	V	0140		*0000177		25.3
LOT0056	V	0150		*0000420		.950

LOT NO.	T	ITEM DATE	MATRIX	DATA 00 01	02 ...
LOT0056	V	0160	*0000419		135
LOT0056	V	0165	*0000381		105
LOT0057	R	0140	*0000177		24.8 26.0 25.8
LOT0057	R	0150	*0000420		.96 .96 .96
LOT0057	R	0160	*0000419		111 126 122
LOT0057	R	0165	*0000381		152 141 129
LOT0057	V	0140	*0000177		25.4
LOT0057	V	0150	*0000420		.947
LOT0057	V	0160	*0000419		130
LOT0057	V	0165	*0000381		99
LOT0059	R	0140	*0000177		25.7 25.3 24.2 #99-> 25.1
LOT0059	R	0150	*0000420		.94 .94 .94 #99-> .94
LOT0059	R	0160	*0000419		98 98 98
LOT0059	R	0165	*0000381	1	211 280 264 221 #99-> 244
LOT0059	R	0165	*0000381	2	267 315 252 291 #99-> 281
LOT0059	R	0165	*0000381	3	227 215 286 277 #99-> 251
LOT0059	V	0140	*0000177		25.8
LOT0059	V	0150	*0000420		.959
LOT0059	V	0160	*0000419		120
LOT0059	V	0165	*0000381		121
LOT0060	R	0140	*0000177		25.9 25.7 25.8 #99-> 25.8
LOT0060	R	0150	*0000420		.95 .95 .95 #99-> .95
LOT0060	R	0160	*0000419		114
LOT0060	R	0165	*0000381		148 192 170 #99-> 170
LOT0060	V	0140	*0000177		25.8
LOT0060	V	0150	*0000420		.959
LOT0060	V	0160	*0000419		120
LOT0060	V	0165	*0000381		121
LOT0061	R	0140	*0000177		24.9 24.9 25.0 #99-> 24.9
LOT0061	R	0150	*0000420		.95 .95 .95 #99-> .95
LOT0061	R	0160	*0000419		96 100 97 #99-> 98
LOT0061	R	0165	*0000381		238 198 233 #99-> 223
LOT0061	V	0140	*0000177		25.8
LOT0061	V	0150	*0000420		.950
LOT0061	V	0160	*0000419		130
LOT0061	V	0165	*0000381		113
LOT0062	R	0140	*0000177		25.5 25.6 25.4 #99-> 25.5
LOT0062	R	0150	*0000420		.957 .958 .957 #99-> .957
LOT0062	R	0160	*0000419		132 118 127 #99-> 126
LOT0062	R	0165	*0000381	1	164.0 176.0 162.0 171.0 #99-> 168
LOT0062	R	0165	*0000381	2	192.0 200.0 199.5 200.0 #99-> 198
LOT0062	R	0165	*0000381	3	169.0 164.0 167.0 171.0 #99-> 168
LOT0062	V	0140	*0000177		25.5
LOT0062	V	0150	*0000420		.954
LOT0062	V	0160	*0000419		150
LOT0062	V	0165	*0000381		117
LOT0063	R	0140	*0000177		25.6 25.6 25.6 #99-> 25.6
LOT0063	R	0150	*0000420		.96 .96 .96 #99-> .96
LOT0063	R	0160	*0000419		124 141 141 #99-> 135
LOT0063	R	0165	*0000381	1	240 219 214 215 #99-> 222
LOT0063	R	0165	*0000381	2	220 200 204 206 #99-> 208
LOT0063	R	0165	*0000381	3	194 215 208 206 #99-> 206

LOT NO.	T	ITEM DATE	MATRIX	DATA 00 01	02 ...
LOT0063	V	0140	*0000177		25.7
LOT0063	V	0150	*0000420		.954
LOT0063	V	0160	*0000419		130
LOT0063	V	0165	*0000381		117
LOT0064		*0000095			
LOT0064	R	0140	*0000177		25.4 25.7 25.8 #99-> 25.6
LOT0064	R	0150	*0000420		.96 .96 .96 #99-> .96
LOT0064	R	0160	*0000419		112 120 119 #99-> 117
LOT0064	R	0165	*0000381	1 305	283 265 238 #99-> 262
LOT0064	R	0165	*0000381	2 288	265 255 300 #99-> 277
LOT0064	R	0165	*0000381	3 243	230 238 240 #99-> 238
LOT0064	V	0140	*0000177		25.3
LOT0064	V	0150	*0000420		.950
LOT0064	V	0160	*0000419		130
LOT0064	V	0165	*0000381		128
LOT0065		*0000095			
LOT0065	R	0140	*0000177		25.4 25.1 25.4 #99-> 25.3
LOT0065	R	0150	*0000420		.97 .97 .97 #99-> .97
LOT0065	R	0160	*0000419	1 190	190 192
LOT0065	R	0160	*0000419	2 201	203 205
LOT0065	R	0165	*0000381	1 183	179 200 200 #99-> 190
LOT0065	R	0165	*0000381	2 235	140 128 145 #99-> 162
LOT0065	R	0165	*0000381	3 193	164 219 197 #99-> 193
LOT0065	V	0140	*0000177		24.5
LOT0065	V	0150	*0000420		.948
LOT0065	V	0160	*0000419		160
LOT0065	V	0165	*0000381		109
LOT0067		*0000095			
LOT0067	R	0140	*0000177		25.6 25.7 25.6 #99-> 25.6
LOT0067	R	0150	*0000420		.95 .95 .95 #99-> .95
LOT0067	R	0160	*0000419		118 119 116
LOT0067	R	0165	*0000381	1 215	210 210 215 #99-> 213
LOT0067	R	0165	*0000381	2 180	175 150 170 #99-> 169
LOT0067	R	0165	*0000381	3 180	180 165 170 #99-> 174
LOT0067	V	0140	*0000177		25.3
LOT0067	V	0150	*0000420		.95
LOT0067	V	0160	*0000419		125
LOT0067	V	0165	*0000381		101
LOT0068		*0000095			
LOT0068	R	0140	*0000177		25.2 25.0 25.1 #99-> 25.1
LOT0068	R	0150	*0000420		.96 .96 .96 #99-> .96
LOT0068	R	0160	*0000419		112 115 115 #99-> 114
LOT0068	R	0165	*0000381	1 200	228 228 268 #99-> 231
LOT0068	R	0165	*0000381	2 265	282 283 260 #99-> 272
LOT0068	R	0165	*0000381	3 211	213 208 248 #99-> 220
LOT0068	V	0140	*0000177		25.5
LOT0068	V	0150	*0000420		.948
LOT0068	V	0160	*0000419		120
LOT0068	V	0165	*0000381		109
LOT0069		*0000095			
LOT0069	R	0140	*0000177		24.0 24.0 24.0 #99-> 24.0
LOT0069	R	0150	*0000420		.96 .96 .96 #99-> .96

LOT NO.	T	ITEM DATE	MATRIX	DATA 00	01	02 ...
LOT0069	R	0160	*0000419			94 99 100 #99-> 98
LOT0069	R	0165	*0000381	1	194	215 225 208 #99-> 210
LOT0069	R	0165	*0000381	2	190	250 240 260 #99-> 235
LOT0069	R	0165	*0000381	3	200	198 195 194 #99-> 197
LOT0069	V	0140	*0000177			25.0
LOT0069	V	0150	*0000420			.949
LOT0069	V	0160	*0000419			105
LOT0069	V	0165	*0000381			109
LOT0070	R	0140	*0000177			24.5 25.5 25.8 #99-> 25.3
LOT0070	R	0150	*0000095			7.97 7.98 7.95 #99-> 7.96
LOT0070	R	0160	*0000419			98 103 103
LOT0070	R	0165	*0000381	1	130	141 170 123 #99-> 141
LOT0070	R	0165	*0000381	2	145	141 121 128 #99-> 134
LOT0070	R	0165	*0000381	3	109	106 104 102 #99-> 105
LOT0070	V	0140	*0000177			25.7
LOT0070	V	0150	*0000095			7.89
LOT0070	V	0160	*0000419			150
LOT0070	V	0165	*0000381			105
LOT0071		*0000153				
LOT0071		*0000201				
LOT0071	R	0140	*0000177			24.3 24.3 24.2 #99-> 24.3
LOT0071	R	0150	*0000095			7.94 7.94 7.92 #99-> 7.93
LOT0071	R	0160	*0000419			105 109 108
LOT0071	R	0165	*0000381	1	231	230 130 207 #99-> 200
LOT0071	R	0165	*0000381	2	223	225 225 212 #99-> 221
LOT0071	R	0165	*0000381	3	179	205 205 207 #99-> 199
LOT0071	V	0140	*0000177			25.0
LOT0071	V	0150	*0000095			7.9
LOT0071	V	0160	*0000419			105
LOT0071	V	0165	*0000381			109
LOT0072		*0000153				
LOT0072		*0000201				
LOT0072	R	0090	*0000177			25 25 25
LOT0072	V	0140	*0000177			25.0
LOT0072	V	0150	*0000095			7.90
LOT0072	V	0160	*0000419			105
LOT0072	V	0165	*0000381			109
LOT0073		*0000153				
LOT0073		*0000201				
LOT0073	R	0140	*0000177			25.0 25.2 25.3 #99-> 25.2
LOT0073	R	0150	*0000095			7.95 7.93 7.95 #99-> 7.94
LOT0073	R	0160	*0000419			93 93 92
LOT0073	R	0165	*0000381	1	203	215 212 198 #99-> 207
LOT0073	R	0165	*0000381	2	190	188 184 195 #99-> 189
LOT0073	R	0165	*0000381	3	176	229 177 224 #99-> 202
LOT0073	V	0140	*0000177			25.2
LOT0073	V	0150	*0000095			7.83
LOT0073	V	0160	*0000419			110
LOT0073	V	0165	*0000381			96
LOT0074		*0000153				
LOT0074		*0000201				
LOT0074	R	0140	*0000177			24.4 24.2 24.3 #99-> 24.3

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LOT NO. T ITEM DATE   MATRIX   DATA
==========================================================================
                               00 01     02 ...
==========================================================================
LOT0074 R 0150        *0000095          7.92 7.99 7.92 #99-> 7.91
LOT0074 R 0160        *0000419          99 98 100 #99-> 99
LOT0074 R 0165        *0000381    1 190 200 175 181 #99-> 186
LOT0074 R 0165        *0000381    2 185 182 171 181 #99-> 180
LOT0074 R 0165        *0000381    3 220 207 252 233 #99-> 228
LOT0074 V 0140        *0000177          25.2
LOT0074 V 0150        *0000095          7.89
LOT0074 V 0160        *0000419          130
LOT0074 V 0165        *0000381          100
LOT0079    *0000153
LOT0079    *0000201
LOT0079 R 0140        *0000177          25.4 25.4 25.3 #99-> 25.4
LOT0079 R 0150        *0000095          7.88 7.85 7.88 #99-> 7.87
LOT0079 R 0160        *0000419          146 150 146 #99-> 147
LOT0079 R 0165        *0000381    1 215 227 218 #99-> 220
LOT0079 R 0165        *0000381    2 203 211 216 #99-> 210
LOT0079 R 0165        *0000381    3 201 193 207 #99-> 200
LOT0079 V 0140        *0000177          25.5
LOT0079 V 0150        *0000095          7.81
LOT0079 V 0160        *0000419          145
LOT0079 V 0165        *0000381          105
LOT0080    *0000153
LOT0080    *0000201
LOT0080 R 0140        *0000177          25.1 25.2 24.8 #99-> 25.0
LOT0080 R 0150        *0000095          7.93 7.93 7.93 #99-> 7.93
LOT0080 R 0160        *0000419          127 139 142 #99-> 136
LOT0080 R 0165        *0000381    1 113 111 122 #99-> 115
LOT0080 R 0165        *0000381    2 135 103 108 #99-> 115
LOT0080 R 0165        *0000381    3 112 105 109 #99-> 109
LOT0081    *0000153
LOT0081    *0000201
LOT0081 R 0140        *0000177          25.6 25.2 25.8 #99-> 25.5
LOT0081 R 0150        *0000095          7.88 7.87 7.87 #99-> 7.87
LOT0081 R 0160        *0000419          139 148 150 #99-> 146
LOT0081 R 0165        *0000381    1 116 114 117 #99-> 116
LOT0081 R 0165        *0000381    2 110 111 101 #99-> 107
LOT0081 R 0165        *0000381    3 182 107 96 #99-> 128
LOT0081 V 0140        *0000177          25.5
LOT0081 V 0150        *0000095          7.81
LOT0081 V 0160        *0000419          145
LOT0081 V 0165        *0000381          105
LOT0082    *0000153
LOT0082    *0000201
LOT0082 R 0140        *0000177          25.3 25.4 25.2 #99-> 25.3
LOT0082 R 0150        *0000095          7.93 7.92 7.93 #99-> 7.93
LOT0082 R 0160        *0000419          142 143 144 #99-> 143
LOT0082 R 0165        *0000381    1 195 167 202 #99-> 188
LOT0082 R 0165        *0000381    2 182 203 221 #99-> 202
LOT0082 R 0165        *0000381    3 194 188 176 #99-> 186
LOT0083    *0000153
LOT0083    *0000201
LOT0083 R 0140        *0000177          24.3 24.3 24.5 #99-> 24.4
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LOT NO.	T	ITEM DATE	MATRIX	DATA 00 01	02 ...
LOT0083	R	0150	*0000095		7.74 7.99 7.88 #99-> 7.87
LOT0083	R	0160	*0000419		155 145 155 #99-> 152
LOT0083	R	0165	*0000381	1 188	196 195 #99-> 193
LOT0083	R	0165	*0000381	2 193	197 210 #99-> 200
LOT0083	R	0165	*0000381	3 205	235 211 #99-> 217
LOT0083	V	0140	*0000177		25.9
LOT0083	V	0150	*0000095		7.84
LOT0083	V	0160	*0000419		130
LOT0083	V	0165	*0000381		107
LOT0084		*0000153			
LOT0084		*0000201			
LOT0084	R	0140	*0000177		25.0 25.2 25.0 #99-> 25.1
LOT0084	R	0150	*0000095		7.81 7.83 7.87 #99-> 7.84
LOT0084	R	0160	*0000419		153 146 164 #99-> 154
LOT0084	R	0165	*0000381		211 201 180 #99-> 197
LOT0084	V	0140	*0000177		24.8
LOT0084	V	0150	*0000095		7.84
LOT0084	V	0160	*0000419		130
LOT0084	V	0165	*0000381		99
LOT0085		*0000126			
LOT0085		*0000153			
LOT0085		*0000201			
LOT0085	R	0140	*0000177		24.7 25.2 24.9 #99-> 24.9
LOT0085	R	0150	*0000095		7.75 7.76 7.78 #99-> 7.76
LOT0085	R	0160	*0000419	1 123	128 126 #99-> 126
LOT0085	R	0160	*0000419	2 130	132 125 #99-> 129
LOT0085	R	0160	*0000419	3 128	126 126 #99-> 127
LOT0085	R	0165	*0000381	1 227	231 232 #99-> 230
LOT0085	R	0165	*0000381	2 252	237 220 #99-> 236
LOT0085	R	0165	*0000381	3 272	272 242 #99-> 262
LOT0085	V	0140	*0000177		24.8
LOT0085	V	0150	*0000095		7.84
LOT0085	V	0160	*0000419		130
LOT0085	V	0165	*0000381		99
LOT0086		*0000153			
LOT0086		*0000201			
LOT0086	R	0140	*0000177		24.9 23.4 24.7 #99-> 24.4
LOT0086	R	0150	*0000095		7.72 7.83 7.83 #99-> 7.79
LOT0086	R	0160	*0000419		137 148 143 #99-> 143
LOT0086	R	0165	*0000381		181 141 121 #99-> 148
LOT0086	V	0140	*0000177		24.8
LOT0086	V	0150	*0000095		7.83
LOT0086	V	0160	*0000419		152
LOT0086	V	0165	*0000381		101
LOT0087		*0000153			
LOT0087		*0000201			
LOT0087	R	0140	*0000177		24.2 24.1 24.3 #99-> 24.2
LOT0087	R	0150	*0000095		7.84 7.84 7.85 #99-> 7.84
LOT0087	R	0160	*0000419		125 137 121 #99-> 128
LOT0087	R	0165	*0000381	1 140	170 150 160 #99-> 155
LOT0087	R	0165	*0000381	2 195	195 185 180 #99-> 189
LOT0087	R	0165	*0000381	3 180	180 190 180 #99-> 182

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LOT NO. T ITEM DATE   MATRIX   DATA
==========================================================================
                               00 01     02 ...
==========================================================================
LOT0087 V 0140        *0000177          25.1
LOT0087 V 0150        *0000095          7.84
LOT0087 V 0160        *0000419          125
LOT0087 V 0165        *0000381          109
LOT0088    *0000153
LOT0088    *0000201
LOT0088 R 0140        *0000177          25.1 25.2 25.3 #99-> 25.2
LOT0088 R 0150        *0000095          7.83 7.89 7.89 #99-> 7.87
LOT0088 R 0160        *0000419          145 140 140 #99-> 142
LOT0088 R 0165        *0000381    1 145 147 148 148 #99-> 147
LOT0088 R 0165        *0000381    2 174 170 180 173 #99-> 174
LOT0088 R 0165        *0000381    3 207 204 203 197 #99-> 203
LOT0088 V 0140        *0000177          25.6
LOT0088 V 0150        *0000095          7.85
LOT0088 V 0160        *0000419          135
LOT0088 V 0165        *0000381          107
LOT0089    *0000153
LOT0089    *0000201
LOT0089 R 0140        *0000177          25.3 25.3 25.5 #99-> 25.4
LOT0089 R 0150        *0000095          7.78 7.83 7.88 #99-> 7.83
LOT0089 R 0160        *0000419          113 110 117 #99-> 113
LOT0089 R 0165        *0000381          206 202 191 #99-> 200
LOT0089 V 0140        *0000177          25.4
LOT0089 V 0150        *0000095          7.82
LOT0089 V 0160        *0000419          150
LOT0089 V 0165        *0000381          117
LOT0090    *0000153
LOT0090    *0000201
LOT0090 R 0140        *0000177          24.9 24.9 24.9 #99-> 24.9
LOT0090 R 0150        *0000095          7.82 7.87 7.90 #99-> 7.86
LOT0090 R 0160        *0000419          140 120 121 #99-> 127
LOT0090 R 0165        *0000381    1 214 232 222 #99-> 223
LOT0090 R 0165        *0000381    2 220 193 232 #99-> 214
LOT0090 R 0165        *0000381    3 190 202 205 #99-> 199
LOT0090 V 0140        *0000177          24.8
LOT0090 V 0150        *0000095          7.84
LOT0090 V 0160        *0000419          130
LOT0090 V 0165        *0000381          99
LOT0094    *0000126
LOT0094    *0000153
LOT0094    *0000201
LOT0094 R 0140        *0000177          24.9 24.8 24.9 #99-> 24.9
LOT0094 R 0150        *0000095          7.74 7.79 7.79 #99-> 7.73
LOT0094 R 0160        *0000419          153 138 140 #99-> 144
LOT0094 R 0165        *0000381    1 77 104 106 135 #99-> 106
LOT0094 R 0165        *0000381    2 102 110 127 96 #99-> 109
LOT0094 R 0165        *0000381    3 153 93 127 97 #99-> 118
LOT0094 V 0140        *0000177          24.8
LOT0094 V 0150        *0000095          7.83
LOT0094 V 0160        *0000419          152
LOT0094 V 0165        *0000381          101
LOT0097    *0000153
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LOT NO. T ITEM DATE   MATRIX   DATA
==================================================================================
                               00 01     02 ...
==================================================================================
LOT0097    *0000201
LOT0097 R 0140         *0000177            25.5 25.5 25.6 #99-> 25.5
LOT0097 R 0150         *0000095            7.80 7.86 7.88 #99-> 7.85
LOT0097 R 0160         *0000419            106 107 105 #99-> 106
LOT0097 R 0165         *0000381     1 197 188 203 #99-> 196
LOT0097 R 0165         *0000381     2 194 176 193 #99-> 188
LOT0097 R 0165         *0000381     3 187 201 189 #99-> 192
LOT0097 V 0140         *0000177            25.0
LOT0097 V 0150         *0000095            7.84
LOT0097 V 0160         *0000419            105
LOT0097 V 0165         *0000381            108
LOT0098    *0000153
LOT0098    *0000201
LOT0098 R 0140         *0000177            25.1 25.1 25.1 #99-> 25.1
LOT0098 R 0150         *0000095            7.89 7.89 7.88 #99-> 7.89
LOT0098 R 0160         *0000419            96 102 100 #99-> 99
LOT0098 R 0165         *0000381     1 205 190 152 #99-> 182
LOT0098 R 0165         *0000381     2 198 192 225 #99-> 205
LOT0098 R 0165         *0000381     3 193 190 182 #99-> 188
LOT0098 V 0140         *0000177            25.6
LOT0098 V 0150         *0000095            7.87
LOT0098 V 0160         *0000419            122
LOT0098 V 0165         *0000381            111
LOT0099    *0000126
LOT0099    *0000153
LOT0099    *0000201
LOT0099 R 0140         *0000177            24.9 24.8 24.9 #99-> 24.9
LOT0099 R 0150         *0000095            7.80 7.88 7.91 #99-> 7.86
LOT0099 R 0160         *0000419            175 200 205 #99-> 193
LOT0099 R 0165         *0000381     1 195 201 200 #99-> 199
LOT0099 R 0165         *0000381     2 206 196 210 #99-> 204
LOT0099 R 0165         *0000381     3 200 196 206 #99-> 200
LOT0099 V 0140         *0000177            25.3
LOT0099 V 0150         *0000095            7.85
LOT0099 V 0160         *0000419            125
LOT0099 V 0165         *0000381            111
LOT0100    *0000153
LOT0100    *0000201
LOT0100 R 0140         *0000177            25.2 25.3 25.3 #99-> 25.3
LOT0100 R 0150         *0000095            7.86 7.85 7.86 #99-> 7.86
LOT0100 R 0160         *0000419            117 114 110 #99-> 114
LOT0100 R 0165         *0000381     1 184 194 186 #99-> 188
LOT0100 R 0165         *0000381     2 222 240 243 #99-> 235
LOT0100 R 0165         *0000381     3 196 188 180 #99-> 188
LOT0100 V 0140         *0000177            25.7
LOT0100 V 0150         *0000095            7.8
LOT0100 V 0160         *0000419            120
LOT0100 V 0165         *0000381            113
LOT0101    *0000126
LOT0101    *0000153
LOT0101    *0000201
LOT0101 R 0140         *0000177            25.2 25.2 25.1 #99-> 25.2
```

LOT NO.	T	ITEM DATE	MATRIX	DATA 00 01	02 ...
LOT0101	R	0150	*0000095		7.82 7.81 7.81 #99-> 7.81
LOT0101	R	0160	*0000419		140 147 146 #99-> 144
LOT0101	R	0165	*0000381		118 121 121 #99-> 120
LOT0101	V	0140	*0000177		25.3
LOT0101	V	0150	*0000095		7.87
LOT0101	V	0160	*0000419		130
LOT0101	V	0165	*0000381		123
LOT0102		*0000126			
LOT0102		*0000153			
LOT0102		*0000201			
LOT0102	R	0140	*0000177		24.8 24.7 24.9 #99-> 24.8
LOT0102	R	0150	*0000095		7.88 7.86 7.89 #99-> 7.88
LOT0102	R	0160	*0000419		131 127 125 #99-> 128
LOT0102	R	0165	*0000381	1 195	193 203 #99-> 197
LOT0102	R	0165	*0000381	2 209	192 222 #99-> 208
LOT0102	R	0165	*0000381	3 195	205 187 #99-> 196
LOT0102	V	0140	*0000177		25.1
LOT0102	V	0150	*0000095		7.89
LOT0102	V	0160	*0000419		135
LOT0102	V	0165	*0000381		111
LOT0103		*0000126			
LOT0103		*0000153			
LOT0103		*0000192			
LOT0103		*0000201			
LOT0103		*0000420			
LOT0103	R	0140	*0000177		25.3 25.6 25.5 #99-> 25.5
LOT0103	R	0150	*0000095		7.82 7.86 7.87 #99-> 7.85
LOT0103	R	0160	*0000419		131 132 136 #99-> 133
LOT0103	R	0165	*0000381	1 198	187 188 182 #99-> 189
LOT0103	R	0165	*0000381	2 187	190 189 185 #99-> 188
LOT0103	R	0165	*0000381	3 192	184 178 190 #99-> 186
LOT0103	V	0140	*0000177		25.4
LOT0103	V	0150	*0000095		7.90
LOT0103	V	0160	*0000419		145
LOT0103	V	0165	*0000381		121
LOT0104		*0000126			
LOT0104		*0000153			
LOT0104		*0000201			
LOT0104	R	0140	*0000177		24.8 24.8 24.9 #99-> 24.8
LOT0104	R	0150	*0000095		7.85 7.86 7.89 #99-> 7.87
LOT0104	R	0160	*0000419		112 114 119 #99-> 115
LOT0104	R	0165	*0000381	1 201	204 201 #99-> 202
LOT0104	R	0165	*0000381	2 205	202 208 #99-> 205
LOT0104	R	0165	*0000381	3 200	195 213 #99-> 203
LOT0104	V	0140	*0000177		24.9
LOT0104	V	0150	*0000095		7.8
LOT0104	V	0160	*0000419		115
LOT0104	V	0165	*0000381		109
LOT0105		*0000126			
LOT0105		*0000153			
LOT0105		*0000201			
LOT0105	R	0140	*0000177		23.6 23.6 23.7 #99-> 23.6

```
LOT NO. T ITEM DATE   MATRIX   DATA
==================================================================================
                               00 01     02 ...
==================================================================================
LOT0105 R 0150         *0000095          7.86 7.79 7.84 #99-> 7.83
LOT0105 R 0160         *0000419          144 155 158 #99-> 152
LOT0105 R 0165         *0000381    1 157 189 182 #99-> 176
LOT0105 R 0165         *0000381    2 180 172 168 #99-> 173
LOT0105 R 0165         *0000381    3 159 172 167 #99-> 166
LOT0105 V 0140         *0000177          25.4
LOT0105 V 0150         *0000095          7.84
LOT0105 V 0160         *0000419          155
LOT0105 V 0165         *0000381          100
LOT0106    *0000126
LOT0106    *0000153
LOT0106    *0000201
LOT0106 R 0140         *0000177          25.5 25.6 25.6 #99-> 25.6
LOT0106 R 0150         *0000095          7.81 7.82 7.82 #99-> 7.82
LOT0106 R 0160         *0000419          141 136 133 #99-> 137
LOT0106 R 0165         *0000381    1 228 226 234 243 #99-> 233
LOT0106 R 0165         *0000381    2 227 207 219 252 #99-> 226
LOT0106 R 0165         *0000381    3 256 252 235 252 #99-> 249
LOT0106 V 0140         *0000177          25.8
LOT0106 V 0150         *0000095          7.85
LOT0106 V 0160         *0000419          135
LOT0106 V 0165         *0000381          115
LOT0107    *0000126
LOT0107    *0000153
LOT0107    *0000201
LOT0107 R 0140         *0000177          25.2 25.2 25.2 #99-> 25.2
LOT0107 R 0150         *0000095          7.94 7.91 7.97 #99-> 7.94
LOT0107 R 0160         *0000419          132 144 145 #99-> 140
LOT0107 R 0165         *0000381    1 224 214 225 #99-> 221
LOT0107 R 0165         *0000381    2 219 246 241 #99-> 235
LOT0107 R 0165         *0000381    3 221 233 225 #99-> 226
LOT0107 V 0140         *0000177          25.4
LOT0107 V 0150         *0000095          7.90
LOT0107 V 0160         *0000419          145
LOT0107 V 0165         *0000381          121
LOT0108    *0000126
LOT0108    *0000153
LOT0108    *0000201
LOT0108 R 0140         *0000177          25.2 25.1 25.1 #99-> 25.1
LOT0108 R 0150         *0000095          7.85 7.86 7.85 #99-> 7.85
LOT0108 R 0160         *0000419          116 116 115 #99-> 116
LOT0108 R 0165         *0000381          190 188 205 #99-> 194
LOT0108 V 0140         *0000177          24.9
LOT0108 V 0150         *0000095          7.8
LOT0108 V 0160         *0000419          115
LOT0108 V 0165         *0000381          109
LOT0109    *0000126
LOT0109    *0000153
LOT0109    *0000201
LOT0109 R 0140         *0000177          24.9 24.9 24.9 #99-> 24.9
LOT0109 R 0150         *0000095          7.79 7.84 7.88 #99-> 7.84
LOT0109 R 0160         *0000419          107 120 112 #99-> 113
```

```
LOT NO. T ITEM DATE   MATRIX   DATA
==================================================================================
                               00 01     02 ...
==================================================================================
LOT0109 R 0165         *0000381    1 230 238 232 #99-> 233
LOT0109 R 0165         *0000381    2 227 221 228 #99-> 225
LOT0109 R 0165         *0000381    3 234 235 214 #99-> 228
LOT0109 V 0140         *0000177            25.1
LOT0109 V 0150         *0000095            7.84
LOT0109 V 0160         *0000419            125
LOT0109 V 0165         *0000381            109
LOT0110    *0000126
LOT0110    *0000153
LOT0110    *0000201
LOT0110 R 0110         *0000419            94 106 96
LOT0110 R 0120         *0000381            249 245 237 257
LOT0110 R 0120         *0000381            265 253 239 210
LOT0110 R 0140         *0000177            24.7 24.8 24.4 #99-> 25.0
LOT0110 R 0150         *0000095            7.77 7.79 7.85 #99-> 7.80
LOT0110 R 0160         *0000419            135 150 132 #99-> 139
LOT0110 R 0165         *0000381            200 200 197 #99-> 199
LOT0110 V 0140         *0000177            24.9
LOT0110 V 0150         *0000095            7.8
LOT0110 V 0160         *0000419            115
LOT0110 V 0165         *0000381            109
LOT0111    *0000126
LOT0111    *0000153
LOT0111    *0000201
LOT0111 R 0140         *0000177            25.5 25.4 25.4 #99-> 25.4
LOT0111 R 0150         *0000095            7.80 7.84 7.88 #99-> 7.84
LOT0111 R 0160         *0000419            127 128 127 #99-> 127
LOT0111 R 0165         *0000381    1 194 190 178 #99-> 187
LOT0111 R 0165         *0000381    2 176 176 185 #99-> 179
LOT0111 R 0165         *0000381    3 190 195 211 #99-> 199
LOT0111 V 0140         *0000177            25.8
LOT0111 V 0150         *0000095            7.86
LOT0111 V 0160         *0000419            135
LOT0111 V 0165         *0000381            107
LOT0112    *0000153
LOT0112    *0000201
LOT0112 R 0140         *0000177            24.4 24.5 24.4 #99-> 24.4
LOT0112 R 0150         *0000095            7.79 7.85 7.83 #99-> 7.82
LOT0112 R 0160         *0000419            90 100 88 #99-> 93
LOT0112 R 0165         *0000381    1 189 184 184 193 #99-> 188
LOT0112 R 0165         *0000381    2 185 188 182 178 #99-> 183
LOT0112 R 0165         *0000381    3 177 177 176 179 #99-> 177
LOT0112 V 0140         *0000177            24.7
LOT0112 V 0150         *0000095            7.82
LOT0112 V 0160         *0000419            99
LOT0112 V 0165         *0000381            113
LOT0113    *0000126
LOT0113    *0000153
LOT0113    *0000201
LOT0113 R 0140         *0000177            24.7 24.7 24.7 #99-> 24.7
LOT0113 R 0150         *0000095            7.76 7.85 7.87 #99-> 7.83
LOT0113 R 0160         *0000419            118 122 120 #99-> 120
```

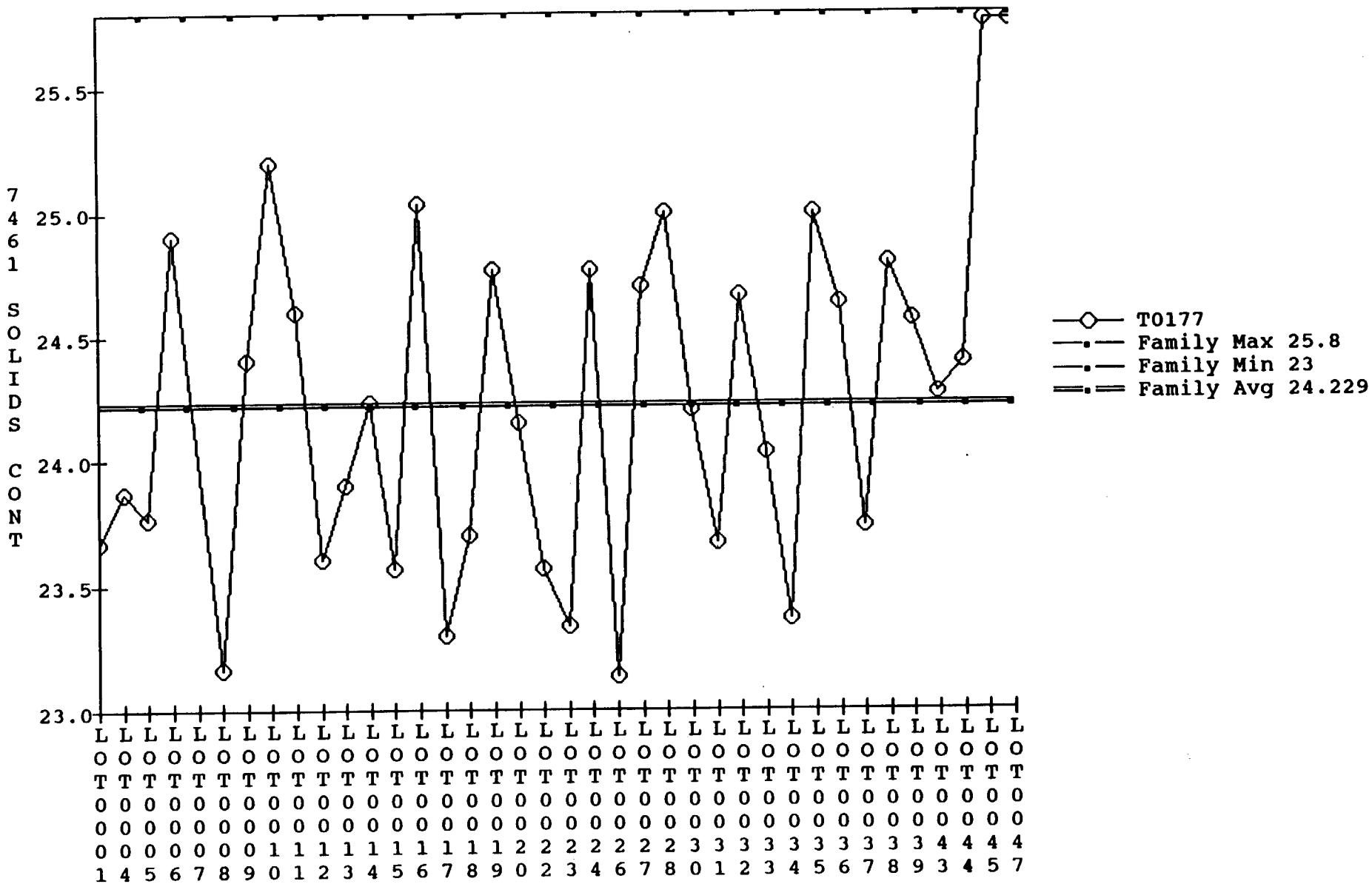
LOT NO.	T	ITEM	DATE	MATRIX	DATA 00	01	02 ...
LOT0113	R	0165		*0000381	1	175	172 181 #99-> 176
LOT0113	R	0165		*0000381	2	167	177 176 #99-> 173
LOT0113	R	0165		*0000381	3	180	188 192 #99-> 187
LOT0113	V	0140		*0000177			24.7
LOT0113	V	0150		*0000095			7.81
LOT0113	V	0160		*0000419			145
LOT0113	V	0165		*0000381			105
LOT0114		*0000153					
LOT0114		*0000201					
LOT0114	R	0140		*0000177			25.0 24.8 25.1 #99-> 25.0
LOT0114	R	0150		*0000095			7.78 7.79 7.80 #99-> 7.79
LOT0114	R	0160		*0000419			162 165 164 #99-> 164
LOT0114	R	0165		*0000381	1	176	192 183 #99-> 184
LOT0114	R	0165		*0000381	2	196	192 186 #99-> 191
LOT0114	R	0165		*0000381	3	180	186 188 #99-> 185
LOT0114	V	0140		*0000177			24.8
LOT0114	V	0150		*0000095			7.73
LOT0114	V	0160		*0000419			165
LOT0114	V	0165		*0000381			121
LOT0115		*0000153					
LOT0115		*0000201					
LOT0115	R	0140		*0000177			24.4 24.5 24.4 #99-> 24.4
LOT0115	R	0150		*0000095			7.82 7.74 7.78 #99-> 7.78
LOT0115	R	0160		*0000419			97 97 95 #99-> 96
LOT0115	R	0165		*0000381	1	177	174 167 174 #99-> 173
LOT0115	R	0165		*0000381	2	174	179 172 178 #99-> 176
LOT0115	R	0165		*0000381	3	169	169 164 166 #99-> 167
LOT0115	V	0140		*0000177			24.7
LOT0115	V	0150		*0000095			7.83
LOT0115	V	0160		*0000419			97
LOT0115	V	0165		*0000381			112
LOT0116		*0000153					
LOT0116		*0000201					
LOT0116	R	0140		*0000177			24.5 24.6 24.5 #99-> 24.5
LOT0116	R	0150		*0000095			7.78 7.85 7.87 #99-> 7.83
LOT0116	R	0160		*0000419			95 98 92 #99-> 95
LOT0116	R	0165		*0000381	1	156	155 178 172 #99-> 165
LOT0116	R	0165		*0000381	2	158	142 150 157 #99-> 152
LOT0116	R	0165		*0000381	3	172	166 176 170 #99-> 171
LOT0116	V	0140		*0000177			25.1
LOT0116	V	0150		*0000095			7.74
LOT0116	V	0160		*0000419			115
LOT0116	V	0165		*0000381			126
LOT0128		*0000126					
LOT0128		*0000153					
LOT0128		*0000201					
LOT0128	R	0140		*0000177			25.2 25.5 25.4 #99-> 25.4
LOT0128	R	0150		*0000095			7.90 7.95 7.94 #99-> 7.93
LOT0128	R	0160		*0000419			134 139 131 #99-> 135
LOT0128	R	0165		*0000381			184 184 157 #99-> 175
LOT0128	V	0140		*0000177			25.4
LOT0128	V	0150		*0000095			7.83

LOT NO.	T	ITEM	DATE	MATRIX	DATA 00	01	02 ...
LOT0128	V	0160		*0000419			130
LOT0128	V	0165		*0000381			111
LOT0129	R	0140		*0000177			25.3 25.0 24.9 #99-> 25.1
LOT0129	R	0150		*0000095			7.74 7.82 7.83 #99-> 7.80
LOT0129	R	0160		*0000419			152 157 157 #99-> 155
LOT0129	R	0165		*0000381	1	192	189 184 #99-> 188
LOT0129	R	0165		*0000381	2	178	191 189 #99-> 186
LOT0129	R	0165		*0000381	3	194	188 181 #99-> 188
LOT0130			*0000153				
LOT0130			*0000201				
LOT0130	R	0140		*0000177			24.7 24.7 24.6 #99-> 24.7
LOT0130	R	0150		*0000095			7.71 7.73 7.76 #99-> 7.73
LOT0130	R	0160		*0000419			94 95 93 #99-> 94
LOT0130	R	0165		*0000381			162 154 163 #99-> 160
LOT0130	V	0140		*0000177			24.9
LOT0130	V	0150		*0000095			7.78
LOT0130	V	0160		*0000419			140
LOT0130	V	0165		*0000381			107
LOT0131			*0000153				
LOT0131			*0000201				
LOT0131	R	0140		*0000177			25.0 25.1 25.0 #99-> 25.1
LOT0131	R	0150		*0000095			7.76 7.78 7.77 #99-> 7.77
LOT0131	R	0160		*0000419			89 91 93 #99-> 91
LOT0131	R	0165		*0000381			180 196 181 #99-> 186
LOT0131	V	0140		*0000177			25.3
LOT0131	V	0150		*0000095			7.81
LOT0131	V	0160		*0000419			110
LOT0131	V	0165		*0000381			119
LOT0133			*0000153				
LOT0133			*0000201				
LOT0133	R	0140		*0000177			25.8 25.7 25.6 #99-> 25.7
LOT0133	R	0150		*0000095			7.78 7.85 7.87 #99-> 7.83
LOT0133	R	0160		*0000419			88 86 86 #99-> 87
LOT0133	R	0165		*0000381			186 170 157 #99-> 171
LOT0133	V	0140		*0000177			26.0
LOT0133	V	0150		*0000095			7.80
LOT0133	V	0160		*0000419			91
LOT0133	V	0165		*0000381			96
LOT0134			*0000153				
LOT0134			*0000201				
LOT0134	R	0140		*0000177	1	24.6	24.6 24.8 #99-> 24.7
LOT0134	R	0140		*0000177	2	24.5	24.6 24.6 #99-> 24.6
LOT0134	R	0140		*0000177	3	24.8	24.8 24.6 #99-> 24.7
LOT0134	R	0150		*0000095	1	7.72	7.80 7.82 #99-> 7.78
LOT0134	R	0150		*0000095	2	7.75	7.81 7.79 #99-> 7.78
LOT0134	R	0150		*0000095	3	7.69	7.78 7.82 #99-> 7.76
LOT0134	R	0160		*0000419	1	88	88 89 89 89 89 #99-> 89
LOT0134	R	0160		*0000419	2	87	88 89 90 89 89 #99-> 89
LOT0134	R	0160		*0000419	3	86	85 87 87 88 87 #99-> 87
LOT0134	R	0165		*0000381	1	185	187 210 215 #99-> 199
LOT0134	R	0165		*0000381	2	165	115 175 176 #99-> 158
LOT0134	R	0165		*0000381	3	197	100 192 125 #99-> 154

LOT NO.	T	ITEM DATE	MATRIX	DATA 00 01	02 ...
LOT0134	V	0140	*0000177		25.0
LOT0134	V	0150	*0000095		7.74
LOT0134	V	0160	*0000419		156
LOT0134	V	0165	*0000381		118
LOT0135		*0000126			
LOT0135		*0000153			
LOT0135		*0000201			
LOT0135	R	0140	*0000177		24.6 24.4 24.4 #99-> 24.5
LOT0135	R	0150	*0000095		7.81 7.80 7.80 #99-> 7.80
LOT0135	R	0160	*0000419		128 130 130 #99-> 129
LOT0135	R	0165	*0000381	1 133	140 146 #99-> 140
LOT0135	R	0165	*0000381	2 143	146 151 #99-> 147
LOT0135	R	0165	*0000381	3 144	153 150 #99-> 149
LOT0135	V	0140	*0000177		24.4
LOT0135	V	0150	*0000095		7.77
LOT0135	V	0160	*0000419		126
LOT0135	V	0165	*0000381		131

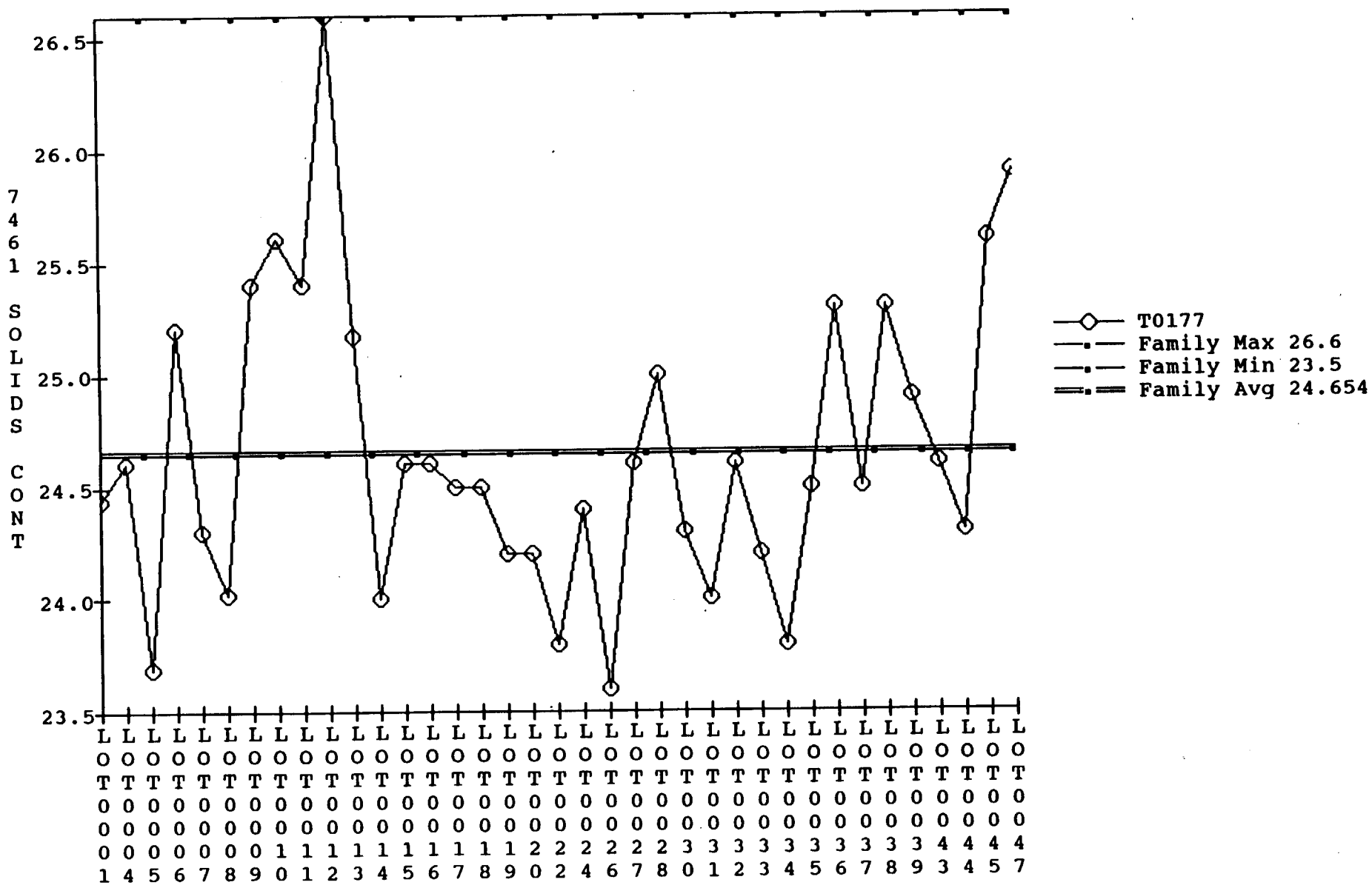
Stock #7461 - Chemlok 205 adhesive for Protective coating

Trend Chart for gxy7461 R_T0177



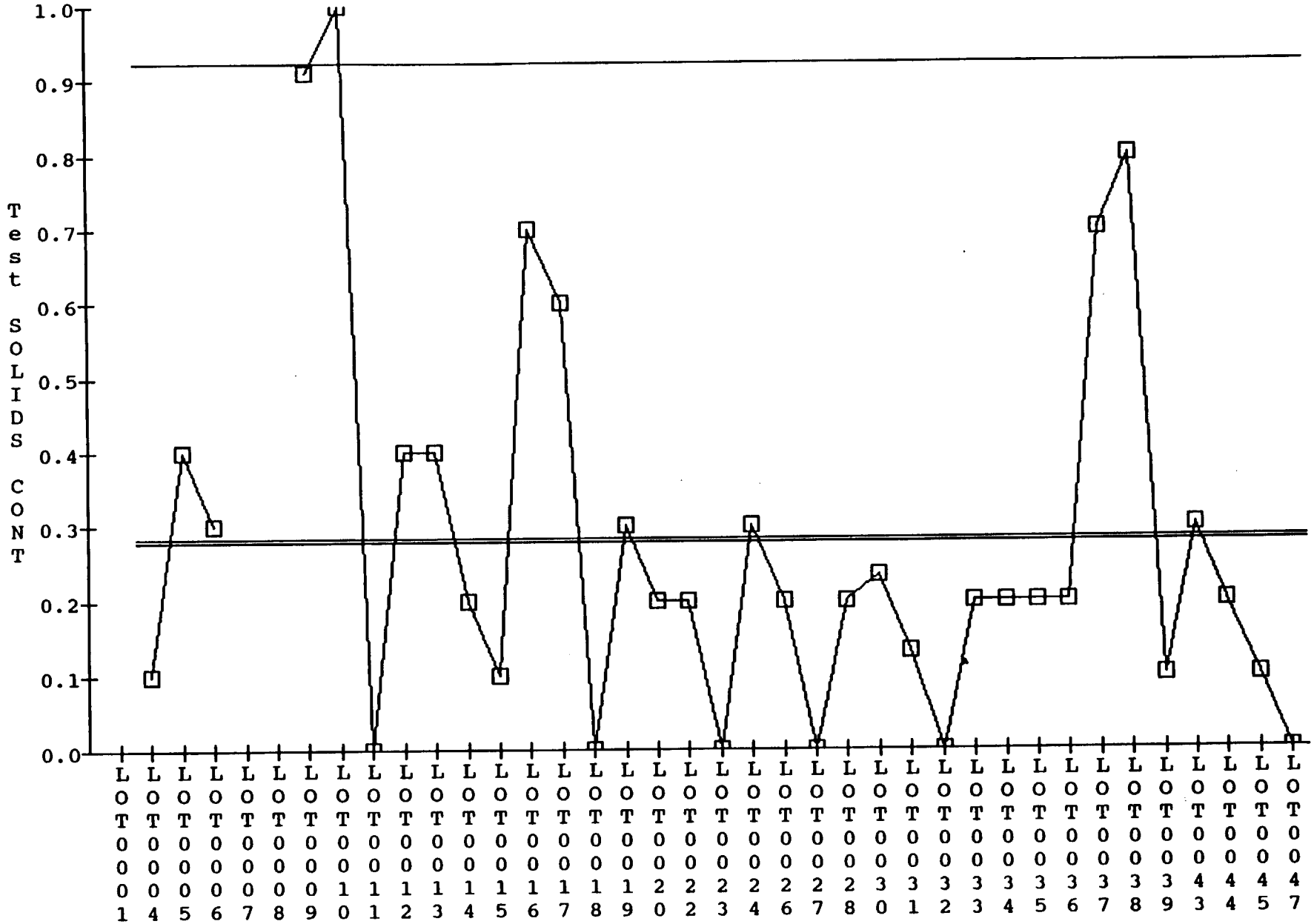
Prepared by Raw Materials PQE

Trend Chart for gxy7461 V_T0177



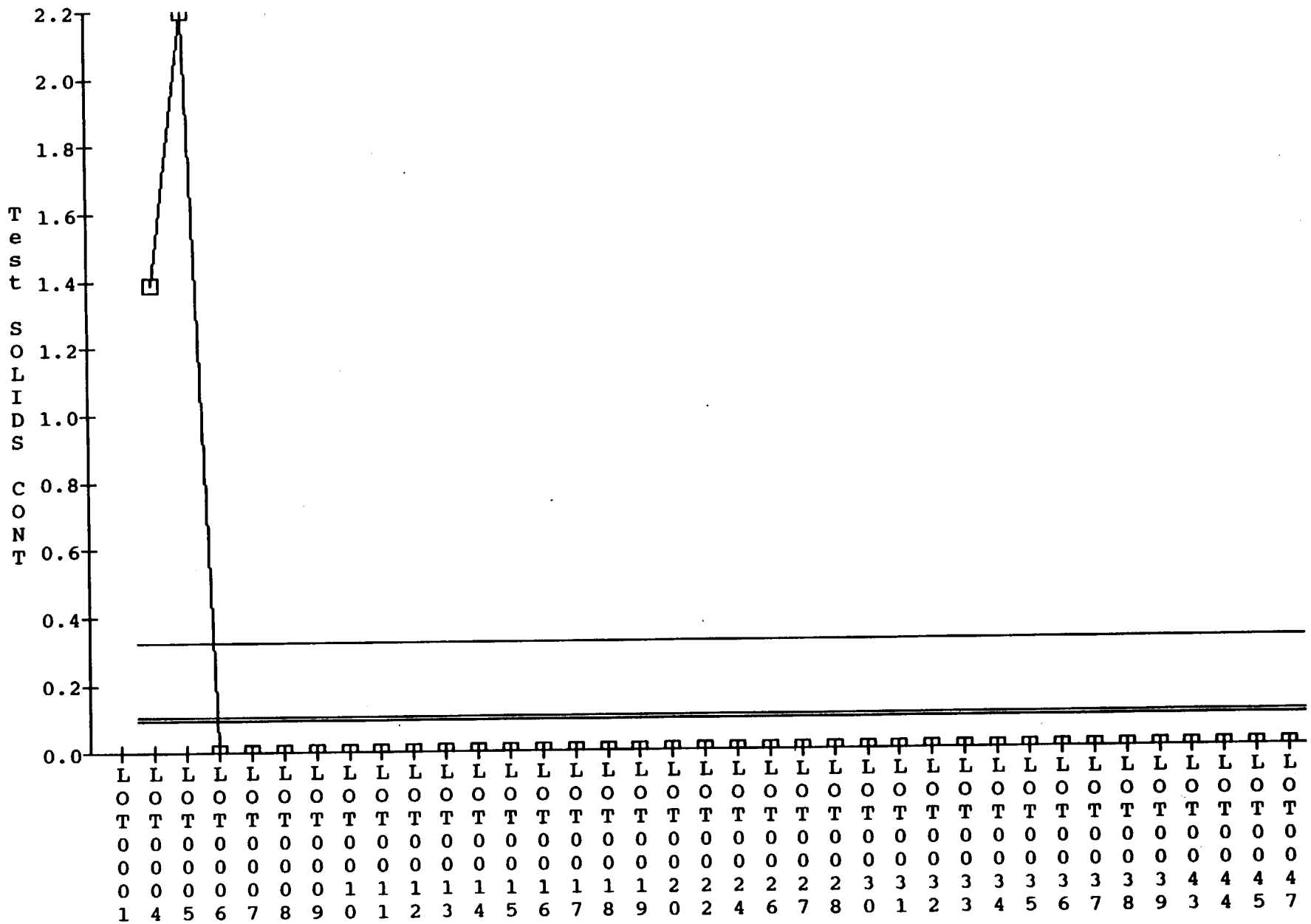
Prepared by Raw Materials PQE

R chart for 7461_R_T0177



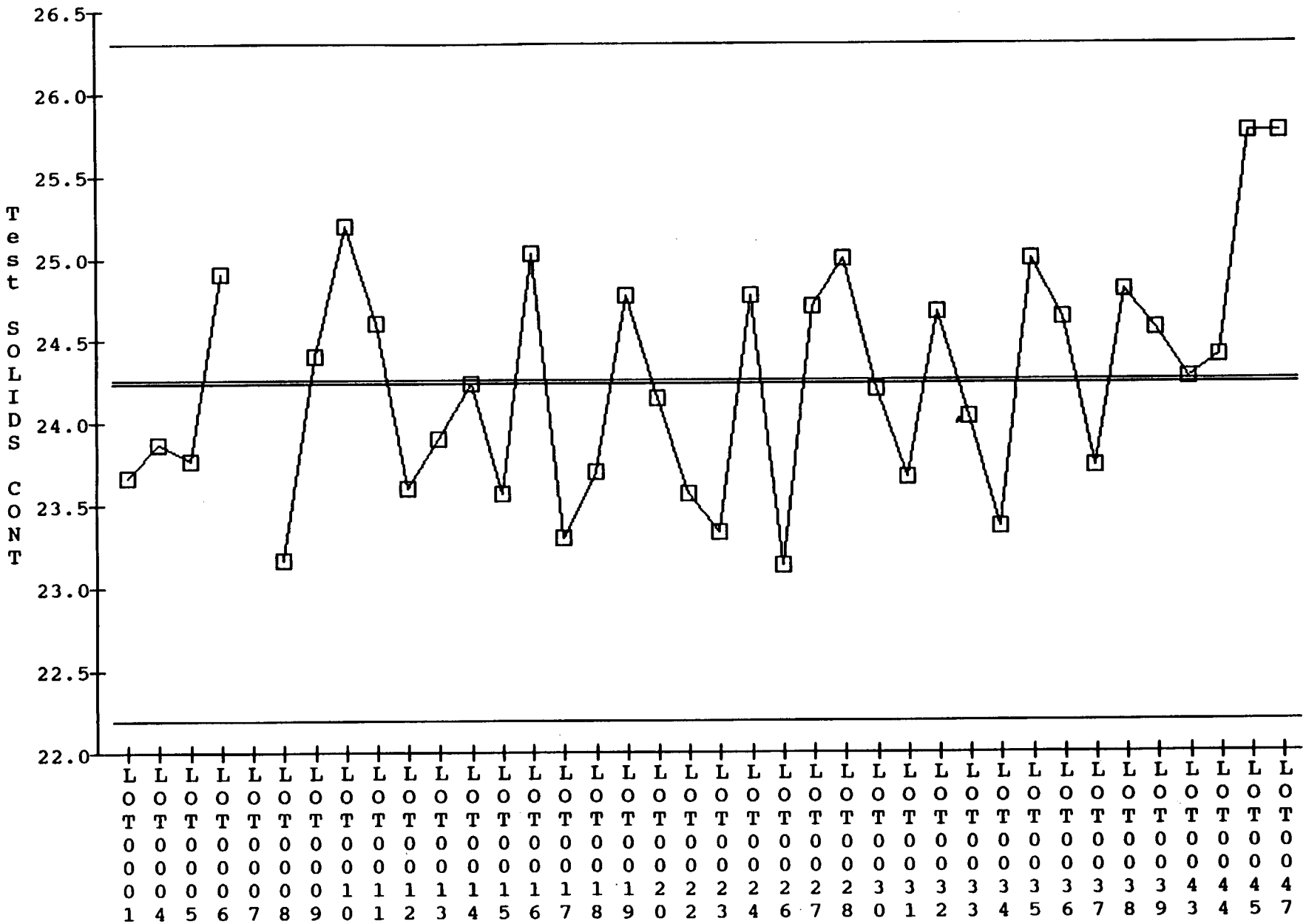
Prepared by Raw Materials PQE 19-FEB-93

R chart for 7461_V_T0177



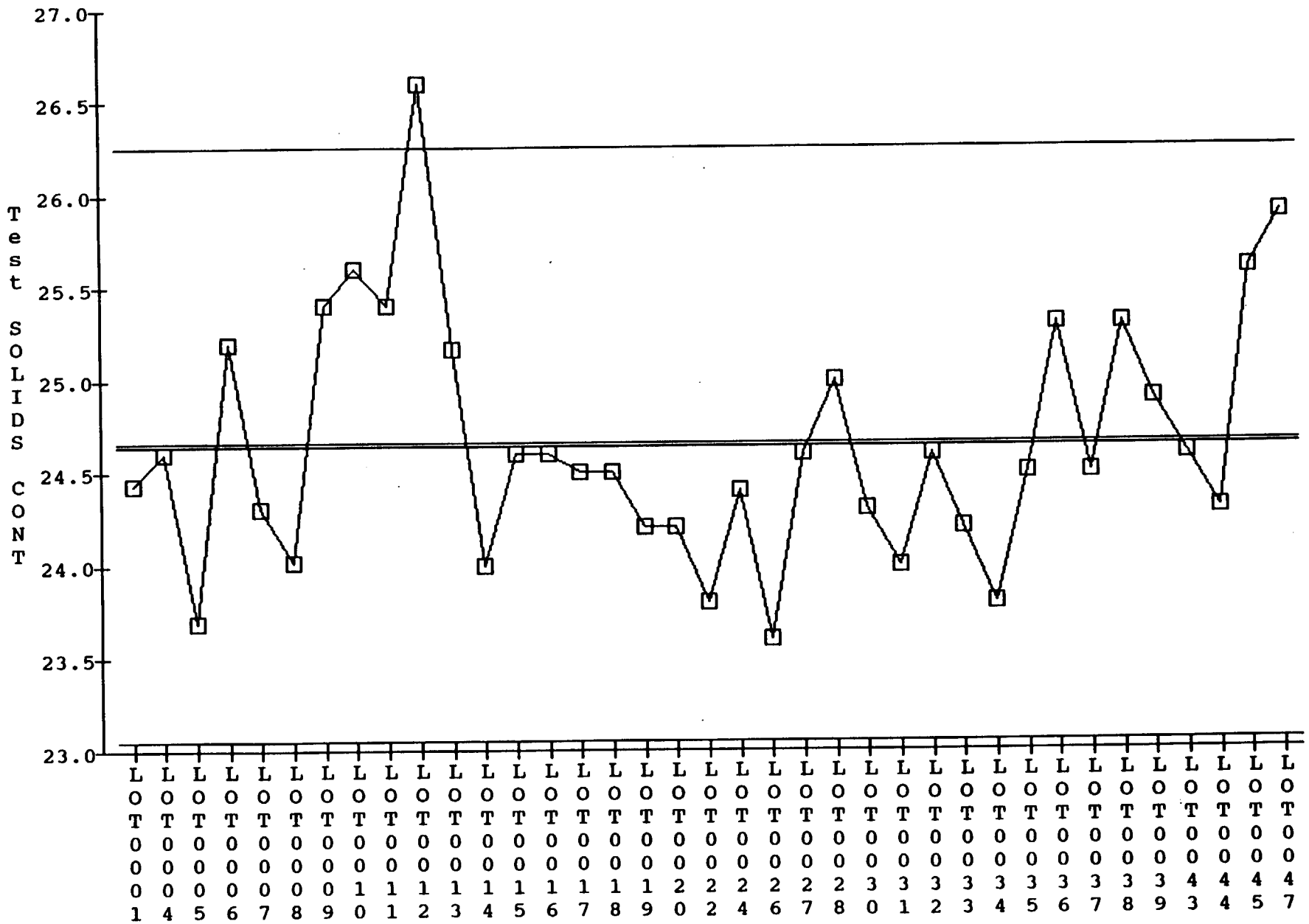
Prepared by Raw Materials PQE 19-FEB-93

Xbar chart for 7461_R_T0177



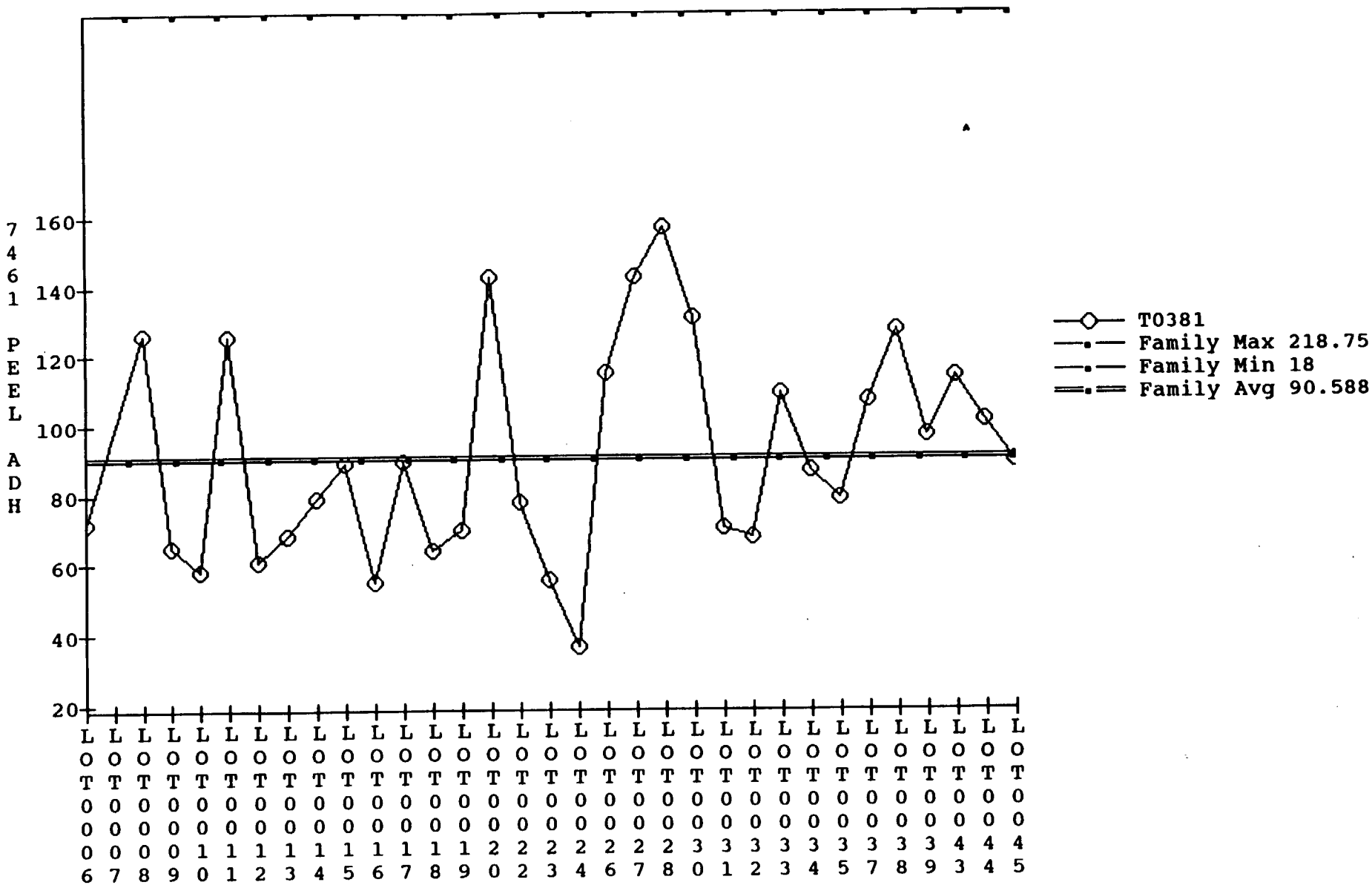
Prepared by Raw Materials PQE 19-FEB-93

Xbar chart for 7461_V_T0177



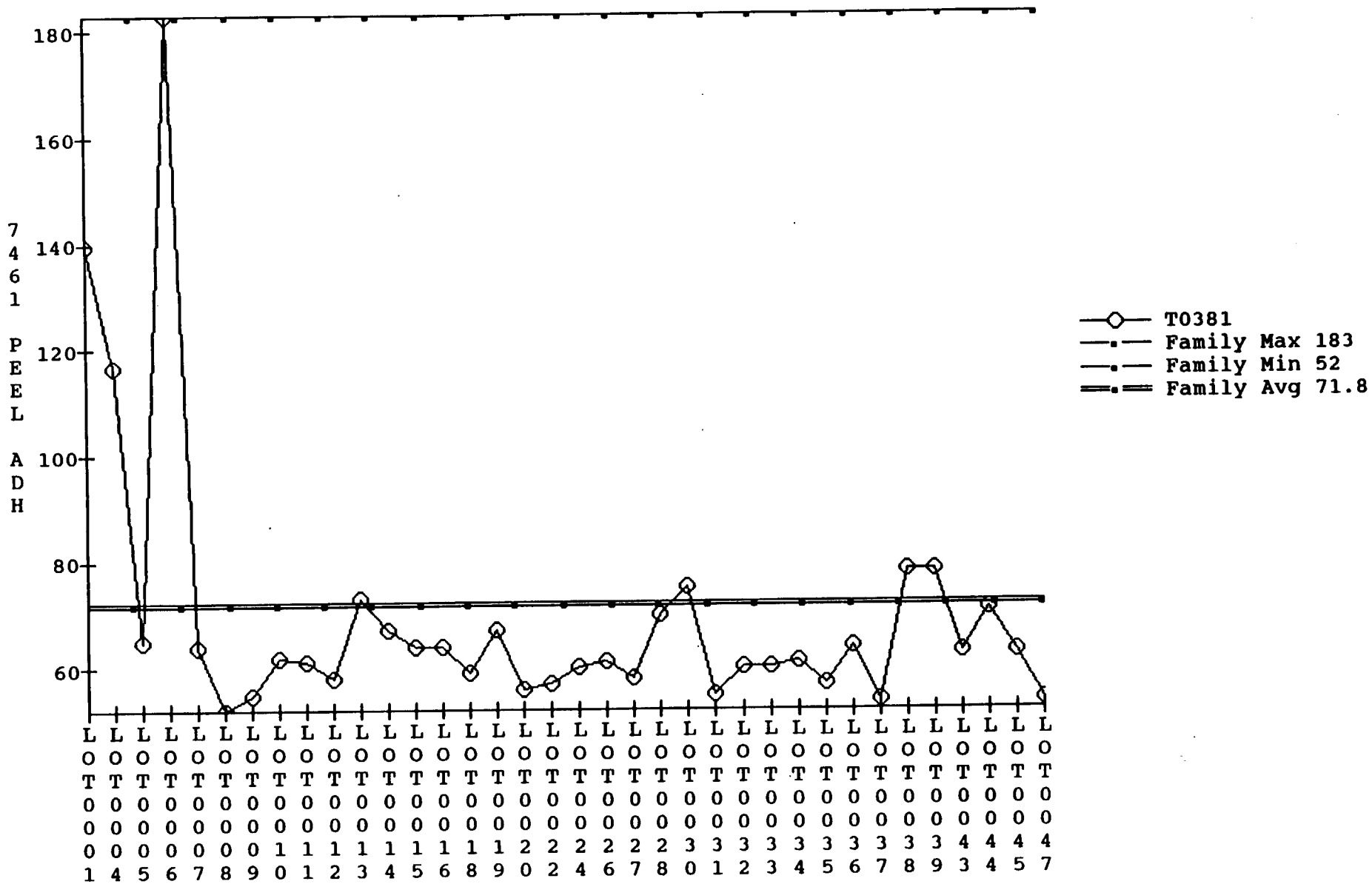
Prepared by Raw Materials PQE 19-FEB-93

Trend Chart for gxy7461 R_T0381



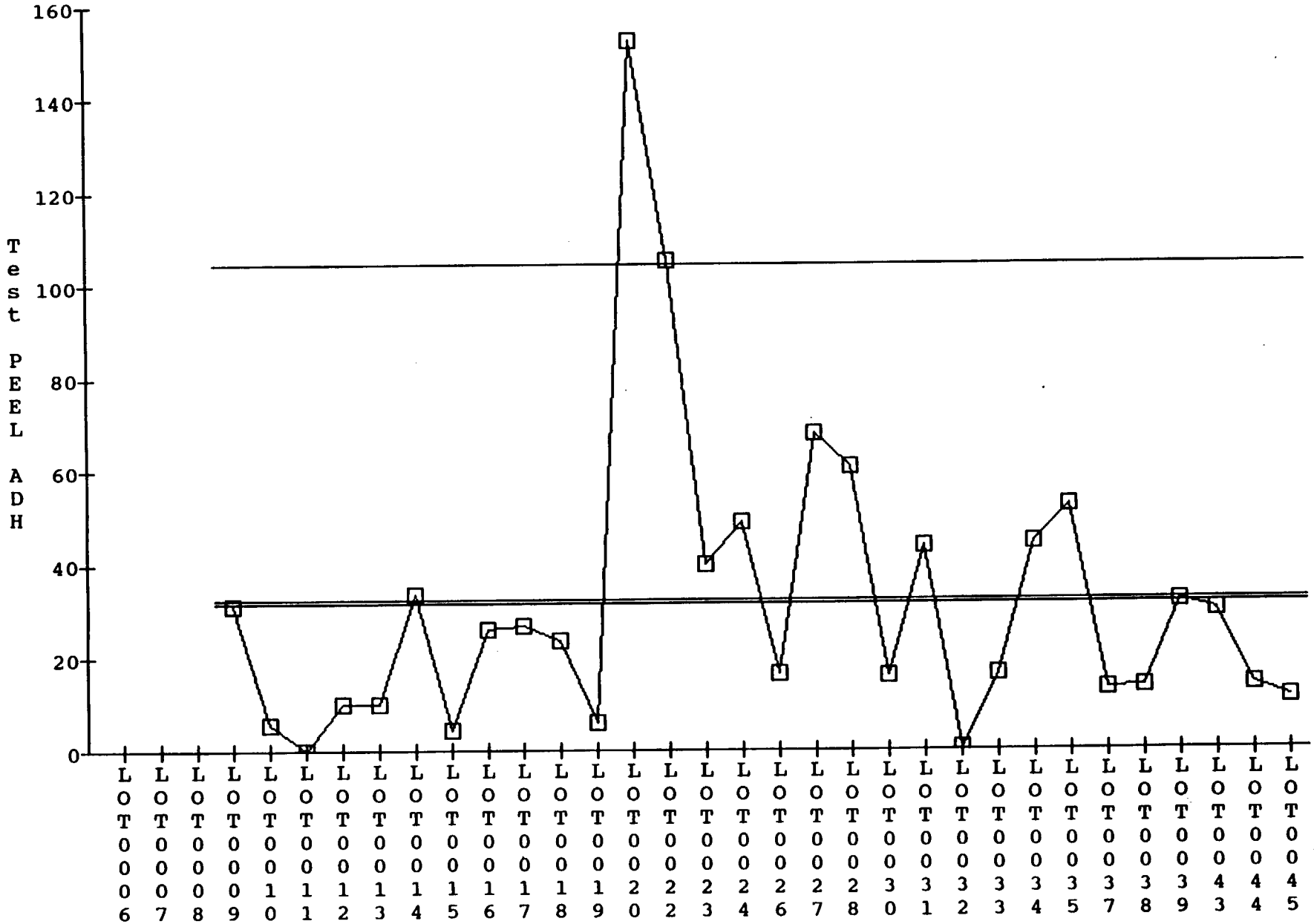
Prepared by Raw Materials PQE

Trend Chart for gxy7461 V_T0381



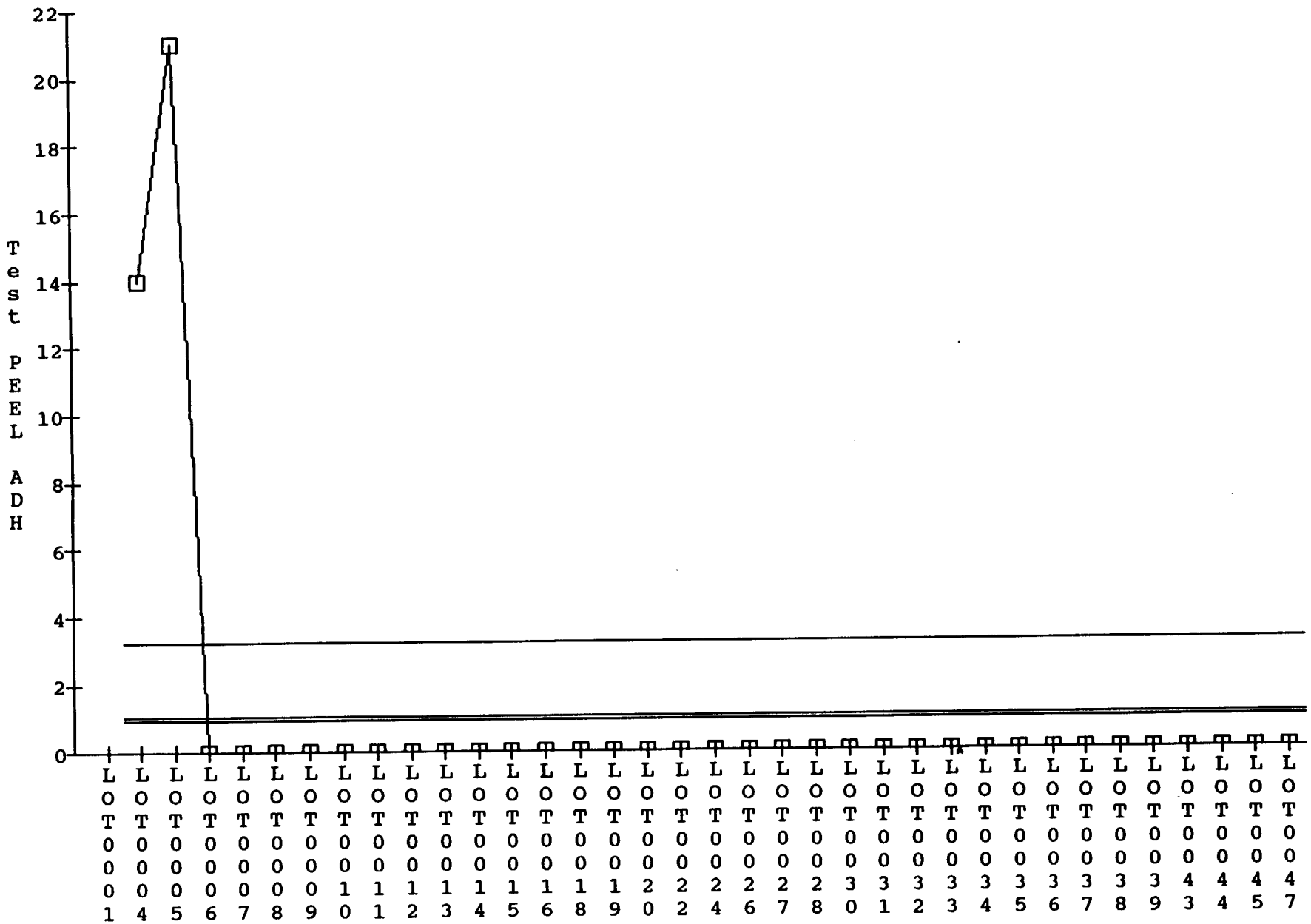
Prepared by Raw Materials PQE

R chart for 7461_R_T0381



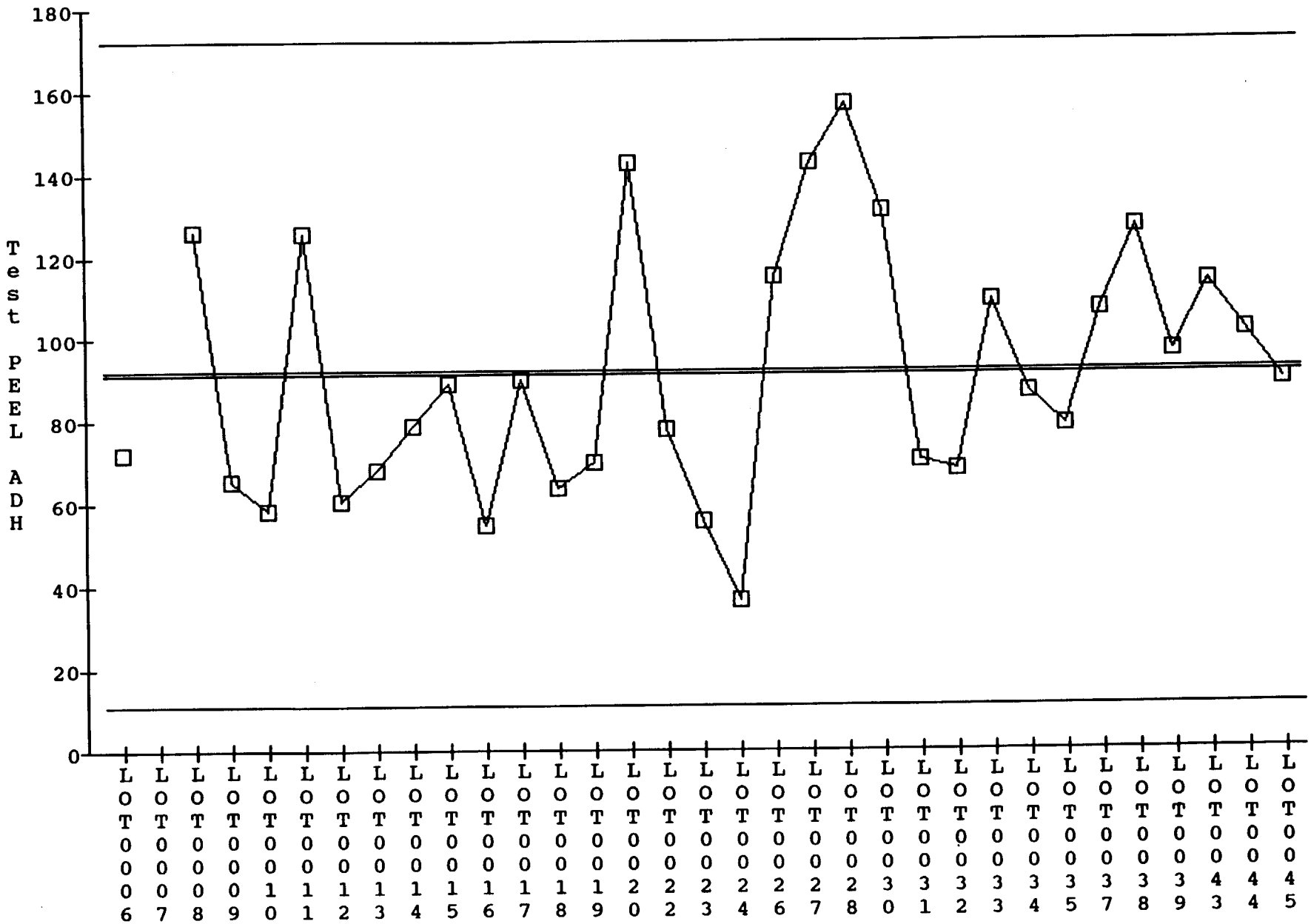
Prepared by Raw Materials PQE 19-FEB-93

R chart for 7461_V_T0381



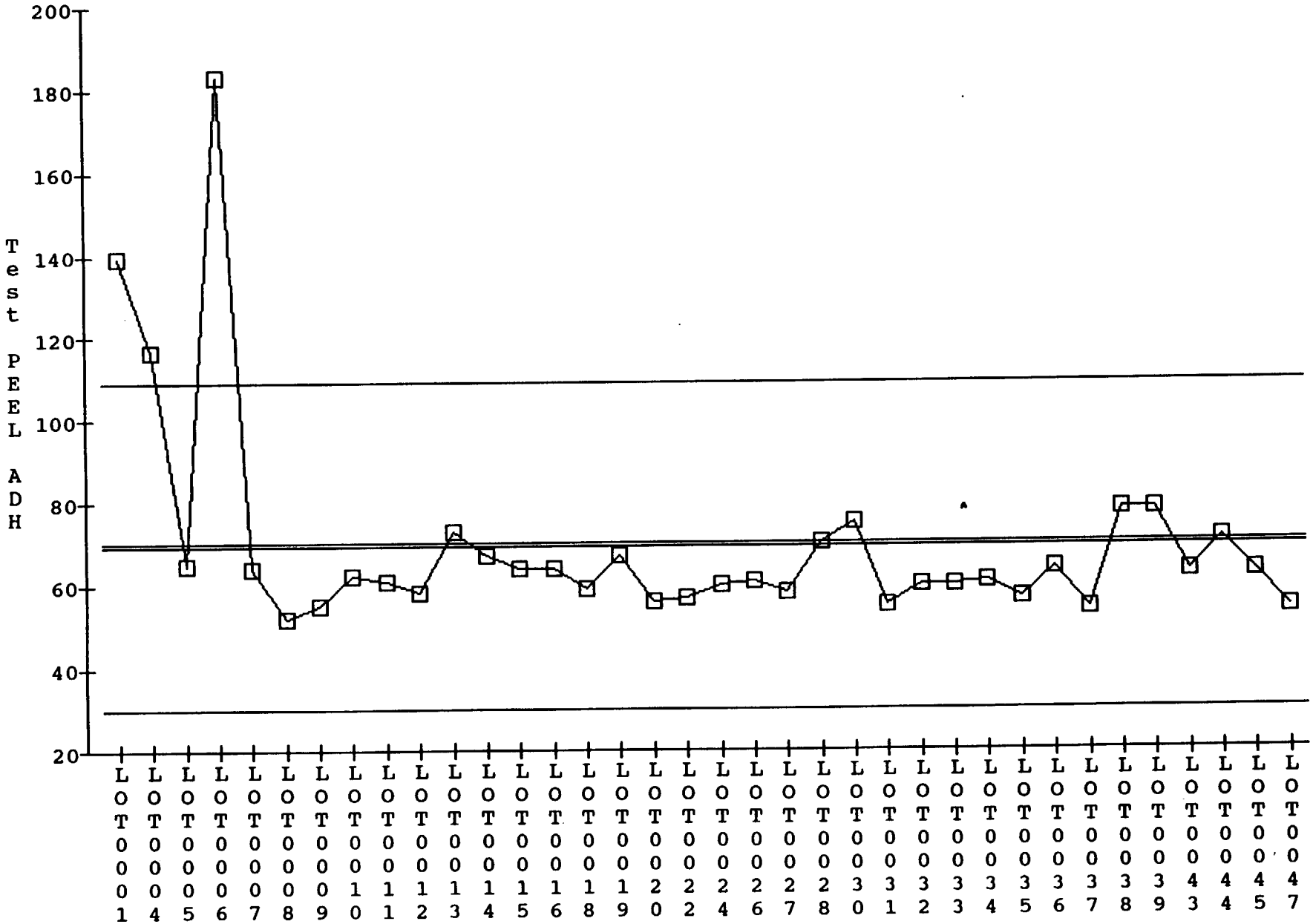
Prepared by Raw Materials PQE 19-FEB-93

Xbar chart for 7461_R_T0381



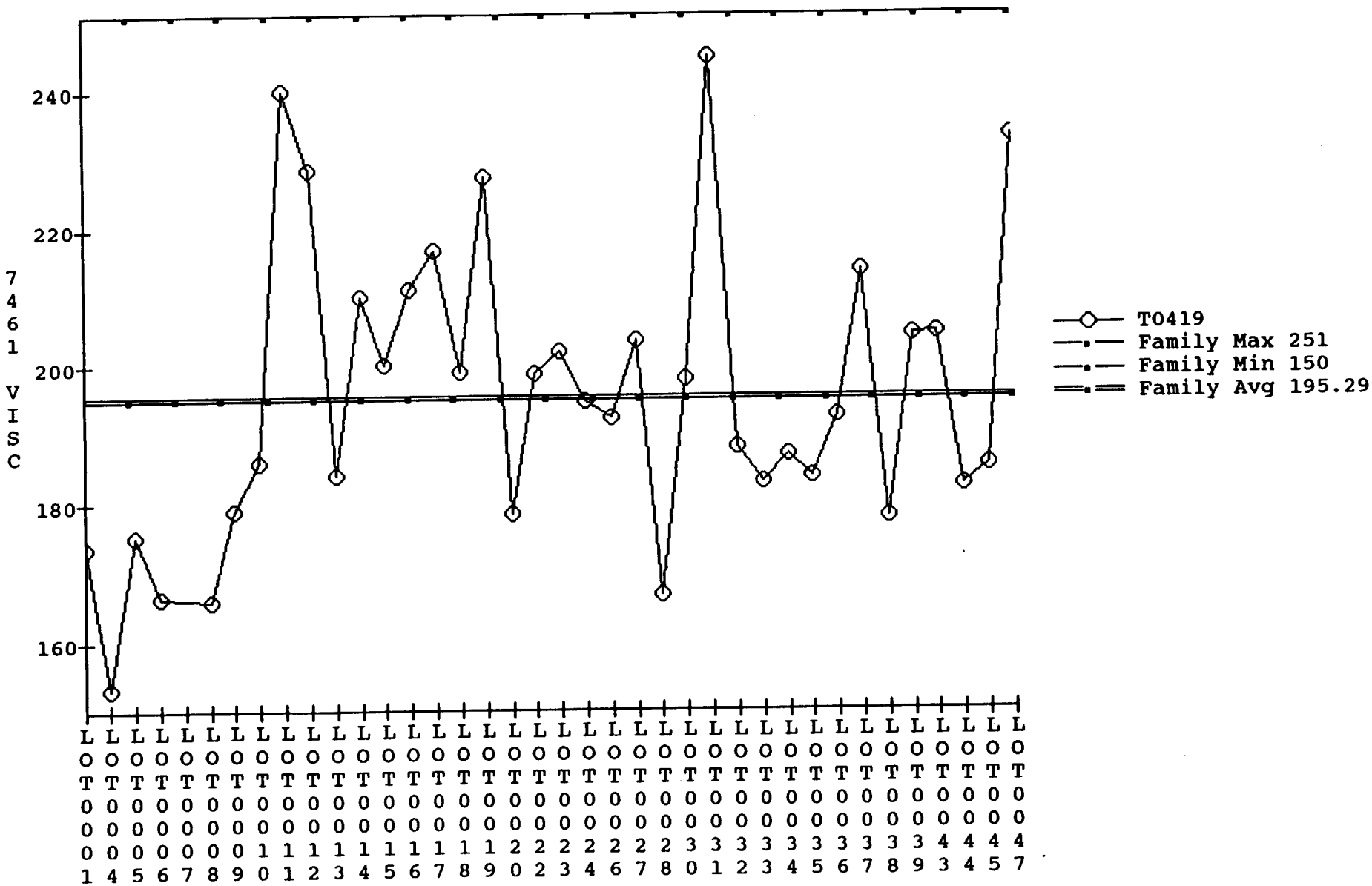
Prepared by Raw Materials PQE 19-FEB-93

Xbar chart for 7461_V_T0381



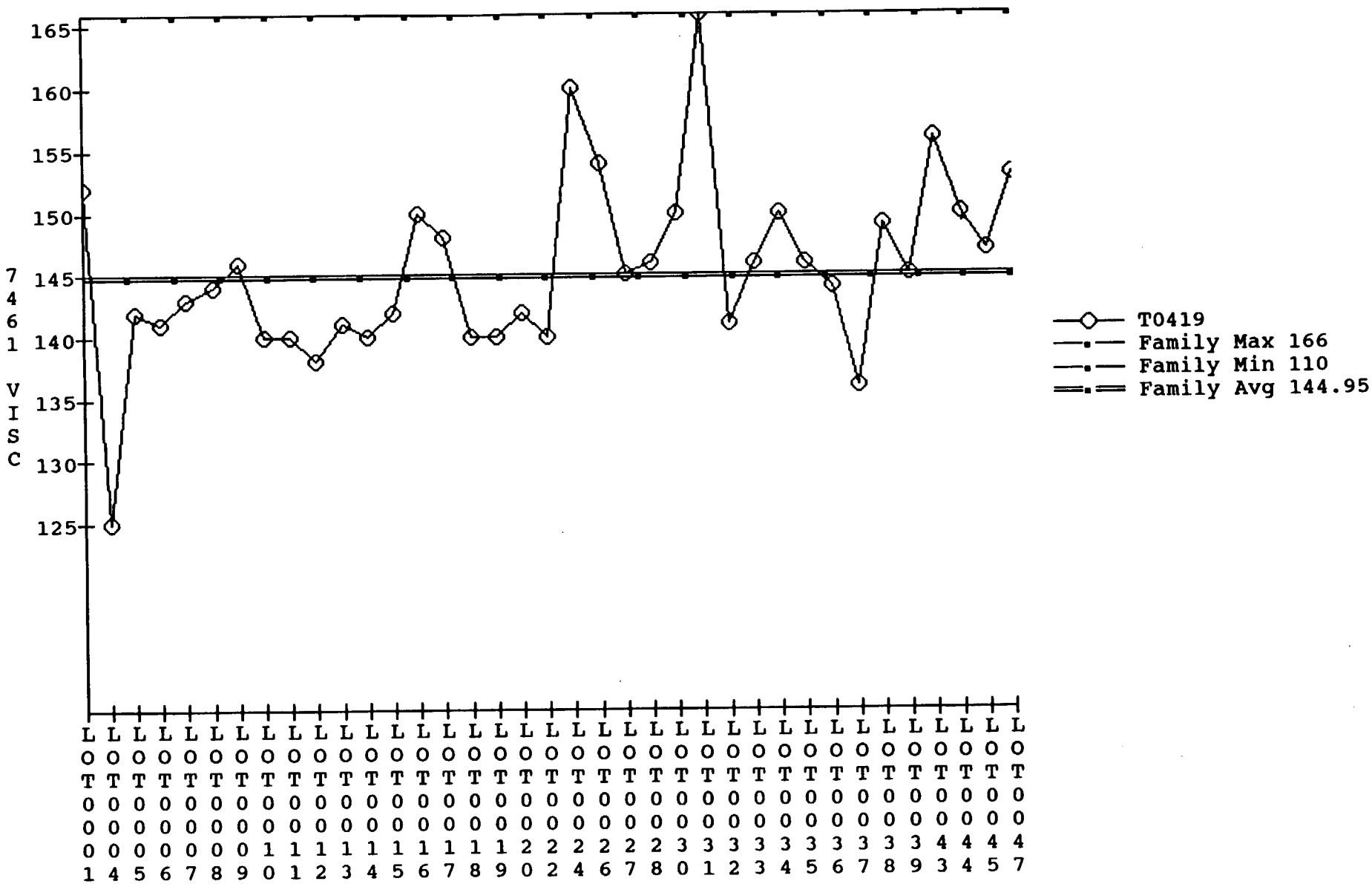
Prepared by Raw Materials PQE 19-FEB-93

Trend Chart for gxy7461 R_T0419



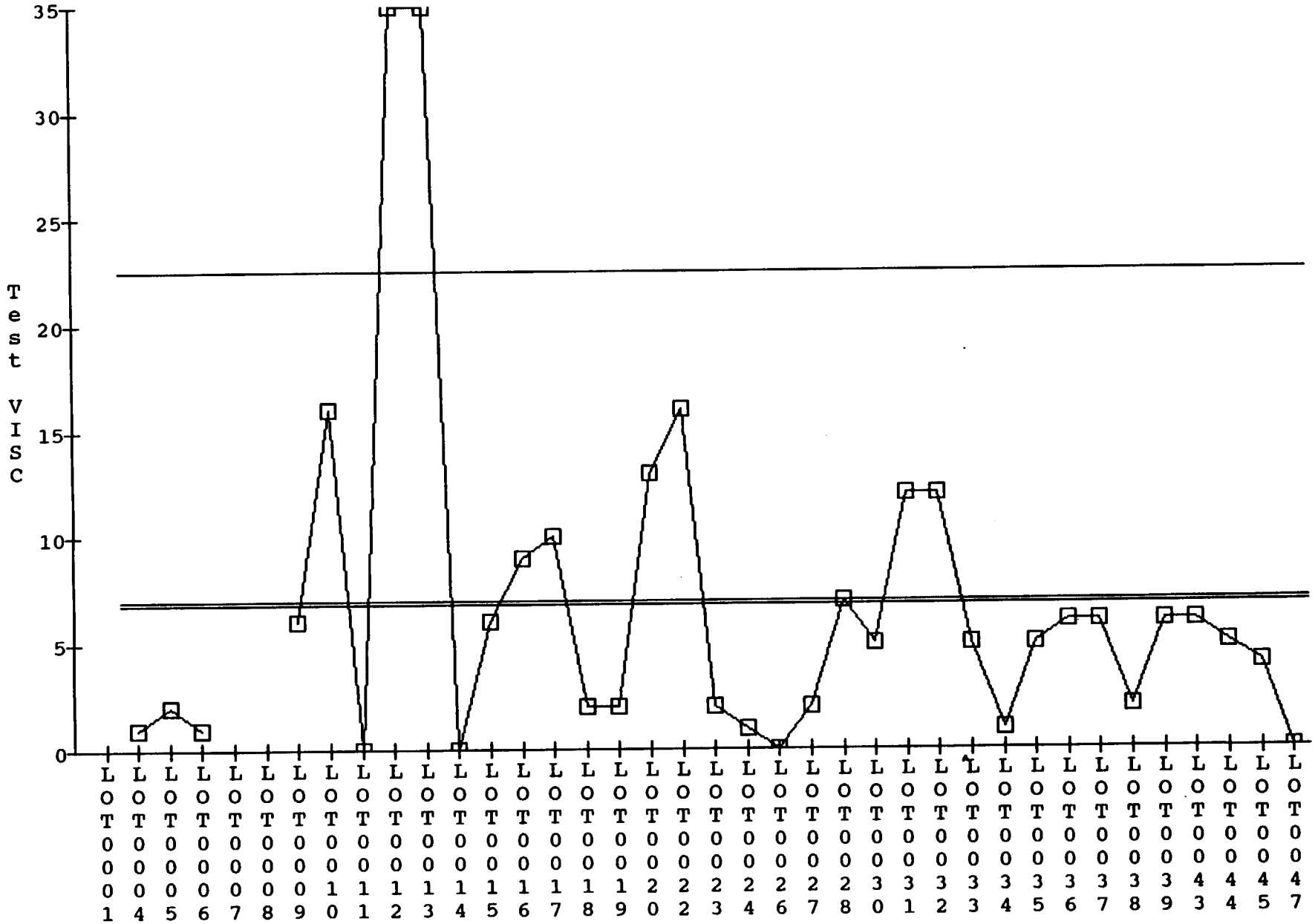
Prepared by Raw Materials PQE

Trend Chart for gxy7461 V_T0419



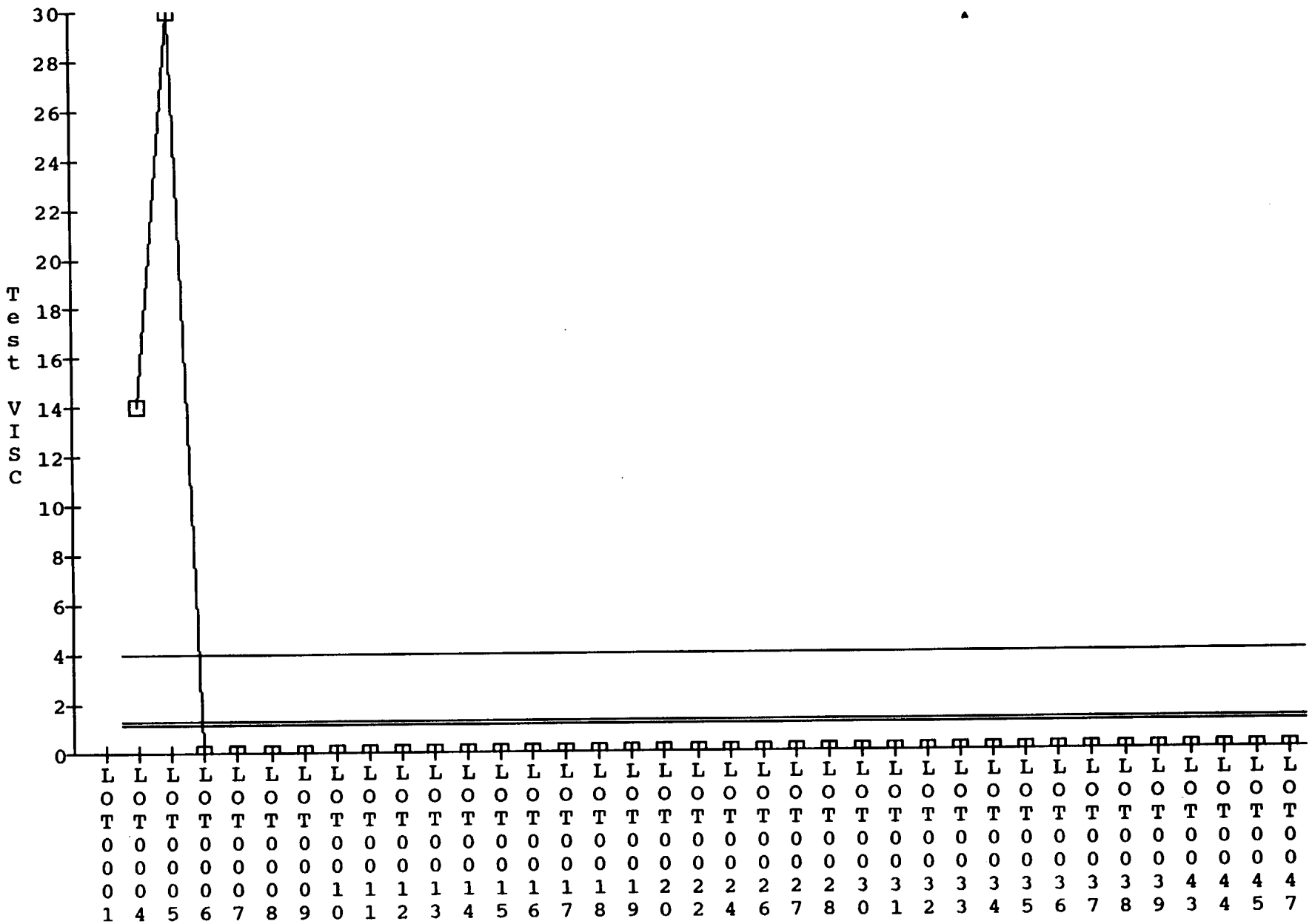
Prepared by Raw Materials PQE

R chart for 7461_R_T0419



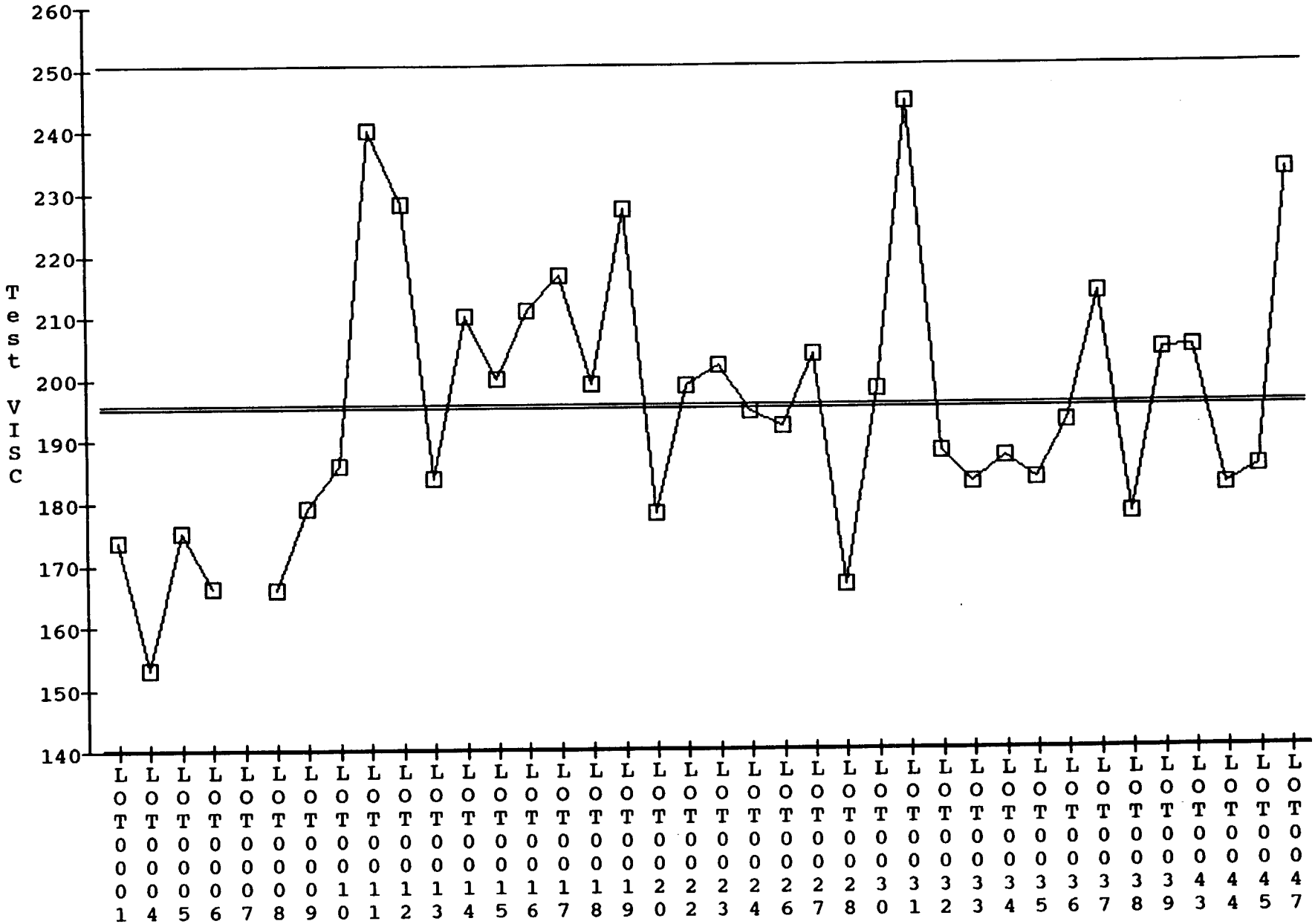
Prepared by Raw Materials PQE 19-FEB-93

R chart for 7461_V_T0419



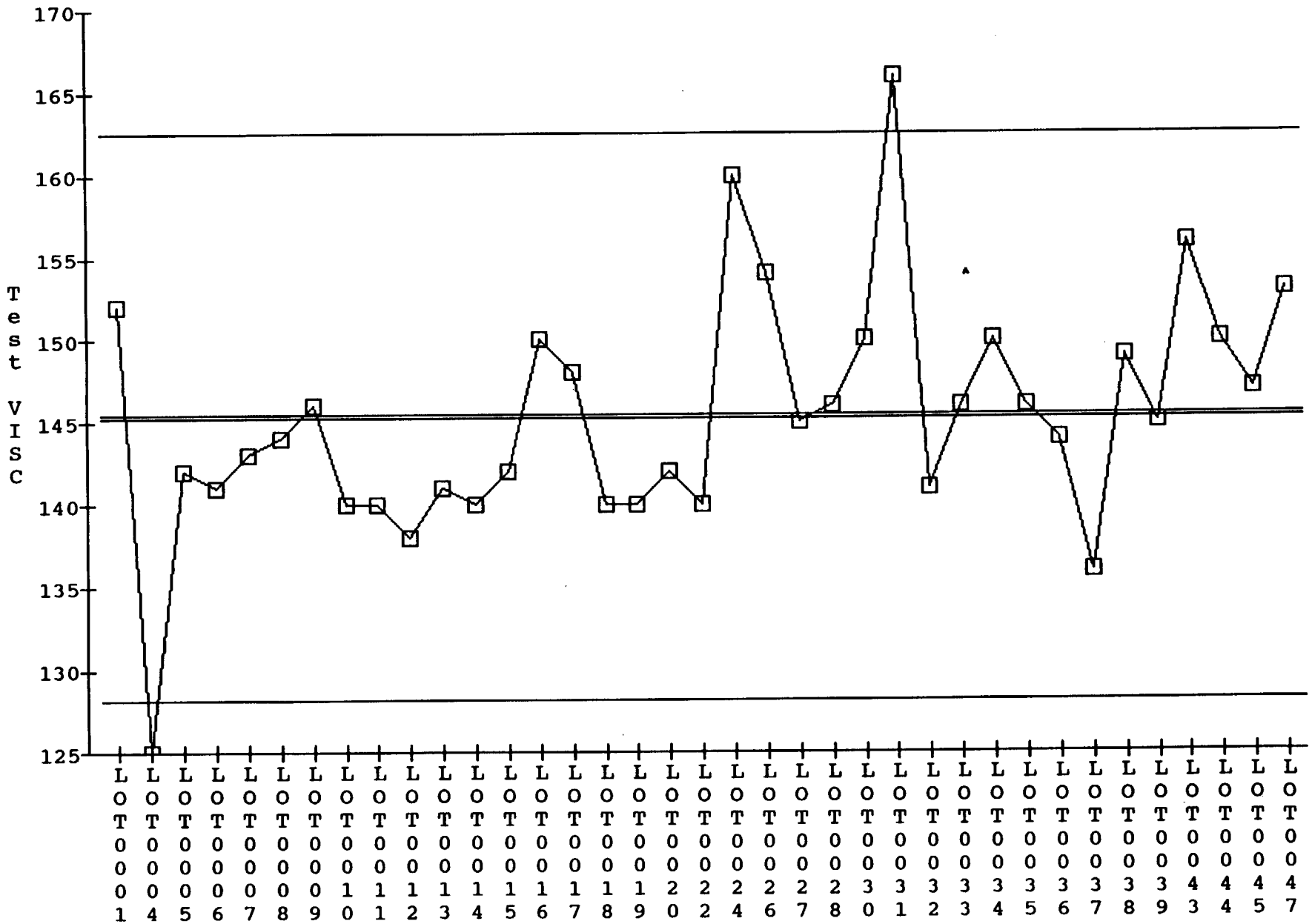
Prepared by Raw Materials PQE 19-FEB-93

Xbar chart for 7461_R_T0419



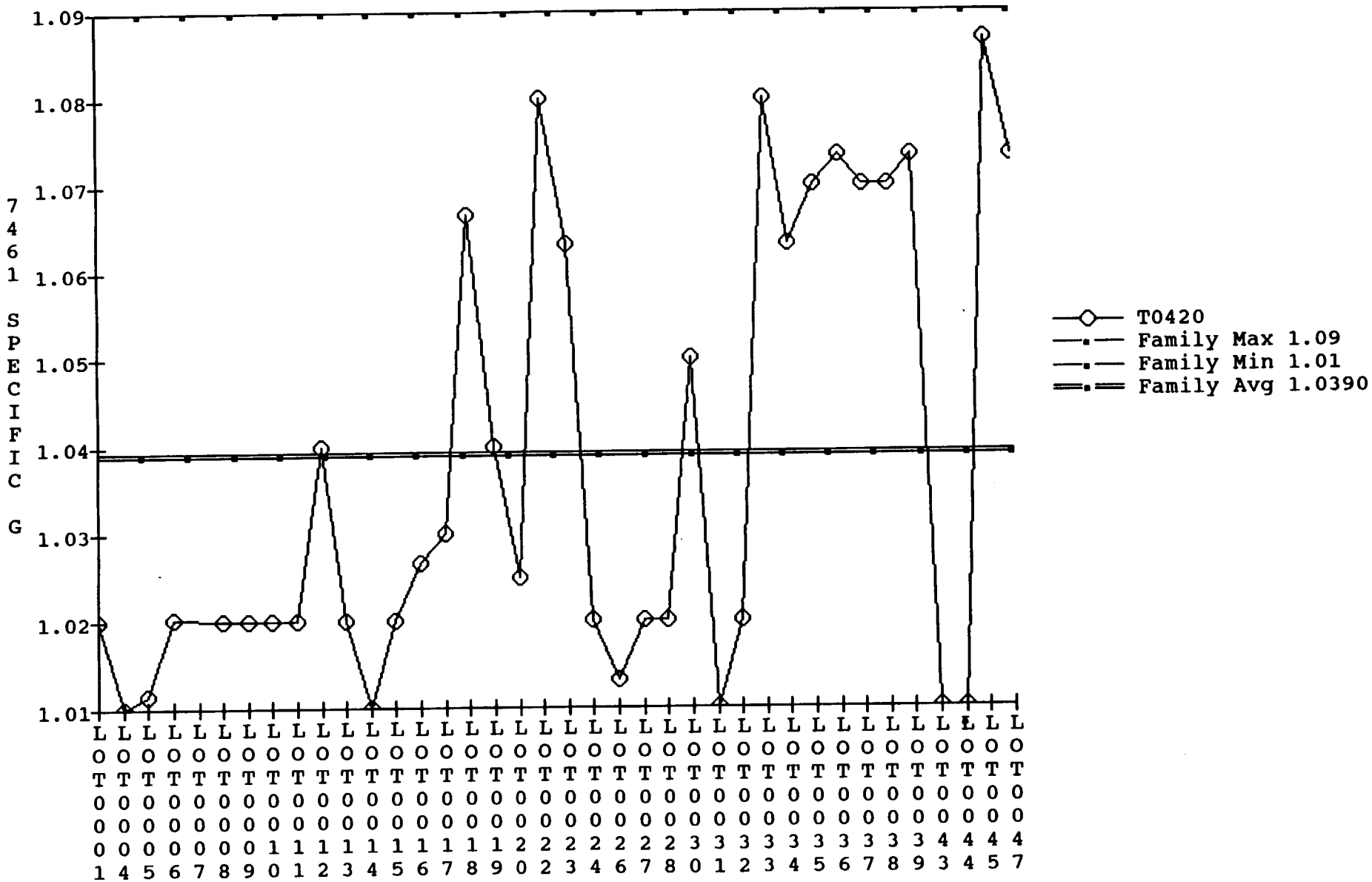
Prepared by Raw Materials PQE 19-FEB-93

Xbar chart for 7461_V_T0419



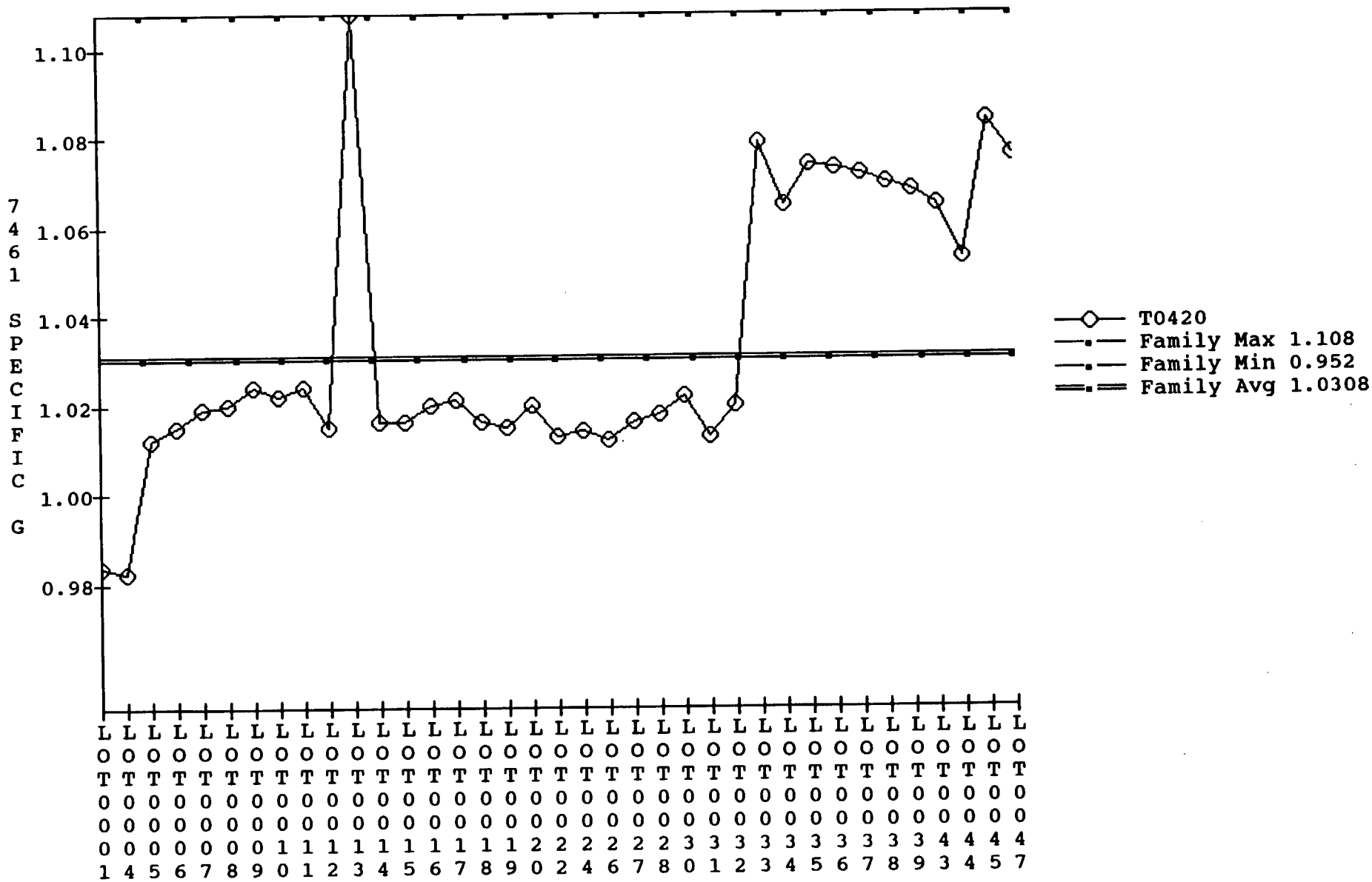
Prepared by Raw Materials PQE 19-FEB-93

Trend Chart for gxy7461 R_T0420



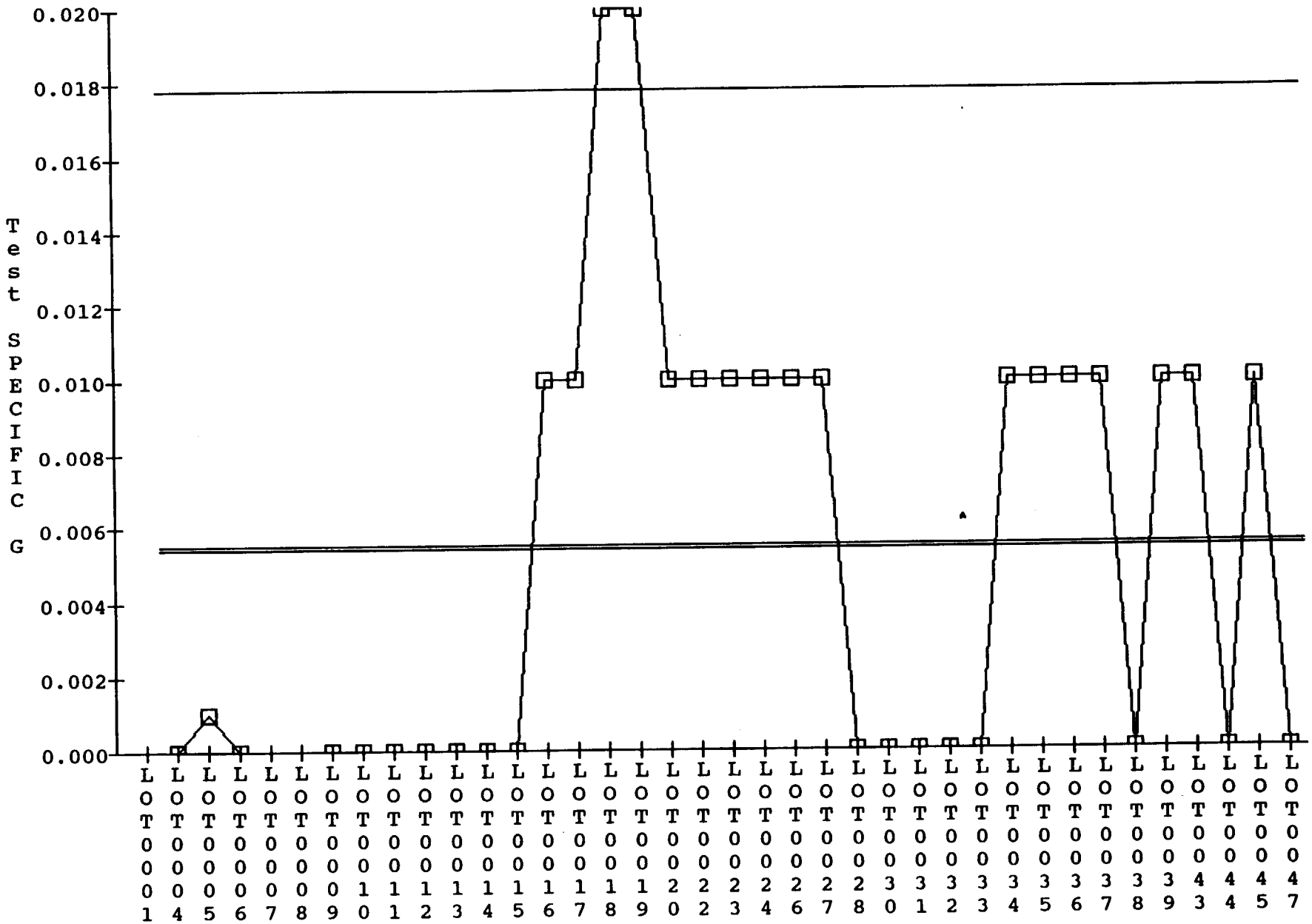
Prepared by Raw Materials PQE

Trend Chart for gxy7461 V_T0420



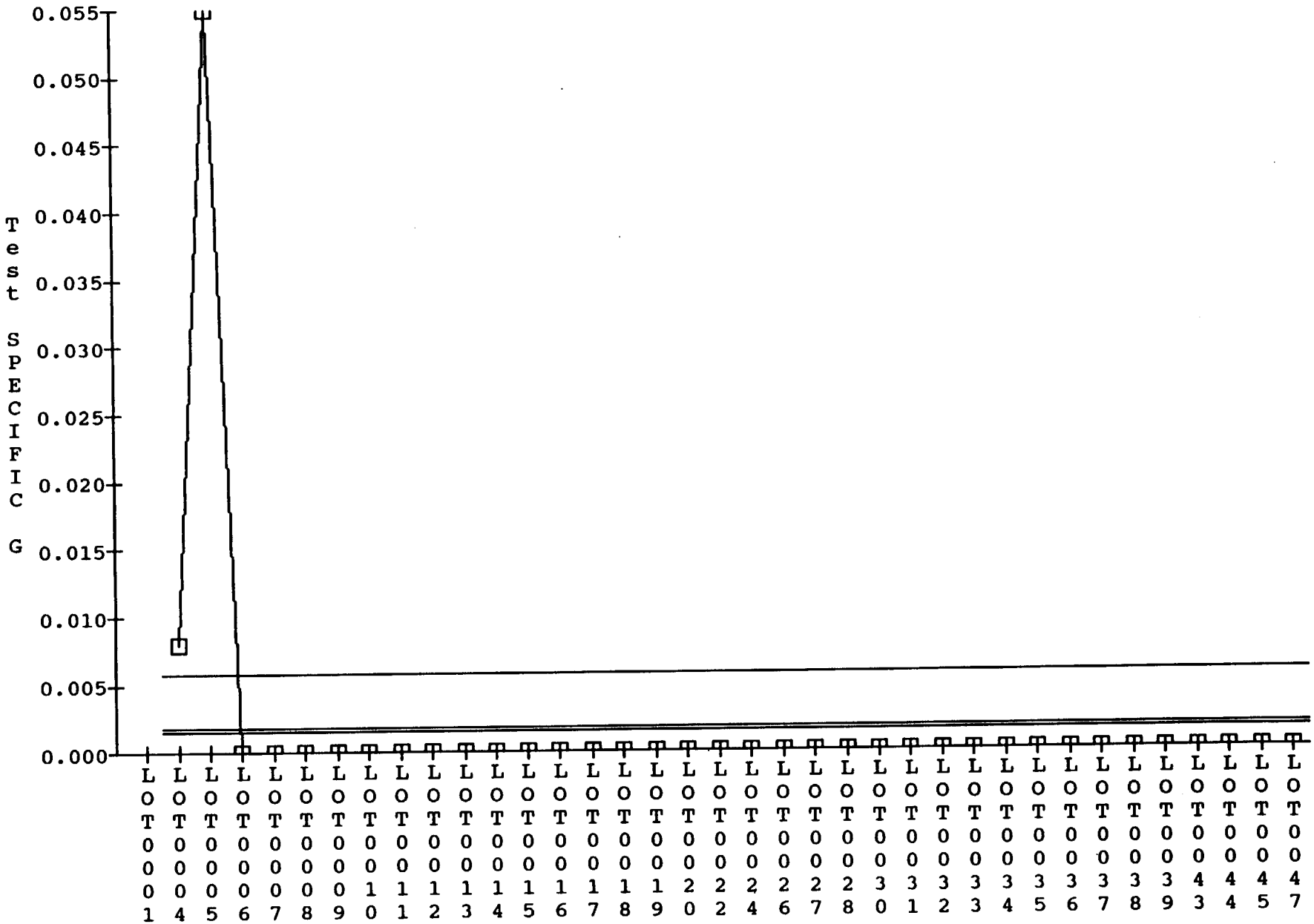
Prepared by Raw Materials PQE

R chart for 7461_R_T0420



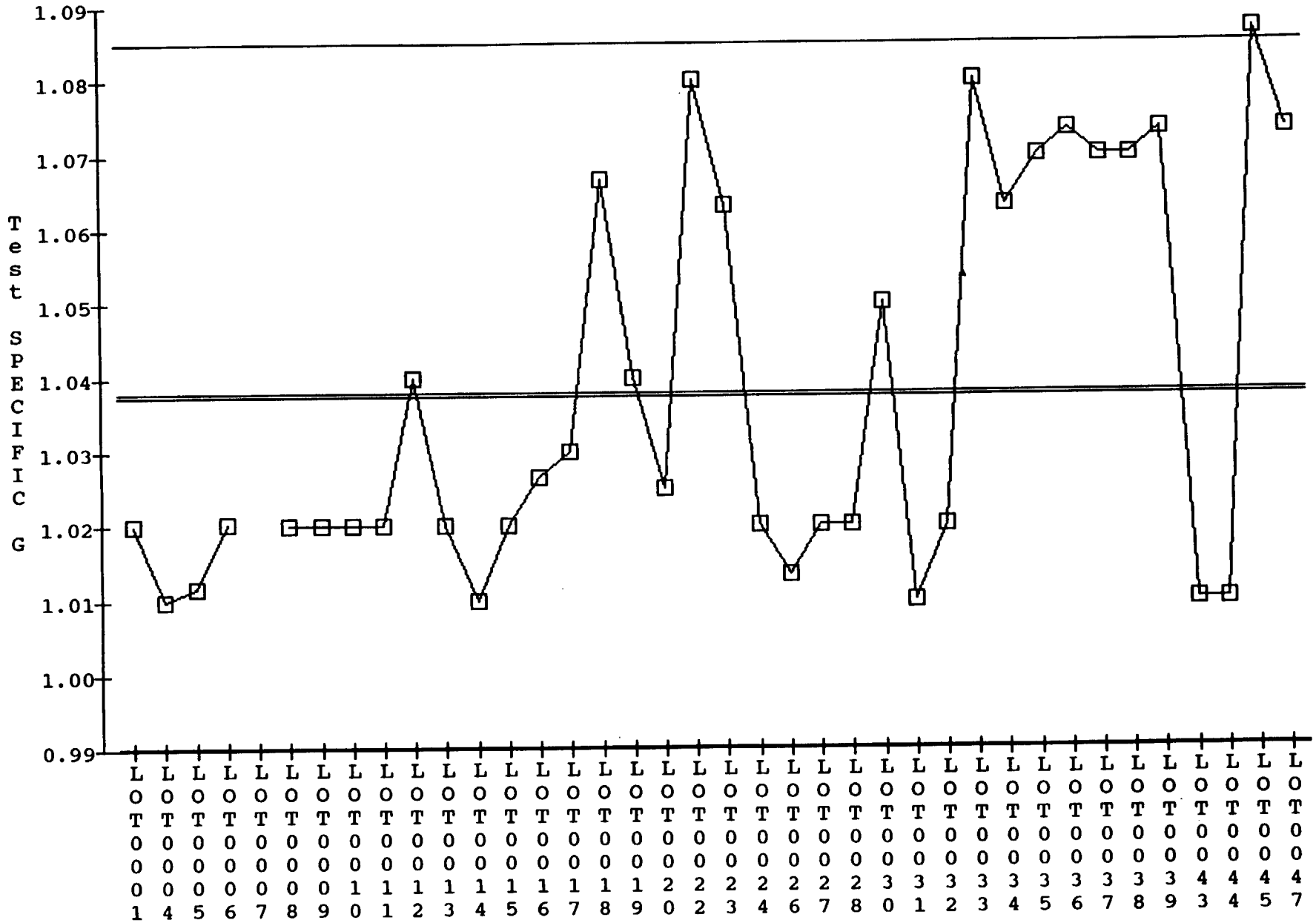
Prepared by Raw Materials PQE 19-FEB-93

R chart for 7461_V_T0420



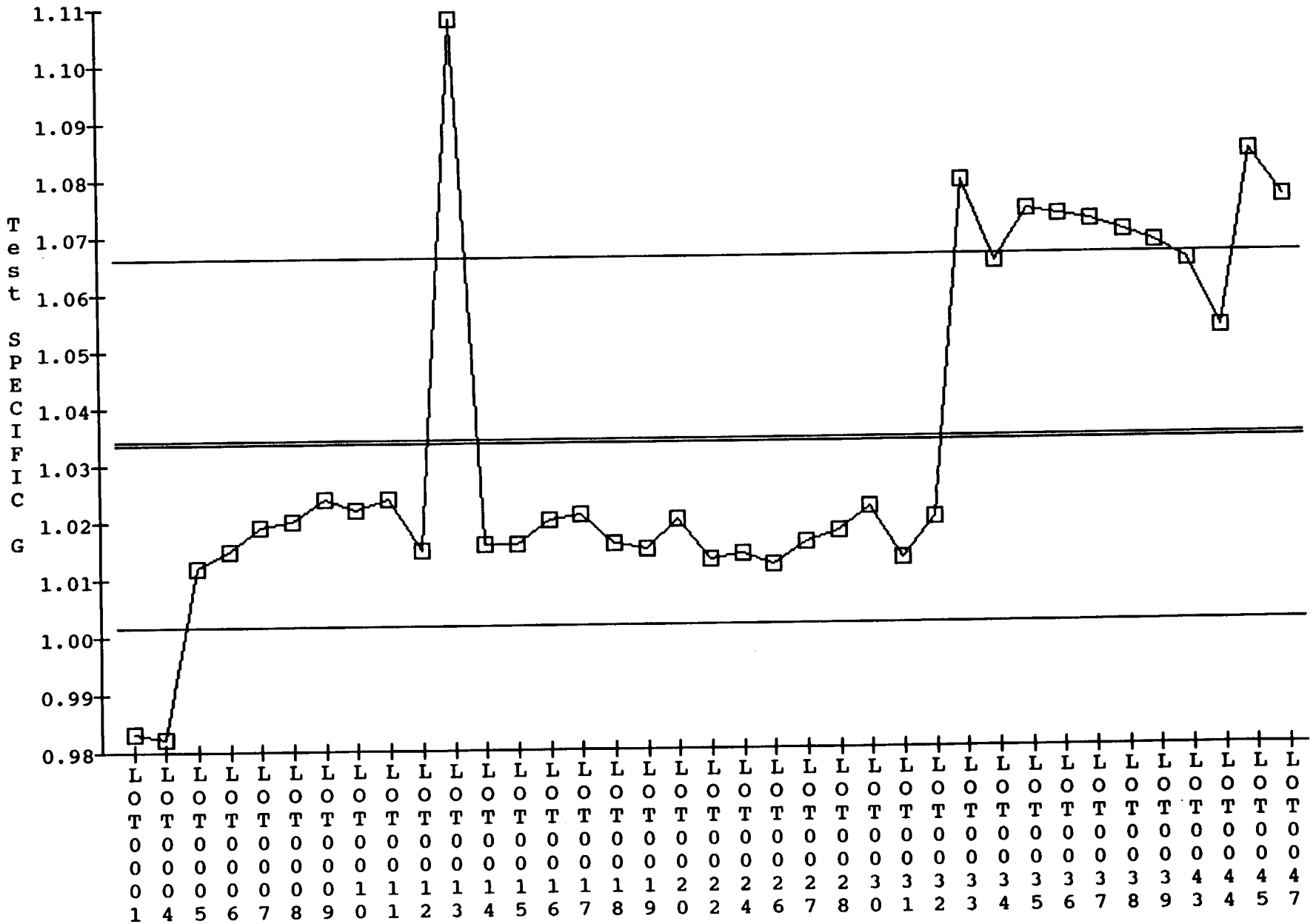
Prepared by Raw Materials PQE 19-FEB-93

Xbar chart for 7461_R_T0420



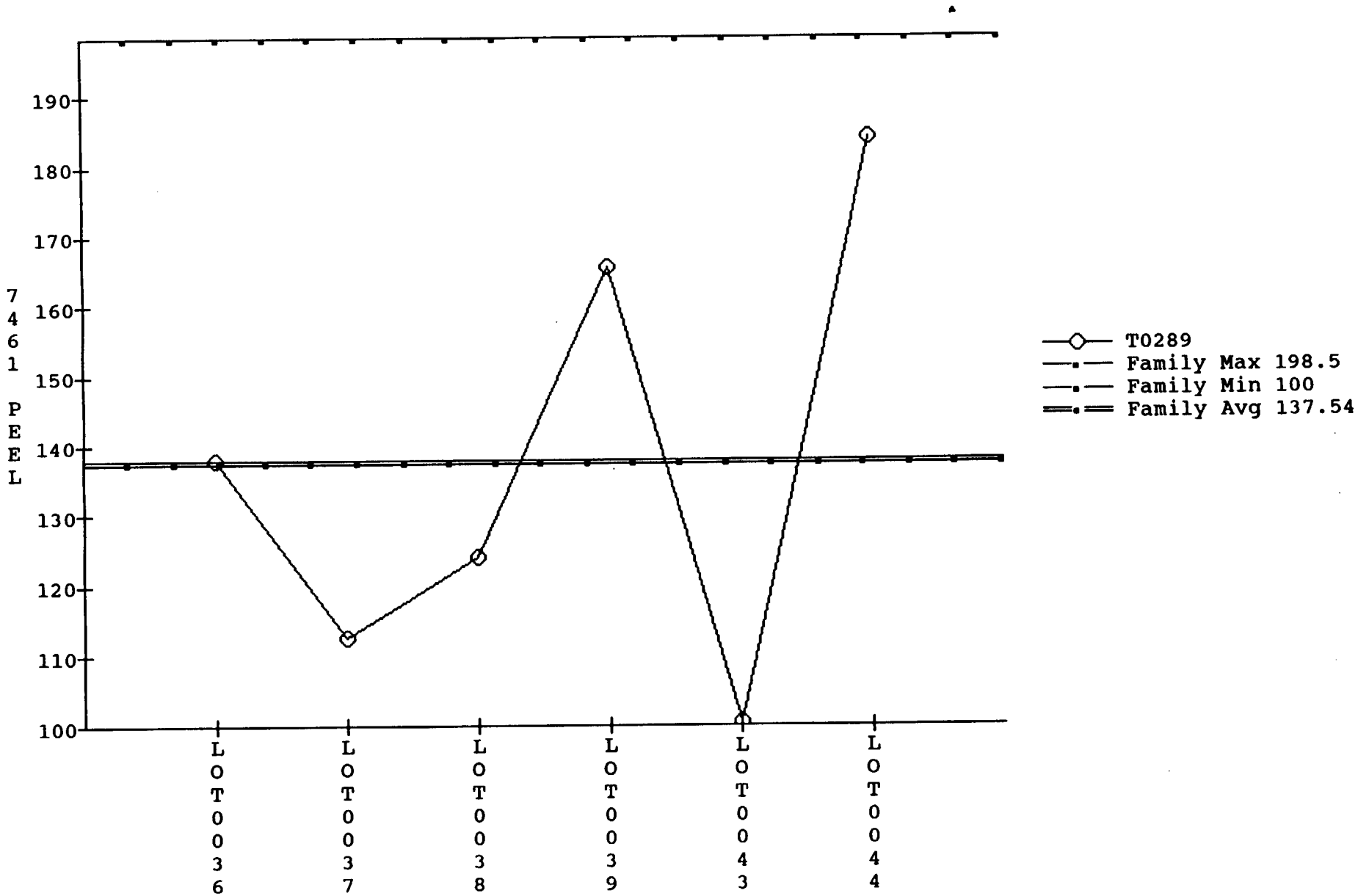
Prepared by Raw Materials PQE 19-FEB-93

Xbar chart for 7461_V_T0420



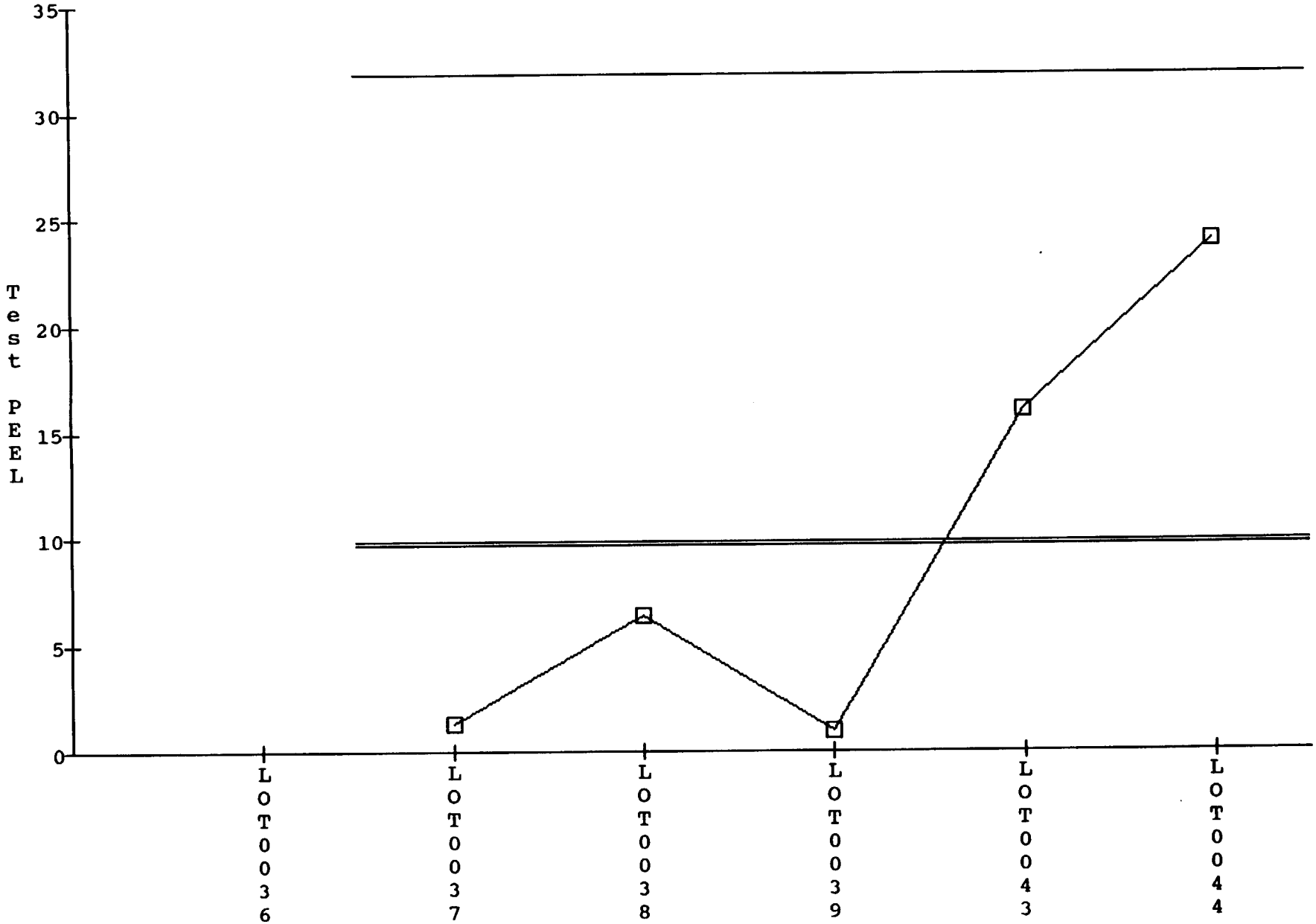
Prepared by Raw Materials PQE 19-FEB-93

Trend Chart for gxy7461 3_T0289



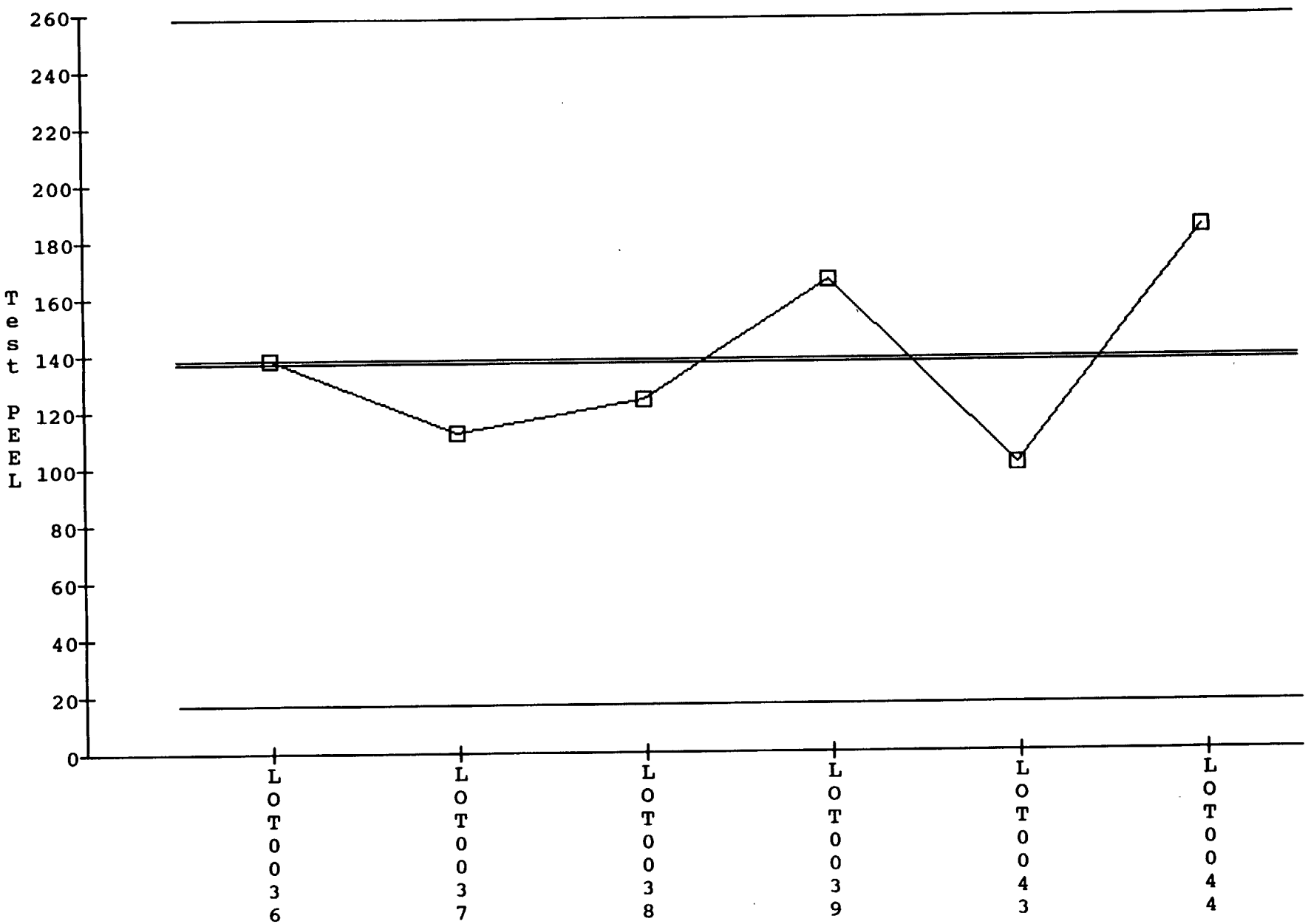
Prepared by Raw Materials PQE

R chart for 7461_3_T0289



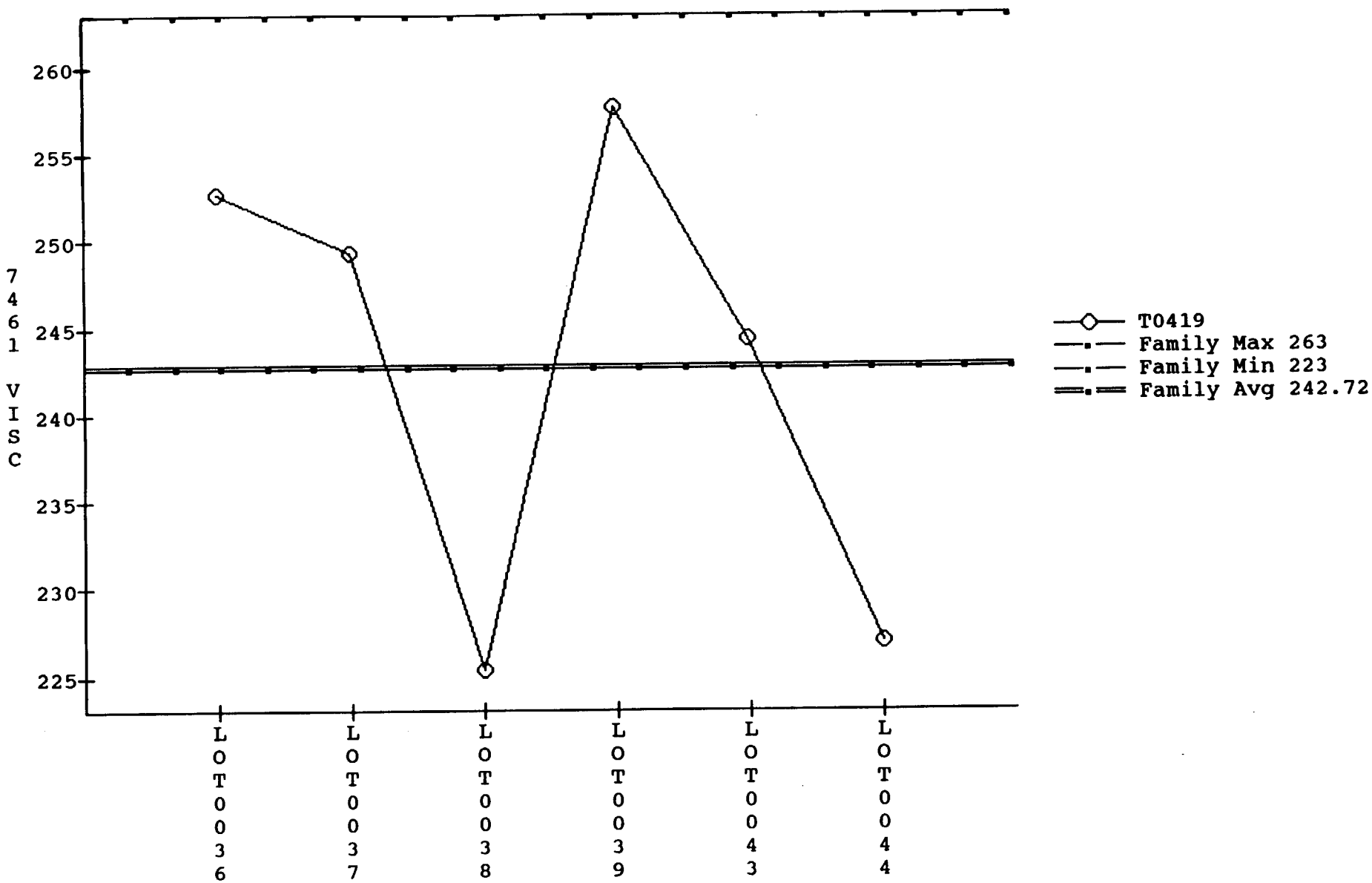
Prepared by Raw Materials PQE 19-FEB-93

Xbar chart for 7461_3_T0289



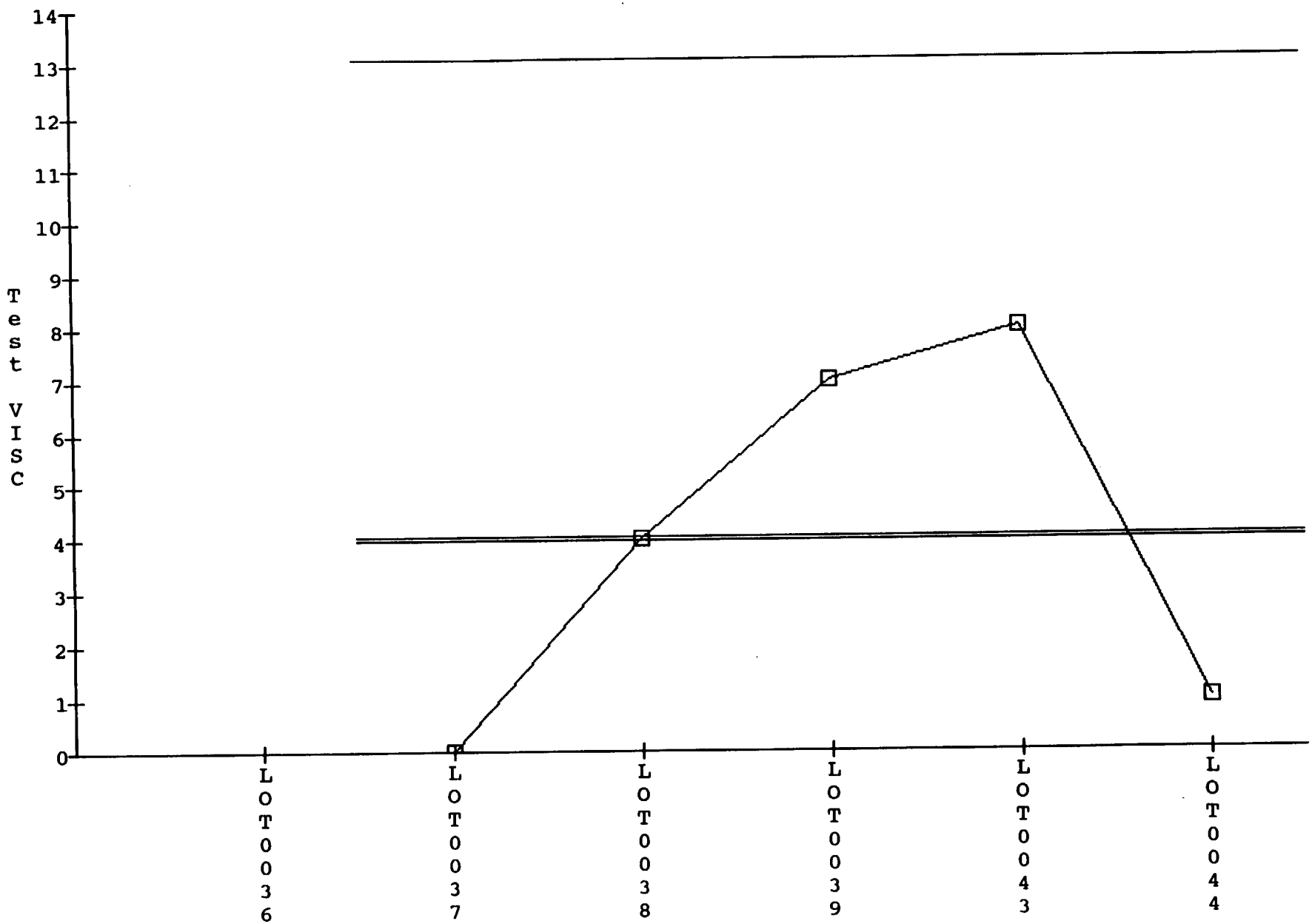
Prepared by Raw Materials PQE 19-FEB-93

Trend Chart for gxy7461 3_T0419



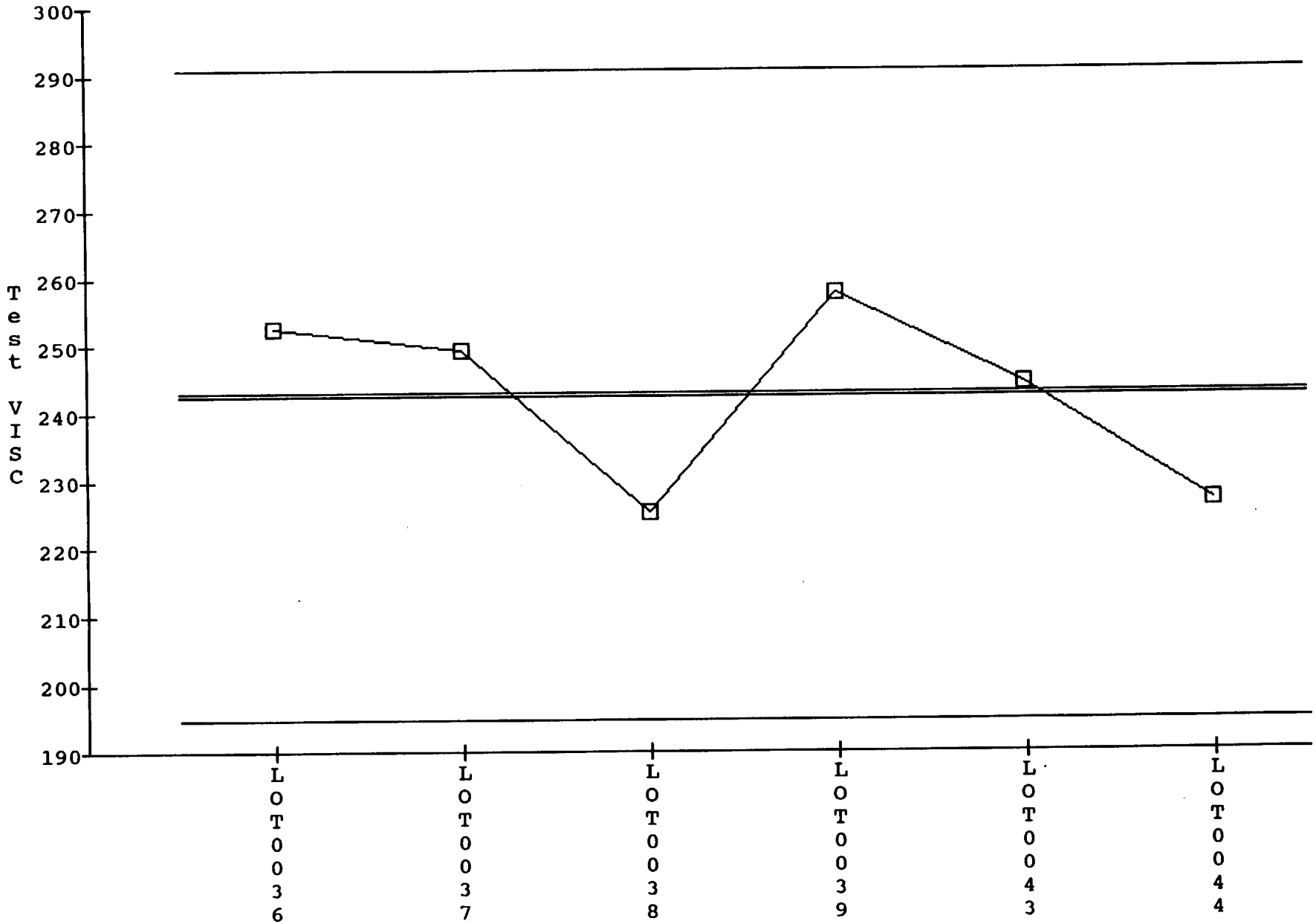
Prepared by Raw Materials PQE

R chart for 7461_3_T0419



Prepared by Raw Materials PQE 19-FEB-93

Xbar chart for 7461_3_T0419



Prepared by Raw Materials PQE 19-FEB-93

JUDY'S SUPER JOB SAVING REPORT - FILE > D7461.DAT 2/17/1993

OT NO.	T	ITEM	DATE	MATRIX	DATA 00	01	02 ...
OT0001	R	0140		*0000177			23.8 23.6 23.6
OT0001	R	0150		*0000420			1.02 1.02 1.02
OT0001	R	0160		*0000419			170 176 175
OT0001	V	0140		*0000177	1	24.84	
OT0001	V	0140		*0000177	2	24.03	
OT0001	V	0150		*0000420	1	.952	
OT0001	V	0150		*0000420	2	1.015	
OT0001	V	0160		*0000419	1	160	
OT0001	V	0160		*0000419	2	144	
OT0001	V	0165		*0000381	1	136	
OT0001	V	0165		*0000381	2	143	
OT0004	R	0140		*0000177			23.9 23.9 23.8
OT0004	R	0150		*0000420			1.01 1.01 1.01
OT0004	R	0160		*0000419			155 150 155
OT0004	V	0140		*0000177	1	25.70	
OT0004	V	0140		*0000177	2	23.50	
OT0004	V	0150		*0000420	1	.955	
OT0004	V	0150		*0000420	2	1.010	
OT0004	V	0160		*0000419	1	110	
OT0004	V	0160		*0000419	2	140	
OT0004	V	0165		*0000381	1	106	
OT0004	V	0165		*0000381	2	127	
OT0005	R	0140		*0000177			23.8 24.0 23.5
OT0005	R	0150		*0000420			1.012 1.011 1.012
OT0005	R	0160		*0000419			174 175 177
OT0005	V	0140		*0000177			23.69
OT0005	V	0150		*0000420			1.012
OT0005	V	0160		*0000419			142
OT0005	V	0165		*0000381			65
OT0006	R	0140		*0000177			25.2 25.1 24.4
OT0006	R	0150		*0000420			1.020 1.021 1.020
OT0006	R	0160		*0000419			165 165 169
OT0006	R	0165		*0000381			73 71 72
OT0006	V	0140		*0000177			25.2
OT0006	V	0150		*0000420			1.015
OT0006	V	0160		*0000419			141
OT0006	V	0165		*0000381			183
OT0007	R	0140		*0000177	#99->	24.2	
OT0007	R	0150		*0000420	#99->	1.02	
OT0007	R	0160		*0000419	#99->	195	
OT0007	R	0165		*0000381	#99->	90.8	
OT0007	V	0140		*0000177			24.3
OT0007	V	0150		*0000420			1.019
OT0007	V	0160		*0000419			143
OT0007	V	0165		*0000381			64
OT0008	R	0140		*0000177			23.20 23.19 23.11
OT0008	R	0150		*0000420			1.02 1.02 1.02
OT0008	R	0160		*0000419			160.0 170.0 168.0
OT0008	R	0165		*0000381			140.8 133.9 103.8
OT0008	V	0140		*0000177			24.02
OT0008	V	0150		*0000420			1.020
OT0008	V	0160		*0000419			144

OT NO.	T	ITEM	DATE	MATRIX	DATA 00 01	02 ...
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OT0009	R	0140		*0000177		24.9
OT0009	R	0140		*0000177		23.9
OT0009	R	0150		*0000420		1.02
OT0009	R	0150		*0000420		1.02
OT0009	R	0160		*0000419		187
OT0009	R	0160		*0000419		171
OT0009	R	0165		*0000381		68
OT0009	R	0165		*0000381		62.7 60.5 63.6
OT0009	V	0140		*0000177	1 25.4	
OT0009	V	0140		*0000177	2 25.4	
OT0009	V	0150		*0000420	1 1.024	
OT0009	V	0150		*0000420	2 1.024	
OT0009	V	0160		*0000419	1 146	
OT0009	V	0160		*0000419	2 146	
OT0009	V	0165		*0000381	1 55	
OT0009	V	0165		*0000381	2 55	
OT0010	R	0140		*0000177		25.2
OT0010	R	0150		*0000420		1.02
OT0010	R	0160		*0000419		186
OT0010	R	0165		*0000381		58
OT0010	V	0140		*0000177		25.6
OT0010	V	0150		*0000420		1.022
OT0010	V	0160		*0000419		140
OT0010	V	0165		*0000381		62
OT0011	R	0140		*0000177		24.6
OT0011	R	0150		*0000420		1.02
OT0011	R	0160		*0000419		240
OT0011	R	0165		*0000381		125.6
OT0011	V	0140		*0000177		25.4
OT0011	V	0150		*0000420		1.024
OT0011	V	0160		*0000419		140
OT0011	V	0165		*0000381		61
OT0012	R	0140		*0000177		23.4 23.8 23.6 #99-> 23.6
OT0012	R	0150		*0000420		1.04 1.04 1.04 #99-> 1.04
OT0012	R	0160		*0000419		215 220 250 #99-> 228
OT0012	R	0165		*0000381		65 64 55 58 #99-> 61
OT0012	V	0140		*0000177		26.6
OT0012	V	0150		*0000420		1.015
OT0012	V	0160		*0000419		138
OT0012	V	0165		*0000381		58
OT0013	R	0140		*0000177		23.9
OT0013	R	0150		*0000420		1.02
OT0013	R	0160		*0000419		184
OT0013	R	0165		*0000381		68
OT0013	V	0140		*0000177		25.17
OT0013	V	0150		*0000420		1.108
OT0013	V	0160		*0000419		141
OT0013	V	0165		*0000381		73
OT0014	R	0140		*0000177		24.1 24.3 24.3 #99-> 24.2
OT0014	R	0150		*0000420		1.01 1.01 1.01 #99-> 1.01
OT0014	R	0160		*0000419		210 210 210 #99-> 210

LOT NO.	T	ITEM	DATE	MATRIX	DATA 00 01	02 ...
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LOT0014	V	0140		*0000177		24.0
LOT0014	V	0150		*0000420		1.016
LOT0014	V	0160		*0000419		140
LOT0014	V	0165		*0000381		67
LOT0015	R	0140		*0000177		23.6 23.5 23.6 #99-> 23.6
LOT0015	R	0150		*0000420		1.02 1.02 1.02 #99-> 1.02
LOT0015	R	0160		*0000419		200 197 203 #99-> 200
LOT0015	R	0165		*0000381		80 79 108 #99-> 89
LOT0015	V	0140		*0000177		24.6
LOT0015	V	0150		*0000420		1.016
LOT0015	V	0160		*0000419		142
LOT0015	V	0165		*0000381		64
LOT0016	R	0140		*0000177		24.7 24.9 25.5 #99-> 25.0
LOT0016	R	0150		*0000420		1.03 1.02 1.03 #99-> 1.03
LOT0016	R	0160		*0000419		203 212 218 #99-> 211
LOT0016	R	0165		*0000381		56 53 55 #99-> 55
LOT0016	V	0140		*0000177		24.6
LOT0016	V	0150		*0000420		1.020
LOT0016	V	0160		*0000419		150
LOT0016	V	0165		*0000381		64
LOT0017	R	0140		*0000177		23.4 23.2 23.3 #99-> 23.3
LOT0017	R	0150		*0000420		1.03 1.03 1.03 #99-> 1.03
LOT0017	R	0160		*0000419		215 220 215 #99-> 217
LOT0017	R	0165		*0000381	1 64 54 83 87	
LOT0017	R	0165		*0000381	2 100 112 108 87	
LOT0017	R	0165		*0000381	3 91 95 105 90	
LOT0017	V	0140		*0000177		24.5
LOT0017	V	0150		*0000420		1.021
LOT0017	V	0160		*0000419		148
LOT0018	R	0140		*0000177		23.8 23.7 23.6
LOT0018	R	0150		*0000420		1.06 1.08 1.06
LOT0018	R	0160		*0000419		200 195 202
LOT0018	R	0165		*0000381		63 61 67
LOT0018	V	0140		*0000177		24.5
LOT0018	V	0150		*0000420		1.016
LOT0018	V	0160		*0000419		140
LOT0018	V	0165		*0000381		59
LOT0019	R	0140		*0000177		25.0 24.5 24.8
LOT0019	R	0150		*0000420		1.04 1.04 1.04
LOT0019	R	0160		*0000419		225 227 230
LOT0019	R	0165		*0000381		70
LOT0019	V	0140		*0000177		24.2
LOT0019	V	0150		*0000420		1.015
LOT0019	V	0160		*0000419		140
LOT0019	V	0165		*0000381		67
LOT0020	R	0140		*0000177	1 24.2 24.5 24.2	
LOT0020	R	0140		*0000177	2 24.0 23.9 24.1	
LOT0020	R	0150		*0000420	1 1.02 1.02 1.02	
LOT0020	R	0150		*0000420	2 1.03 1.03 1.03	
LOT0020	R	0160		*0000419	1 170 170 168	
LOT0020	R	0160		*0000419	2 185 190 187	

LOT NO.	T	ITEM	DATE	MATRIX	DATA 00 01 02 ...
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LOT0020	R	0165		*0000381	2 150 255 245 225
LOT0020	V	0140		*0000177	1 24.2
LOT0020	V	0140		*0000177	2 24.2
LOT0020	V	0150		*0000420	1 1.020
LOT0020	V	0150		*0000420	2 1.020
LOT0020	V	0160		*0000419	1 142
LOT0020	V	0160		*0000419	2 142
LOT0020	V	0165		*0000381	1 56
LOT0020	V	0165		*0000381	2 56
LOT0022	R	0140		*0000177	23.5 23.6 23.6 #99-> 23.6
LOT0022	R	0150		*0000420	1.08 1.08 1.08 #99-> 1.08
LOT0022	R	0160		*0000419	200 198 198 #99-> 199
LOT0022	R	0165		*0000381	1 60 58 62 40 #99-> 55
LOT0022	R	0165		*0000381	2 74 66 80 88 #99-> 77
LOT0022	R	0165		*0000381	3 94 113 98 103 #99-> 102
LOT0022	V	0140		*0000177	23.8
LOT0022	V	0150		*0000420	1.013
LOT0022	V	0160		*0000419	140
LOT0022	V	0165		*0000381	57
LOT0023	R	0140		*0000177	23.3 23.3 23.4 #99-> 23.3
LOT0023	R	0150		*0000420	1.06 1.06 1.07 #99-> 1.06
LOT0023	R	0160		*0000419	202 202 202 #99-> 202
LOT0023	R	0165		*0000381	60 54 53 #99-> 56
LOT0024	R	0140		*0000177	25.0 24.7 24.6 #99-> 24.8
LOT0024	R	0150		*0000420	1.02 1.02 1.02 #99-> 1.02
LOT0024	R	0160		*0000419	194 195 195 #99-> 195
LOT0024	R	0165		*0000381	1 72 70 64 90 #99-> 74
LOT0024	R	0165		*0000381	2 36 52 43 34 #99-> 41
LOT0024	R	0165		*0000381	3 16 19 22 15 #99-> 18
LOT0024	R	0165		*0000381	2 22 29 32 27 #99-> 27
LOT0024	R	0165		*0000381	3 28 14 10 30 #99-> 20
LOT0024	V	0140		*0000177	24.4
LOT0024	V	0150		*0000420	1.014
LOT0024	V	0160		*0000419	160
LOT0024	V	0165		*0000381	60
LOT0026	R	0140		*0000177	23.2 23.2 23.0 #99-> 23.1
LOT0026	R	0150		*0000420	1.01 1.01 1.02 #99-> 1.01
LOT0026	R	0160		*0000419	192 192 193 #99-> 192
LOT0026	R	0165		*0000381	1 94 101 92 97 #99-> 96
LOT0026	R	0165		*0000381	2 80 89 87 98 #99-> 88
LOT0026	R	0165		*0000381	3 162 146 166 169 #99-> 161
LOT0026	V	0140		*0000177	23.6
LOT0026	V	0150		*0000420	1.012
LOT0026	V	0160		*0000419	154
LOT0026	V	0165		*0000381	61
LOT0027	R	0140		*0000177	24.7 24.8 24.6 #99-> 24.7
LOT0027	R	0150		*0000420	1.02 1.02 1.02 #99-> 1.02
LOT0027	R	0160		*0000419	202 204 205 #99-> 204
LOT0027	R	0165		*0000381	1 130 141 150 150 #99-> 143
LOT0027	R	0165		*0000381	2 153 138 147 140 #99-> 144
LOT0027	R	0165		*0000381	3 128 148 152 133 #99-> 140

LOT NO.	T	ITEM	DATE	MATRIX	DATA 00 01 02 ...
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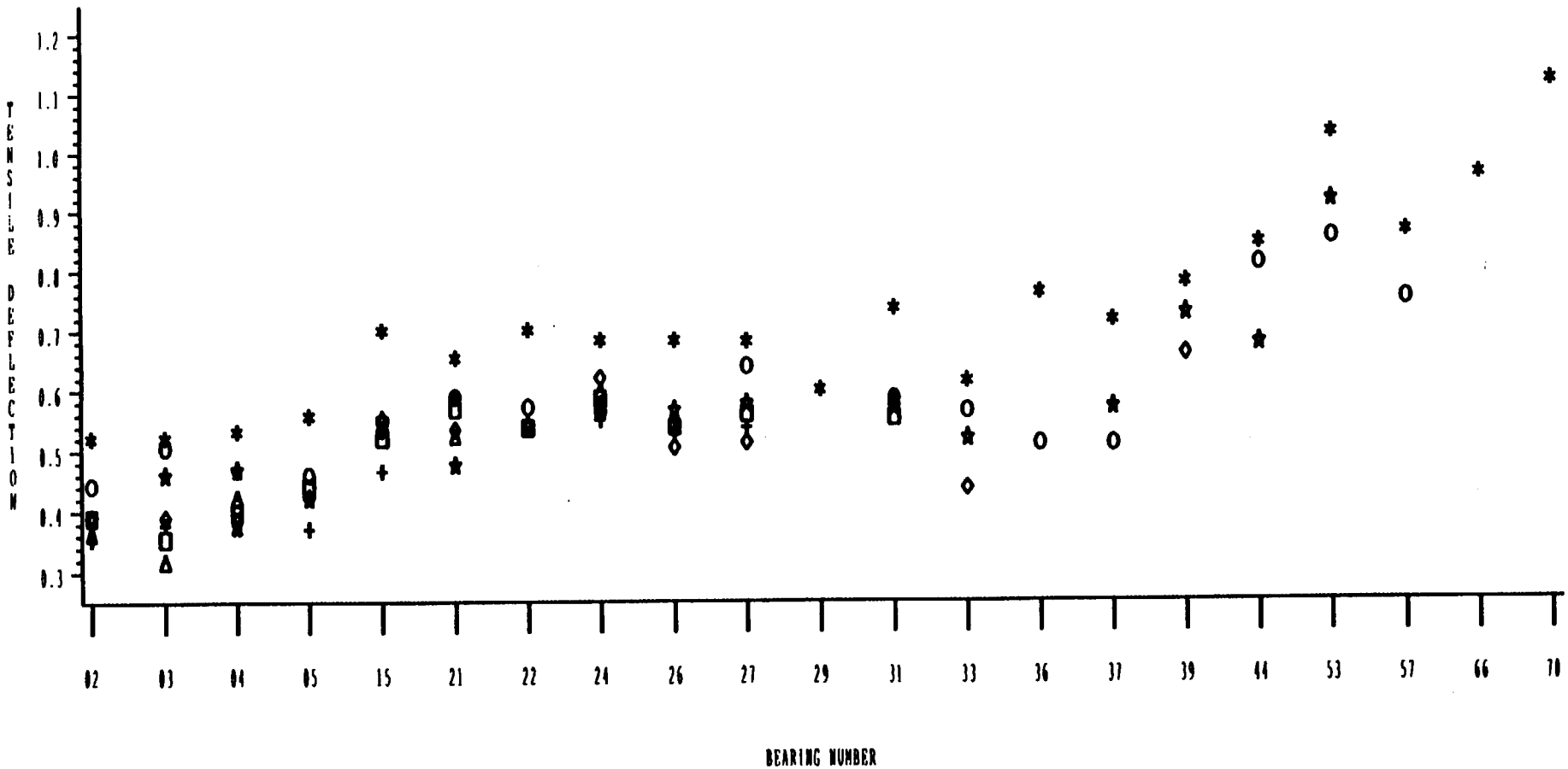
LOT0027	V	0150		*0000420	1.016
LOT0027	V	0160		*0000419	145
LOT0027	V	0165		*0000381	58
LOT0028	R	0140		*0000177	25.0 25.0 25.0 #99-> 25.0
LOT0028	R	0150		*0000420	1.02 1.02 1.02 #99-> 1.02
LOT0028	R	0160		*0000419	160 170 170 #99-> 167
LOT0028	R	0165		*0000381	1 99 129 134 #99-> 121
LOT0028	R	0165		*0000381	2 165 142 185 #99-> 164
LOT0028	R	0165		*0000381	3 158 199 200 #99-> 186
LOT0028	V	0140		*0000177	25.0
LOT0028	V	0150		*0000420	1.018
LOT0028	V	0160		*0000419	146
LOT0028	V	0165		*0000381	70
LOT0030	R	0140		*0000177	1 24.3 24.3 24.3 #99-> 24.3
LOT0030	R	0140		*0000177	2 24 24.1 24.1 #99-> 24.1
LOT0030	R	0140		*0000177	3 24.4 24.2 24.1 #99-> 24.2
LOT0030	R	0150		*0000420	1.05 1.05 1.05 #99-> 1.05
LOT0030	R	0160		*0000419	1 196 196 196 #99-> 196
LOT0030	R	0160		*0000419	2 197 197 197 #99-> 197
LOT0030	R	0160		*0000419	3 201 201 201 #99-> 201
LOT0030	R	0165		*0000381	1 148 165 169 143
LOT0030	R	0165		*0000381	2 105 97 100 127
LOT0030	R	0165		*0000381	3 91 115 183
LOT0030	V	0140		*0000177	24.3
LOT0030	V	0150		*0000420	1.022
LOT0030	V	0160		*0000419	150
LOT0030	V	0165		*0000381	75
LOT0031	R	0140		*0000177	23.7 23.6 23.7 #99-> 23.7
LOT0031	R	0150		*0000420	1.01 1.01 1.01 #99-> 1.01
LOT0031	R	0160		*0000419	234 249 251 #99-> 245
LOT0031	R	0165		*0000381	1 72 88 61 #99-> 74
LOT0031	R	0165		*0000381	2 54 70 83 #99-> 69
LOT0031	R	0165		*0000381	3 72 64 70 #99-> 69
LOT0031	V	0140		*0000177	24.0
LOT0031	V	0150		*0000420	1.013
LOT0031	V	0160		*0000419	166
LOT0031	V	0165		*0000381	55
LOT0032	R	0140		*0000177	24.6 24.7 24.7 #99-> 24.7
LOT0032	R	0150		*0000420	1.02 1.02 1.02 #99-> 1.02
LOT0032	R	0160		*0000419	185 190 189 #99-> 188
LOT0032	R	0165		*0000381	1 69 64 59 83 #99-> 69
LOT0032	R	0165		*0000381	2 76 63 58 61 #99-> 64
LOT0032	R	0165		*0000381	3 67 61 81 72 #99-> 70
LOT0032	V	0140		*0000177	24.6
LOT0032	V	0150		*0000420	1.02
LOT0032	V	0160		*0000419	141
LOT0032	V	0165		*0000381	60
LOT0033	R	0140		*0000177	23.9 24.0 24.2 #99-> 24.0
LOT0033	R	0150		*0000420	1.08 1.08 1.08 #99-> 1.08
LOT0033	R	0160		*0000419	178 183 188 #99-> 183
LOT0033	R	0165		*0000381	1 118 110 120 #99-> 116

LOT NO.	T	ITEM	DATE	MATRIX	DATA 00 01	02 ...
LOT0033	R	0165		*0000381	2 105 114 130	#99-> 116
LOT0033	R	0165		*0000381	3 105 90 88	#99-> 94
LOT0033	V	0140		*0000177		24.2
LOT0033	V	0150		*0000420		1.079
LOT0033	V	0160		*0000419		146
LOT0033	V	0165		*0000381		60
LOT0034			*0000126			
LOT0034	R	0140		*0000177		23.4 23.4 23.3 #99-> 23.4
LOT0034	R	0150		*0000420		1.06 1.07 1.06 #99-> 1.06
LOT0034	R	0160		*0000419		191 188 182 #99-> 187
LOT0034	R	0165		*0000381	1 82.2 80.0 91.3	#99-> 84
LOT0034	R	0165		*0000381	2 58.0 50.0 56.4	#99-> 55
LOT0034	R	0165		*0000381	3 116.3 119.2 128.2	#99-> 121
LOT0034	V	0140		*0000177		23.8
LOT0034	V	0150		*0000420		1.065
LOT0034	V	0160		*0000419		150
LOT0034	V	0165		*0000381		61
LOT0035			*0000126			
LOT0035	R	0140		*0000177		24.9 24.9 25.2 #99-> 25.0
LOT0035	R	0150		*0000420		1.07 1.07 1.07 #99-> 1.07
LOT0035	R	0160		*0000419		186 182 183 #99-> 184
LOT0035	R	0165		*0000381		87 76 73 #99-> 79
LOT0035	V	0140		*0000177		24.5
LOT0035	V	0150		*0000420		1.074
LOT0035	V	0160		*0000419		146
LOT0035	V	0165		*0000381		57
LOT0036			*0000126			
LOT0036	3	0160	890523	*0000419		249 257 252 #99-> 253
LOT0036	3	0165	890523	*0000289		136 145 133 #99-> 138
LOT0036	R	0140		*0000177		24.6 24.6 24.7 #99-> 24.6
LOT0036	R	0150		*0000420		1.08 1.07 1.07 #99-> 1.07
LOT0036	R	0160		*0000419		186 196 196 #99-> 193
LOT0036	V	0140		*0000177		25.3
LOT0036	V	0150		*0000420		1.073
LOT0036	V	0160		*0000419		144
LOT0036	V	0165		*0000381		64
LOT0037			*0000126			
LOT0037	3	0160	891002	*0000419		254 246 248 #99-> 249
LOT0037	3	0165	891002	*0000289	1 118 108 124	#99-> 117
LOT0037	3	0165	891002	*0000289	2 93 119 106	#99-> 106
LOT0037	3	0165	891002	*0000289	3 105 133 108	#99-> 115
LOT0037	R	0140		*0000177		23.2 24.0 24.0 #99-> 23.7
LOT0037	R	0150		*0000420		1.07 1.07 1.07 #99-> 1.07
LOT0037	R	0160		*0000419		216 212 213 #99-> 214
LOT0037	R	0165		*0000381	1 95 145 130	#99-> 123
LOT0037	R	0165		*0000381	2 90 103 111	#99-> 101
LOT0037	R	0165		*0000381	3 80 106 102	#99-> 96
LOT0037	V	0140		*0000177		24.5
LOT0037	V	0150		*0000420		1.072
LOT0037	V	0160		*0000419		136
LOT0037	V	0165		*0000381		54
LOT0038			*0000126			

LOT NO.	T	ITEM	DATE	MATRIX	DATA 00	01	02 ...
LOT0038	3	0160	900905	*0000419			226 227 223 #99-> 225
LOT0038	3	0165	900905	*0000289	1	122.8	106.0 116.3 #99-> 115.0
LOT0038	3	0165	900905	*0000289	2	120.9	133.3 142.0 #99-> 132.0
LOT0038	3	0165	900905	*0000289	3	123.5	121.0 132.1 #99-> 126.0
LOT0038	R	0140		*0000177			24.8 24.8 24.8 #99-> 24.8
LOT0038	R	0150		*0000420			1.07 1.07 1.07 #99-> 1.07
LOT0038	R	0160		*0000419			174 180 180 #99-> 178
LOT0038	R	0165		*0000381			142 138 101 #99-> 127
LOT0038	V	0140		*0000177			25.3
LOT0038	V	0150		*0000420			1.070
LOT0038	V	0160		*0000419			149
LOT0038	V	0165		*0000381			78
LOT0039	3	0160	910523	*0000419			258 263 252 #99-> 258
LOT0039	3	0165	910523	*0000289			165 175 157 #99-> 166
LOT0039	R	0140		*0000177			24.6 24.5 24.6 #99-> 24.6
LOT0039	R	0150		*0000420			1.07 1.08 1.07 #99-> 1.07
LOT0039	R	0160		*0000419			210 198 205 #99-> 204
LOT0039	R	0165		*0000381			97 101 92 #99-> 97
LOT0039	V	0140		*0000177			24.9
LOT0039	V	0150		*0000420			1.068
LOT0039	V	0160		*0000419			145
LOT0039	V	0165		*0000381			78
LOT0043	3	0160	911103	*0000419			246 243 244 #99-> 244
LOT0043	3	0165	911103	*0000289			100 100 102 #99-> 101
LOT0043	R	0140		*0000177			24.4 24.4 24.0 #99-> 24.3
LOT0043	R	0150		*0000420			1.01 1.01 1.01 #99-> 1.01
LOT0043	R	0160		*0000419			206 201 207 #99-> 205
LOT0043	R	0165		*0000381			136 97 108 #99-> 114
LOT0043	V	0140		*0000177			24.6
LOT0043	V	0150		*0000420			1.065
LOT0043	V	0160		*0000419			156
LOT0043	V	0165		*0000381			63
LOT0044	3	0160	920129	*0000419			227 226 228 #99-> 227
LOT0044	3	0165	920129	*0000289	1	161	158 188 218 #99-> 181
LOT0044	3	0165	920129	*0000289	2	206	220 174 194 #99-> 198
LOT0044	3	0165	920129	*0000289	3	174	158 196 162 #99-> 172
LOT0044	R	0140		*0000177			24.4 24.3 24.5 #99-> 24.4
LOT0044	R	0150		*0000420			1.01 1.01 1.01 #99-> 1.01
LOT0044	R	0160		*0000419			182 182 183 #99-> 182
LOT0044	R	0165		*0000381			90 115 99 #99-> 101
LOT0044	V	0140		*0000177			24.3
LOT0044	V	0150		*0000420			1.053
LOT0044	V	0160		*0000419			150
LOT0044	V	0165		*0000381			71
LOT0045	R	0140		*0000177			25.8 25.7 25.8 #99-> 25.8
LOT0045	R	0150		*0000420			1.09 1.08 1.09 #99-> 1.09
LOT0045	R	0160		*0000419			183 185 188 #99-> 185
LOT0045	R	0165		*0000381	1	96	90 93 #99-> 93
LOT0045	R	0165		*0000381	2	94	92 98 #99-> 95
LOT0045	R	0165		*0000381	3	78	85 80 #99-> 81
LOT0045	V	0140		*0000177			25.6
LOT0045	V	0150		*0000420			1.084

OT NO.	T	ITEM DATE	MATRIX	DATA 00 01	02 ...
OT0045	V	0160	*0000419		147
OT0045	V	0165	*0000381		63
OT0047	R	0120	*0000126		1 1 2
OT0047	R	0140	*0000177		25.7 25.8 25.8 #99-> 25.8
OT0047	R	0150	*0000420		1.08 1.07 1.07 #99-> 1.07
OT0047	R	0160	*0000419		230 235 235 #99-> 233
OT0047	V	0140	*0000177		25.9
OT0047	V	0150	*0000420		1.076
OT0047	V	0160	*0000419		153
OT0047	V	0165	*0000381		54

FLEX BEARINGS TENSILE DEFLECTION

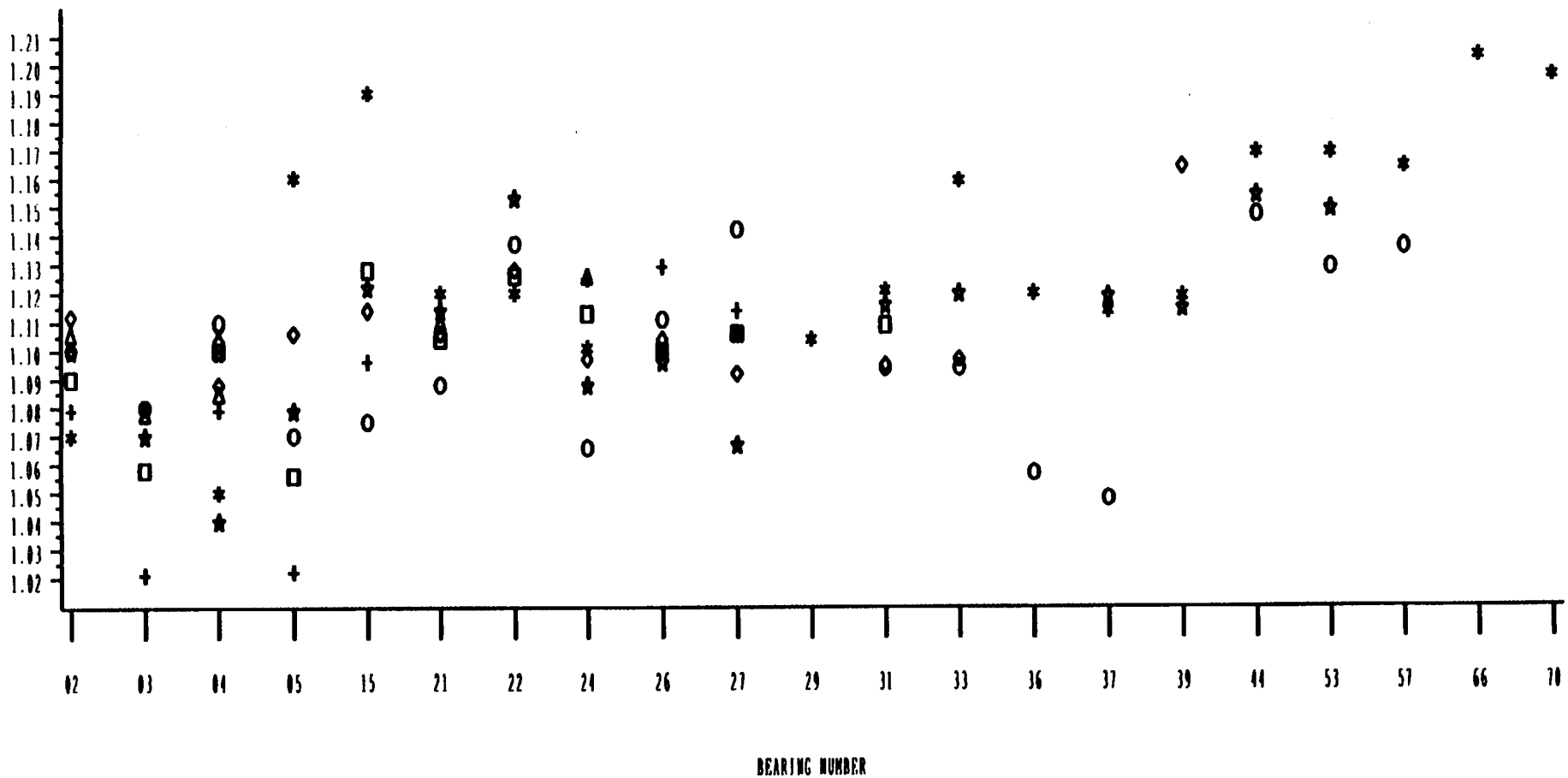


REFURBISHMENT NUMBER

* * * 0 O O 1 ☆ ☆ ☆ 2 ◇ ◇ ◇ 3 □ □ □ 4

+ + + 5 Δ Δ Δ 6 # # # 7 X X X 8

FLEX BEARINGS COMPRESSIVE DEFLECTION (FLAT PLATE)

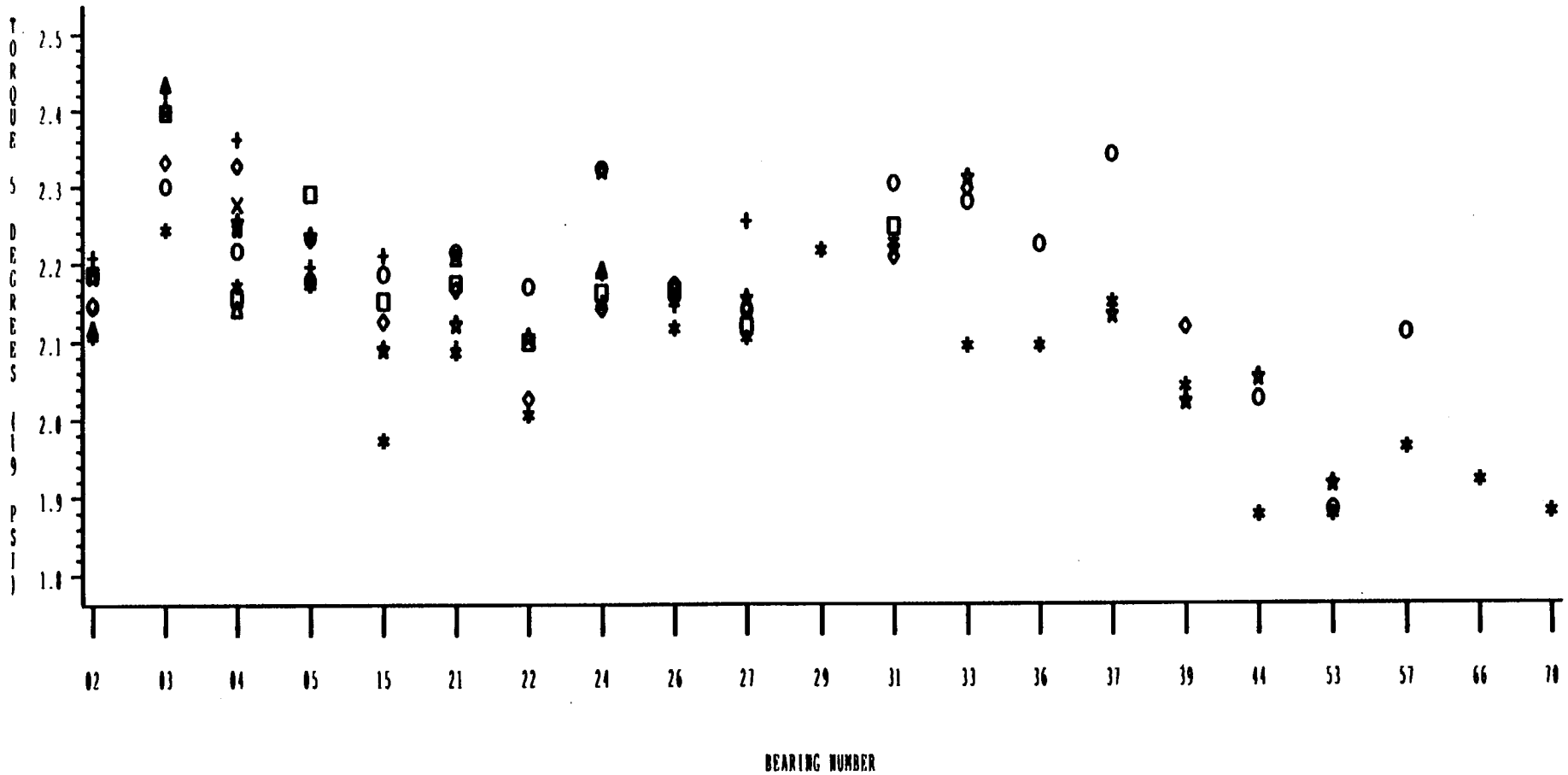


REFURBISHMENT NUMBER

* * * 1 O O O 1 ☆ ☆ ☆ 2 ◇ ◇ ◇ 3 □ □ □ 4

+ + + 5 Δ Δ Δ 6 # # # 7 X X X 8

FLEX BEARINGS TORQUE 5 DEGREES (19 PSI)



REFURBISHMENT NUMBER

* * * 0 O O 1 ☆ ☆ ☆ 2 ◇ ◇ ◇ 3 □ □ □ 4

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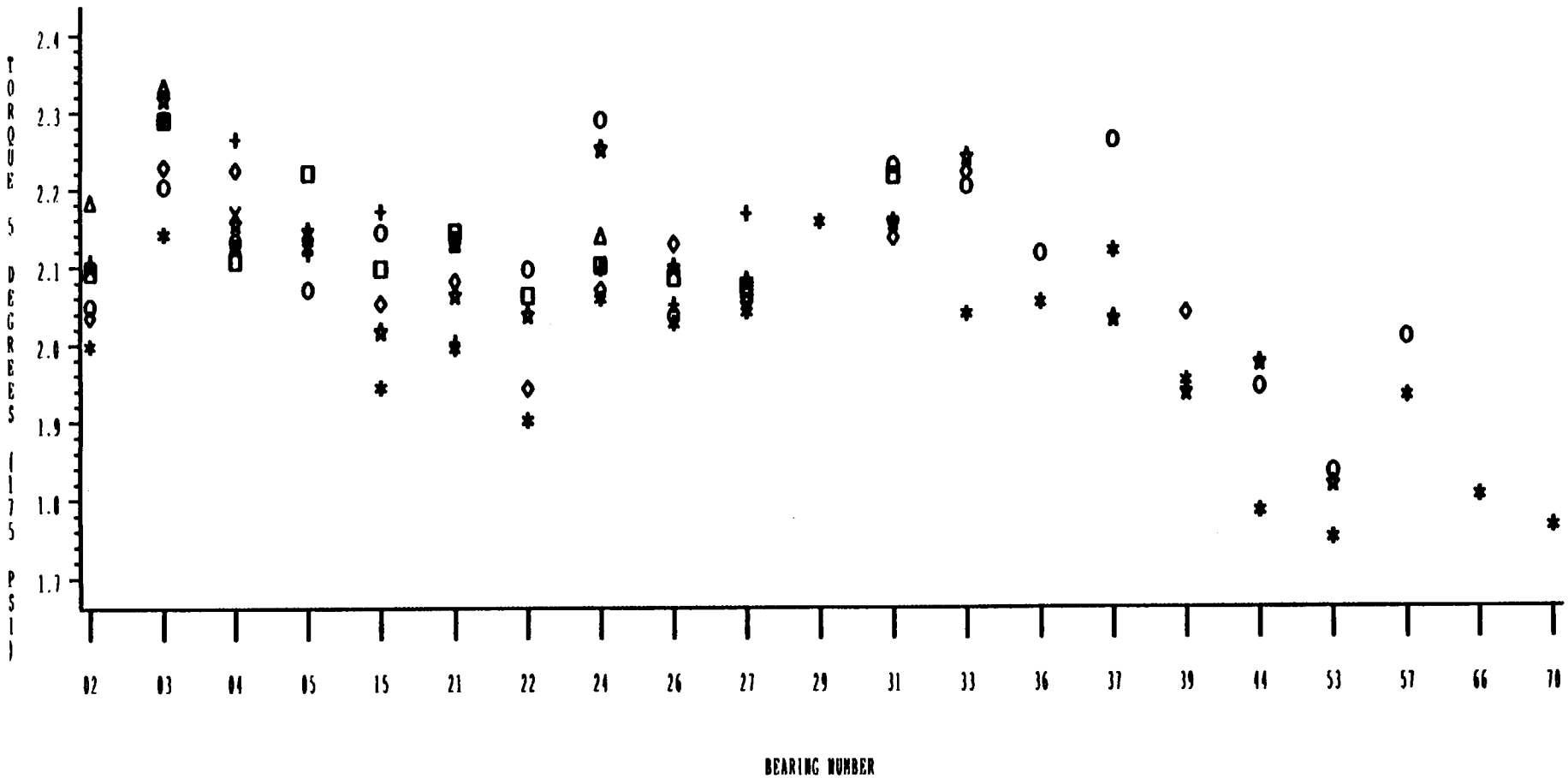
FLEX BEARINGS TORQUE 5 DEGREES (175 PSI)

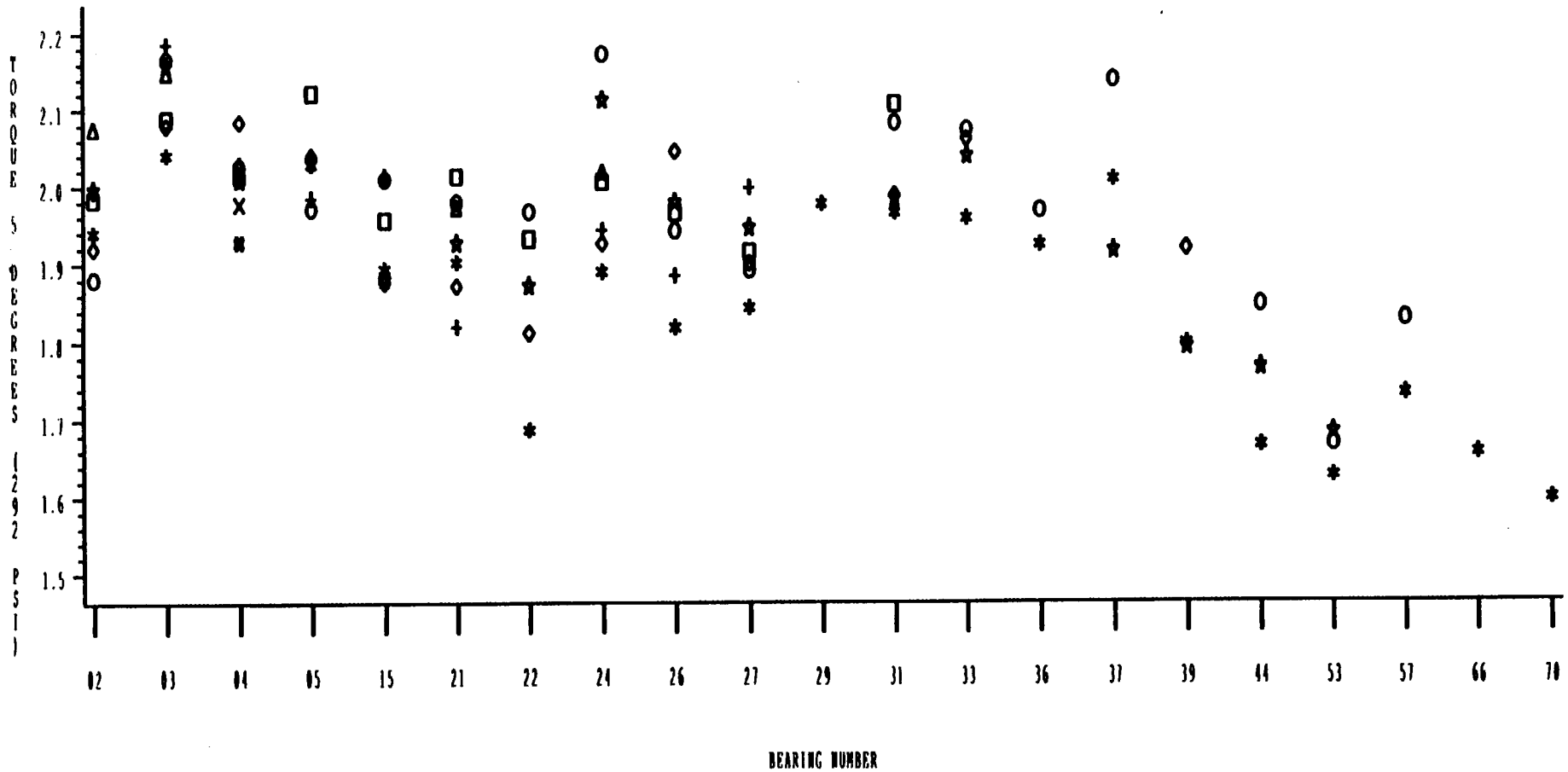


REFURBISHMENT NUMBER

* * * 0 O O O 1 ☆ ☆ ☆ 2 ◇ ◇ ◇ 3 □ □ □ 4

+ + + 5 Δ Δ Δ 6 # # # 7 X X X 8

FLEX BEARINGS TORQUE 5 DEGREES (292 PSI)

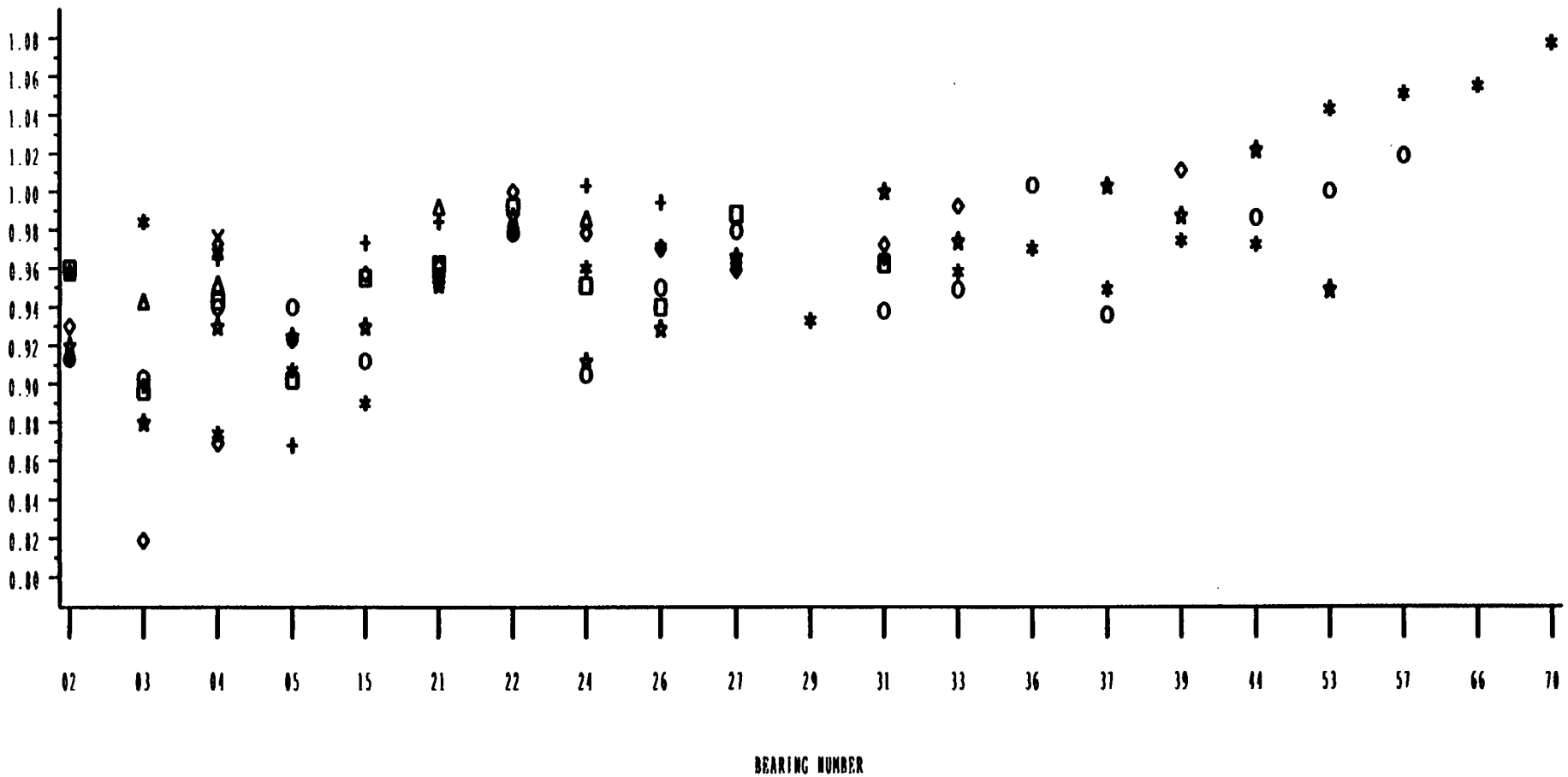


REFURBISHMENT NUMBER

* * * 1 O O O 1 ☆ ☆ ☆ 2 ◇ ◇ ◇ 3 □ □ □ 4

+ + + 5 Δ Δ Δ 6 # # # 7 X X X 8

FLEX BEARINGS COMPRESSIVE DEFLECTION (RELIEF PISTON)



REFURBISHMENT NUMBER

* * * 0 O O 1 ☆ ☆ ☆ 2 ◇ ◇ ◇ 3 □ □ □ 4

+ + + 5 Δ Δ Δ 6 # # # 7 X X X 8

Thiokol CORPORATION
SCIENCE & ENGINEERING

9 April 1993
2466-FY93-M125

TO: L. N. Paulsen

CC: A. G. Christiansen, N. A. Mumford, J. M. Oliva, G. R. Lierd, A. L. Olsen, M. B. Kuwana, B. L. Henderson, D. T. Hougaard

FROM: C. L. Denton

SUBJECT: **CHEMLOKS 205, 220: OFF-GAS AT 340 AND 380°F**

Past flex bearing and test sample history have shown us that heating above 340°F during cure with subsequent exposure to moisture causes the Chemlok 205 to decompose. In particular, heating Chemlok 220 releases HCl that overcomes the acid acceptors in Chemlok 205 and attacks it. It isn't instantaneous. It frequently takes weeks or months before the Chemlok 205 is degraded enough to decompose and allow the steel under it to rust.

Someone raised the question, "What does come off these adhesives and at what temperatures?" The G.C. Mass Spectrometer was used to analyze off-gassing.

The first time (LWR698957) liquid Chemloks 205 and 220 were heated to 380°F. No HCl or HBr were seen in either sample.

The second time (LWR719310) dried Chemloks 205 and 220 were heated to 380°F and held about 12 hours. HCl evolved in large quantities from both 205 and 220 at 1.8-2.0 hours at 380°F. A repeat test was run at 340°F. Only Chemlok 220 generated HCl at about 1.8 hr at 340°F. No HBr was identified in any of the testing. Lord Corporation, Chemlok manufacturer, inferred we should see both HCl and HBr. We should note that the HCl levels in Chemlok 205 and 220 vary from lot-to-lot, as does the level of acid acceptor in the Chemlok 205.

The factors of % acid acceptors in 205, % acid in 205 and 220, the thickness of 205, the thickness of 220, the time exposure at over 340°F and the time exposed to moisture all contribute to whether or not Chemlok 205 is destroyed. If it is destroyed, they control the rate of destruction and resultant rubber-to-steel unbonds and rust.

The % acid acceptors and acids in Chemloks are controlled by weigh-up. All weights are $\pm$X%. Process techniques control Chemlok thickness and heat exposure. Moisture is whatever atmospheric conditions provide.

C. L. Denton
/sm
Attachments

P.O. Box 707, Brigham City, UT 84302-0707 (801) 863-3511

LABORATORY WORK REQUEST

MAR-3-93 — LOATE

NO.698957

TO: MITCH RULAND

FROM:	EXTENSION	COST CENTER	PROJECT NO.	TASK	SUBTASK
LYNDON PAULSEN	9557	L520			
ORGANIZATION	**MAIL STOP**	**WORK ORDER NO.**		**USER**	**PCN**
MEIDE	L50	B1352			

SAMPLE INFORMATION

SAMPLE DESCRIPTION		DATE
CHEMLOK 205 MIXED WITH MEK CHEMLOK 220 MIXED WITH XYLENE	☐ RAW MATERIAL ☐ INPROCESS ☒ POST PROCESS	3 MARCH 1993

PART NO./STOCK NO.	SERIAL NO./LOT NO.	ASSEMBLY PART NO.	ASSEMBLY SERIAL NO.

MIX	GRIND	SAMPLED BY

TEST REQUIRED OR DESCRIPTION OF WORK REQUIRED. INCLUDE REASON FOR REQUEST.

1. PERFORM GC/MS TO IDENTIFY VOLATILES FROM CHEMLOK 205/MEK MIX AND CHEMLOK 220/XYLENE
2. MIX, FOCUSING ON HCl. TAKE SAMPLES EVERY 10°F WHILE HEATING SPECIMENS FROM
3. 240°F TO 380°F.
4. SHAKE WELL BEFORE TESTING; UNTIL ALL SOLIDS ARE IN SUSPENSION
5.
6.
7.
8.

REPORT RESULTS TO	SEND COPY TO	RESULTS DESIRED BY (SPECIFIC DATE)
LYNDON PAULSEN		18 MARCH 1993
		AUTHORIZED SIGNATURE OR INSPECTION STAMP: Lyndon W Paulsen

FOR LABORATORY USE ONLY

SPECIAL INSTRUCTIONS

RESULTS OF LABORATORY ANALYSIS

8-1

DISPOSITION

☐ ACCEPT ☐ REJECT ☐ RESAMPLE

DATE AND TIME COMPLETED	TIME REQUIRED	DATE REPORTED	SIGNATURE

FORM TC 716-510 (Rev. 2-86)

SCIENCE AND ENGINEERING
THIOKOL ENVIRONMENTAL LABORATORY

TO: LYNDON PAULSEN ,
M & DE

FROM: M. M. ROLAND,
SPECTROCHEMICAL ANALYSIS

SUBJECT: CHEMLOC ANALYSIS , LWR 698957

DATE: 9 MARCH, 1993

BOTH CHEMLOC 205/MEK AND 220/XYLENE WERE ANALYZED FOR OFFGASSING PRODUCTS OVER A BROAD TEMPERATURE RANGE. A PORTION OF EACH MATERIAL WAS WEIGHED INTO A HEADSPACE BOTTLE AND HEATED FOR ONE HOUR AT TEMPERATURE. THE EVALUATION TEMPERATURES WERE 380, 240 AND 100 DEGREES F. NO HCL WAS EVER OBSERVED FROM ANY SAMPLE. ALSO, REGARDLESS OF THE TEMPERATURE, ONLY THE VOLATILE ORGANIC COMPOUNDS SHOWN ON THE FOLLOWING PAGE WERE OBSERVED. THE PERCENTAGE OF VOLATILES AND NONVOLATILES ARE SHOWN AT THE BOTTOM OF THE FOLLOWING PAGE.

M. M. ROLAND

WASTE DRUM ANALYSIS

Sample Name: CHEMLOCK 220
LWR# 698957
Method of Analysis: NSD.M
Lab data file: C:\CHEMPC\DATA\116463AG.D

Date Received: 3/4/93
Date Analyzed: 03/09/93

COMPOUND	CONC.(uL)	PERCENTAGE
METHANOL	0.000	0.000
ETHANOL	0.000	0.000
ACETONE	0.000	0.000
ACETONITRILE	0.000	0.000
IPA	0.000	0.000
FREON TF	0.000	0.000
METHYLENE CHLORIDE	0.000	0.000
CARBON DISULFIDE	0.000	0.000
1,2-DICHLOROETHANE	0.000	0.000
MEK	0.000	0.000
HEXANE	0.000	0.000
CHLOROFORM	0.000	0.000
THF	0.000	0.000
METHYLCHLOROFORM	0.482	0.480
GLYME	0.000	0.000
BENZENE	0.000	0.000
CYCLOHEXANE	0.000	0.000
CARBONTETRACHLORIDE	0.000	0.000
1-BUTANOL	0.000	0.000
1-METHOXY 2-PROPANOL	0.000	0.000
TRICHLOROETHYLENE	0.000	0.000
1,4-DIOXANE	0.000	0.000
MIBK	0.000	0.000
PYRIDINE	0.000	0.000
TOLUENE	0.827	0.534
DMF	0.000	0.000
TETRACHLOROETHYLENE	9.717	11.755
N-BUTYLACETATE	0.000	0.000
CHLOROBENZENE	0.000	0.000
ETHYL BENZENE	25.730	16.627
M,P-XYLENE	62.545	40.417
O-XYLENE	24.127	15.645
VOLATILES %		85.458
NONVOLATILES %		14.542

CHEMLOCK ANALYSIS

Sample Name: CHEMLOCK 205
LWR#698957
Method of Analysis: NSD.M
Lab data file: C:\CHEMPC\DATA\116463AF.D

Date Received: 3/4/93
Date Analyzed: 03/09/93

COMPOUND	CONC.(uL)	PERCENTAGE
METHANOL	0.000	0.000
ETHANOL	0.000	0.000
ACETONE	0.000	0.000
ACETONITRILE	0.000	0.000
IPA	0.000	0.000
FREON TF	0.000	0.000
METHYLENE CHLORIDE	0.000	0.000
CARBON DISULFIDE	0.000	0.000
1,2-DICHLOROETHANE	0.000	0.000
MEK	117.750	15.039
HEXANE	0.000	0.000
CHLOROFORM	0.000	0.000
THF	0.000	0.000
METHYLCHLOROFORM	0.000	0.000
GLYME	0.000	0.000
BENZENE	0.000	0.000
CYCLOHEXANE	0.000	0.000
CARBONTETRACHLORIDE	0.000	0.000
1-BUTANOL	0.000	0.000
1-METHOXY 2-PROPANOL	2.747	0.419
TRICHLOROETHYLENE	0.000	0.000
1,4-DIOXANE	0.000	0.000
MIBK	487.846	61.999
PYRIDINE	0.000	0.000
TOLUENE	0.000	0.000
DMF	0.000	0.000
TETRACHLOROETHYLENE	0.000	0.000
N-BUTYLACETATE	0.000	0.000
CHLOROBENZENE	0.000	0.000
ETHYL BENZENE	7.755	1.067
M,P-XYLENE	11.840	1.629
O-XYLENE	6.860	0.947
VOLATILES %		81.100
NONVOLATILES %		18.900

LABORATORY WORK REQUEST

31 MAR 93 60607

719310

TO:					
H. Boland					
FROM:	EXTENSION	COST CENTER	PROJECT NO.	TASK	SUBTASK
[illegible]	2678	2466			
ORGANIZATION	MAIL STOP	WORK ORDER NO.		USER	PCN
Insulation	2-1	51837			

SAMPLE INFORMATION

SAMPLE DESCRIPTION			DATE
Air dried [illegible] 205, 220		☒ RAW MATERIAL ☐ INPROCESS ☐ POST PROCESS	29 Mar 93
PART NO./STOCK NO.	SERIAL NO./LOT NO.	ASSEMBLY PART NO.	ASSEMBLY SERIAL NO.
MIX	GRIND	SAMPLED BY	

TEST REQUIRED OR DESCRIPTION OF WORK REQUIRED, INCLUDE REASON FOR REQUEST

1. GC Mass Spec.
2. Run at 340°F & 350°F for a
3. minimum of 6 hr each
4.
5. [illegible] wire Peak for
6. HCl & HBr out of the Chemical 220.
7.
8.

REPORT RESULTS TO	SEND COPY TO	RESULTS DESIRED BY (SPECIFIC DATE)
[illegible]		5 APR 93
		AUTHORIZED SIGNATURE OR INSPECTION STAMP: [illegible]

FOR LABORATORY USE ONLY

SPECIAL INSTRUCTIONS

RESULTS OF LABORATORY ANALYSIS

DISPOSITION

☐ ACCEPT ☐ REJECT ☐ RESAMPLE

DATE AND TIME COMPLETED	TIME REQUIRED	DATE REPORTED	SIGNATURE

FORM TC 716 (REV 9-91)

SCIENCE AND ENGINEERING
THIOKOL ENVIRONMENTAL LABORATORY

TO: CHUCK DENTON ,
INSULATION

FROM: M. M. ROLAND,
SPECTROCHEMICAL ANALYSIS

SUBJECT: GC/MS ANALYSIS OF CHEMLOCK 205 AND 220 , LWR 719310

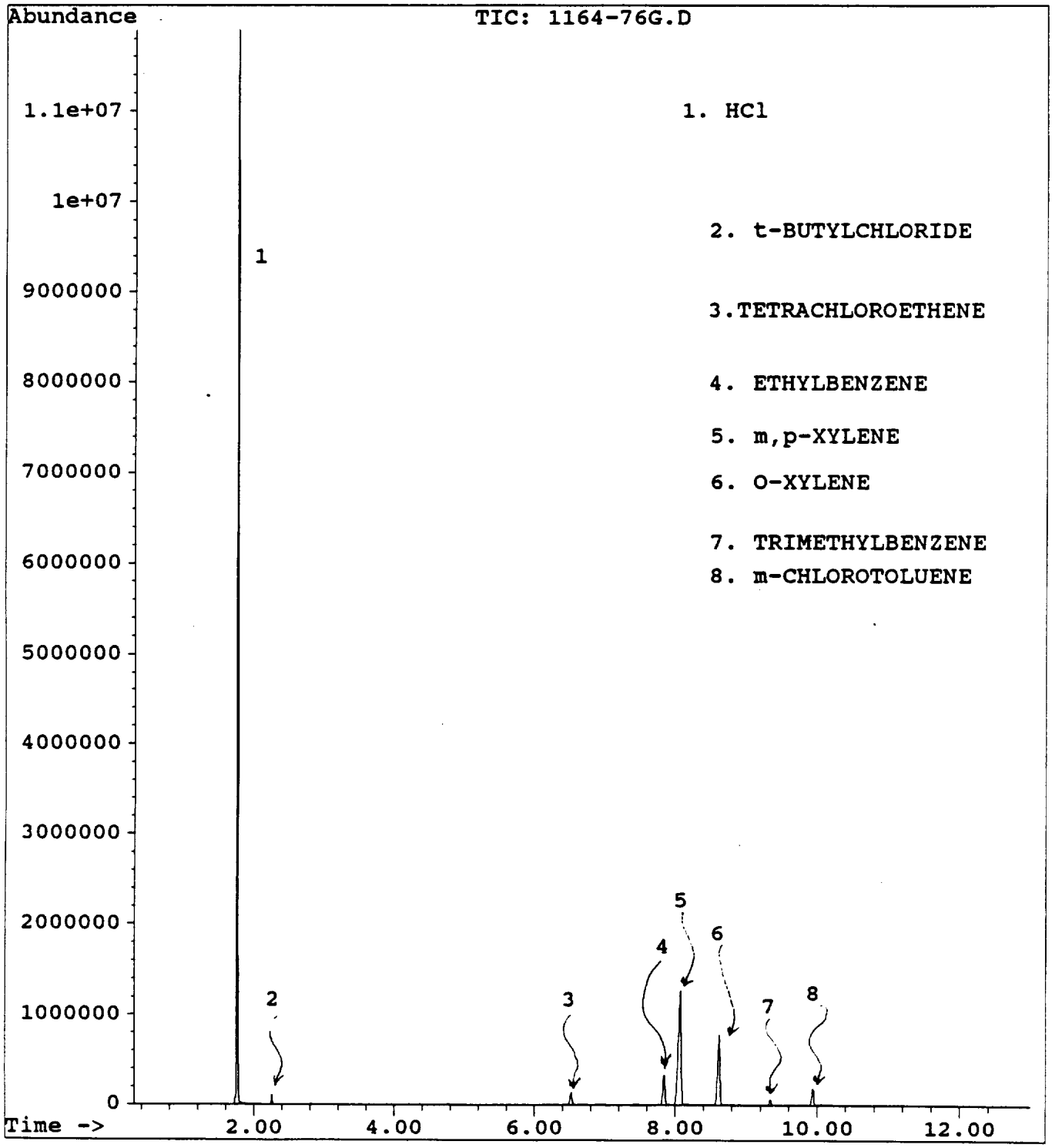
DATE: 31 MARCH, 1993

THE DRIED CHEMLOCK SAMPLES WERE PLACED IN A HEADSPACE BOTTLE AND HEATED AT 380 F. AFTER ONLY A FEW MINUTES BOTH SAMPLES SHOWED EVIDENCE OF GROSS THERMAL DECOMPOSITION. A 100 uL SAMPLE OF THE HEADSPACE GASSES WAS WITHDRAWN AND INJECTED INTO THE GC/MS. THE TOTAL ION CHROMATOGRAM (TIC) FOR BOTH CHEMLOCK 205 AND 220 ARE SHOWN ON THE FOLLOWING PAGES. HCl WAS FOUND IN BOTH SAMPLES AND WAS THE MAJOR CONSTITUENT.

M. M. ROLAND

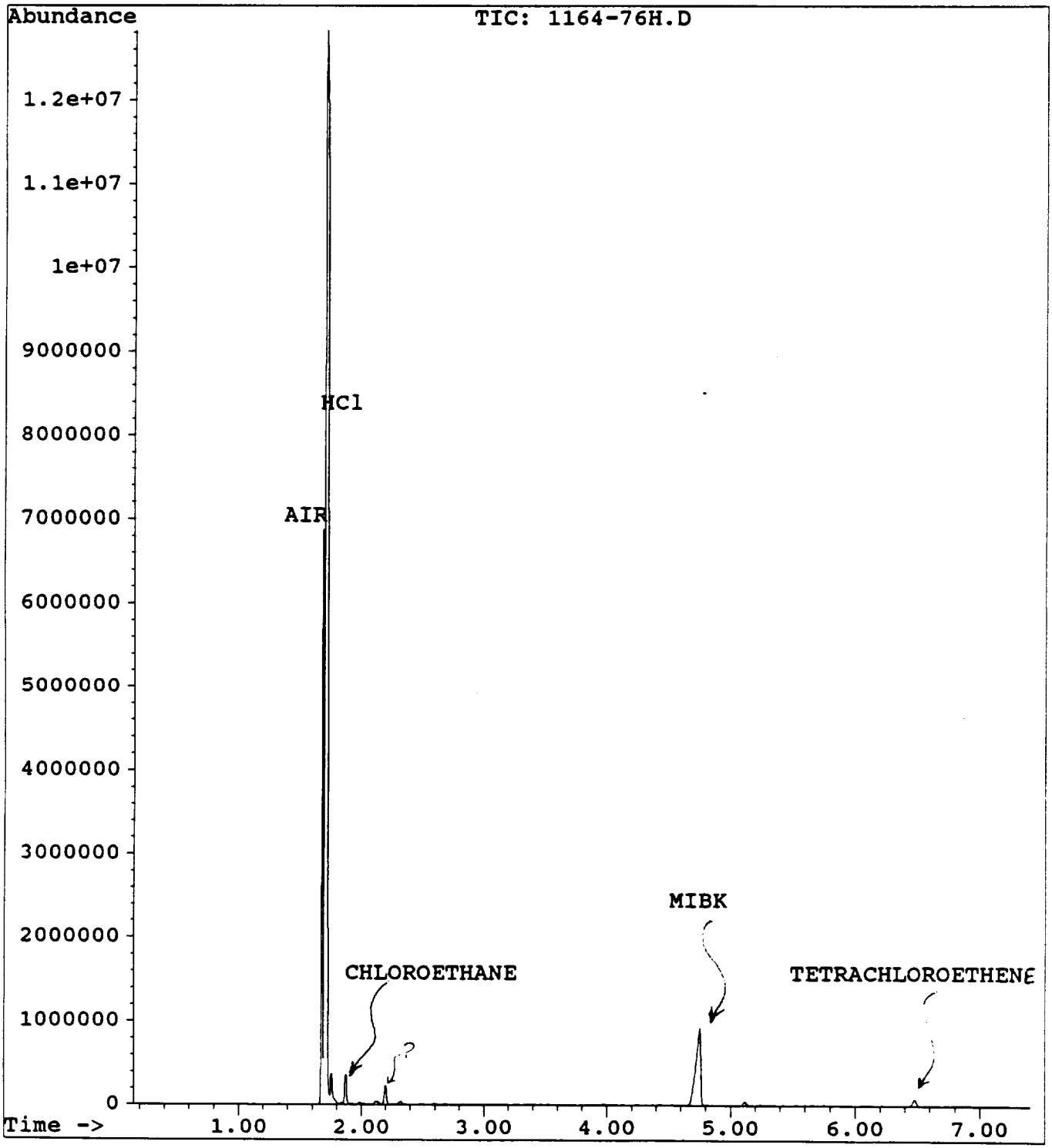
LWR 719310

File: C:\CHEMPC\DATA\1164-76G.D
Operator: MMR
Date Acquired: 31 Mar 93 9:53 am
Method File: NSD.M
Sample Name: CHEMLOC 220
Misc Info:
ALS vial: 1



LWR 719310

File: C:\CHEMPC\DATA\1164-76H.D
Operator: MMR
Date Acquired: 31 Mar 93 10:38 am
Method File: NSD.M
Sample Name: CHEMLOC 205
Misc Info:
ALS vial: 1



SCIENCE AND ENGINEERING
THIOKOL ENVIRONMENTAL LABORATORY

TO: CHUCK DENTON ,
INSULATION MATERIALS AND PROCESS

FROM: MITCH ROLAND,
SPECTROCHEMICAL ANALYSIS

SUBJECT: CHEMLOCK 220 AND 205 STUDY, LWR 719310

DATE: 08 APR., 1993

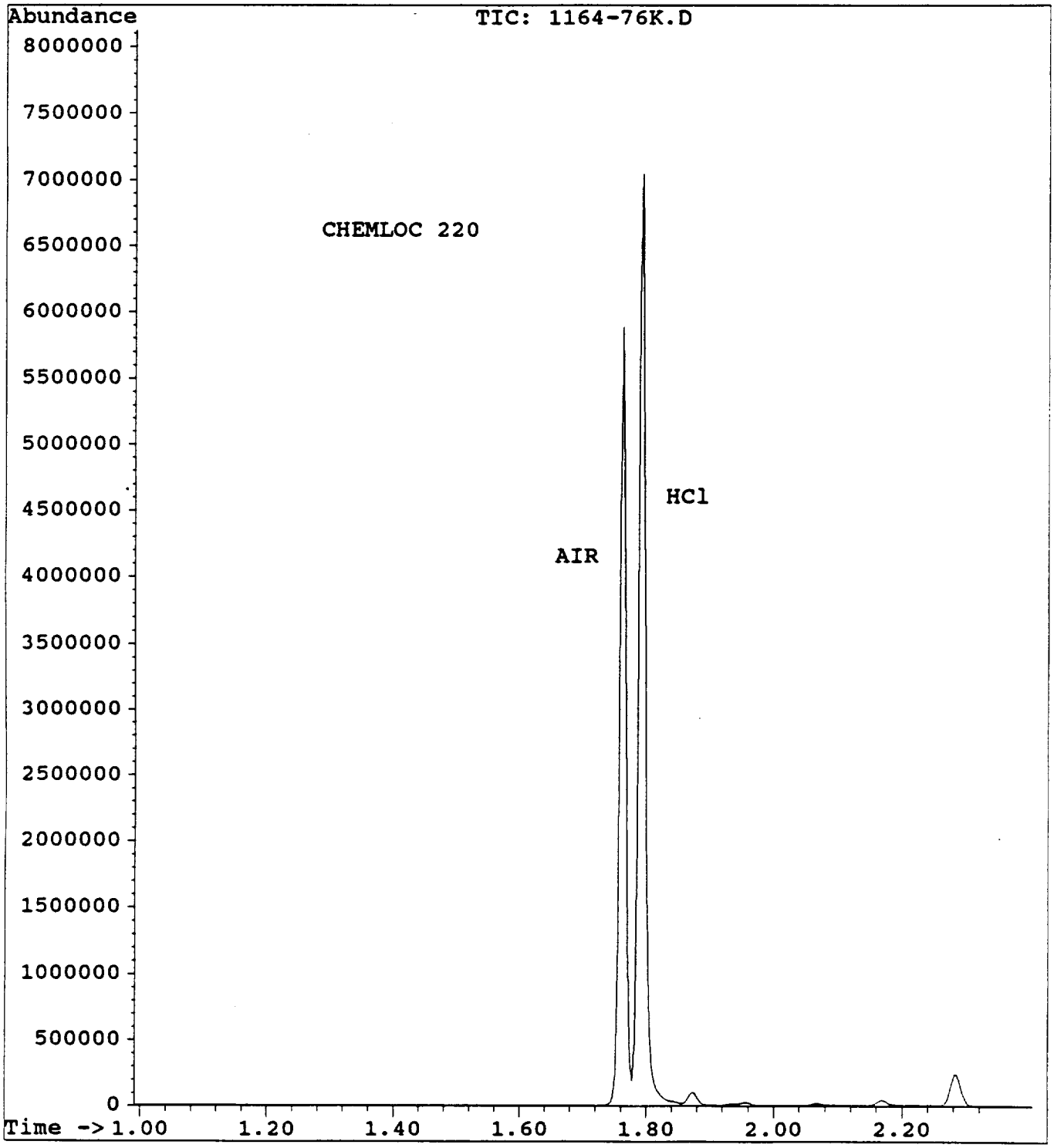
LAST WEEK WE REPORTED THE GENERATION OF HCl FROM SAMPLES OF CHEMLOCK 220 AND 205 AT 380 DEGREES F. WHEN THE TEMPERATURE WAS LOWERED TO 340 DEG. F ONLY THE CHEMLOC 220 SHOWED THE EVOLUTION OF HCl. GC SPECTRA ARE ATTACHED.

Mitch

M. M. ROLAND

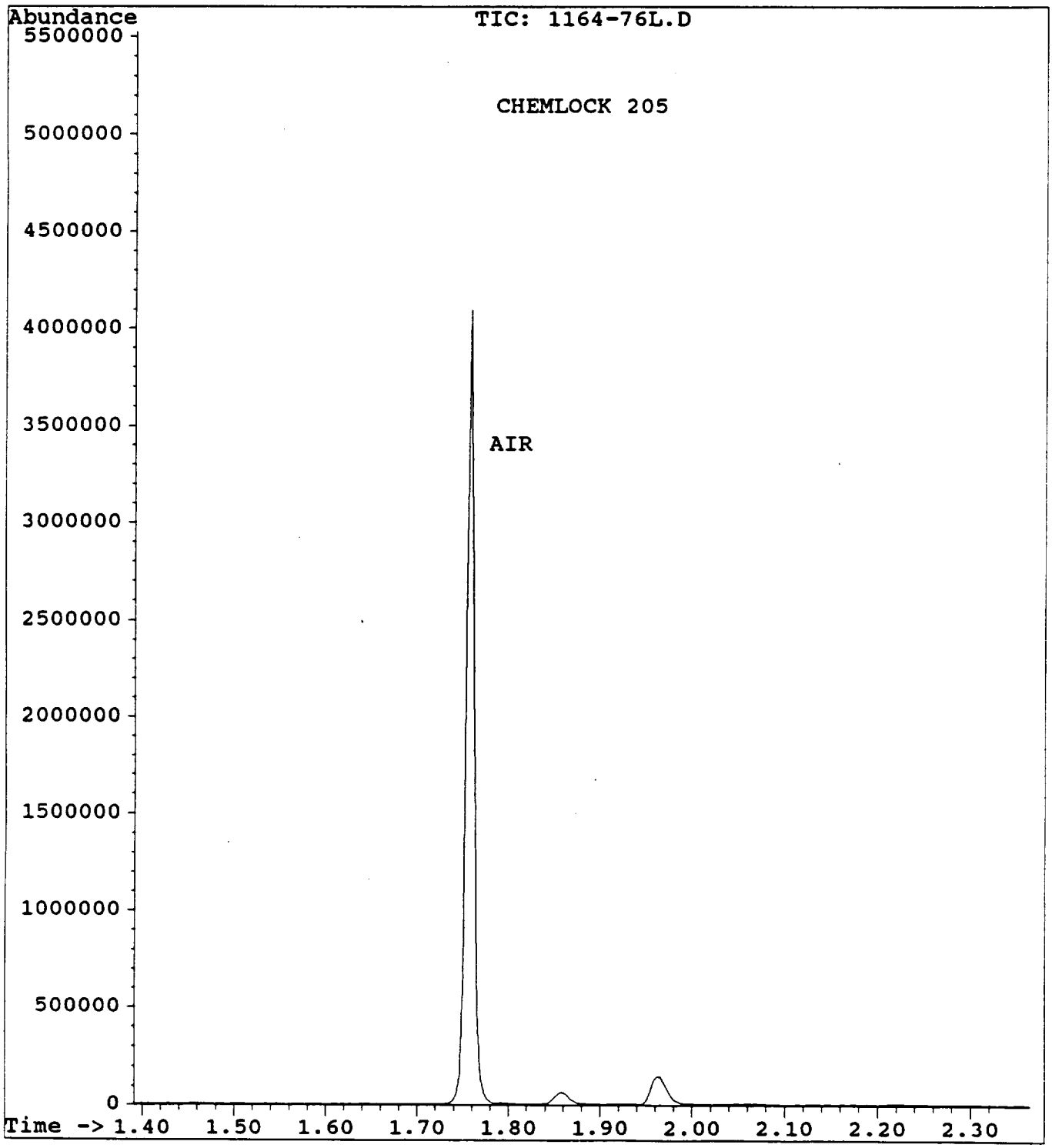
LWR 719310

File: C:\CHEMPC\DATA\1164-76K.D
Operator: MMR
Date Acquired: 5 Apr 93 10:09 am
Method File: NSD.M
Sample Name: CHEMLOC 220 (340 F)
Misc Info:
ALS vial: 2



LWR 719310

File: C:\CHEMPC\DATA\1164-76L.D
Operator: MMR
Date Acquired: 5 Apr 93 10:51 am
Method File: NSD.M
Sample Name: CHEMLOC 205 (340 F)
Misc Info:
ALS vial: 2



INTER-OFFICE MEMO

DATE 13 November 1980

2433-80-M223

TO: J. D. McGregor

CC: D. B. Davis

FROM: H. G. Pulsipher

SUBJECT: GC/MS Analysis of Chemloks 205 and 220. Per LWR-341842

The original request called for comparing two lots of Chemlok 205 (lots 14 and 16) by analyzing on the GC/MS probe at 320° and 350°F to determine what could be forming that might cause rusting on the shims during the 5 hour cure cycle. The first run was on lot 14 at 350°F. It was noted that a persistent mass spectrum was established after about 10 to 12 minutes, with the heaviest mass at a 36 mass number. This was identified as hydrichloric acid (HCl). The trace is shown in Figure 1. Figure 2 shows a corresponding trace of water for the run. Similar traces were made for lot 14 when run at 320°F and are shown as Figures 3 and 4. Similar runs were made on lot 16 and Chemlok 220 lot 35 and are included as Figures 5 through 12.

While both water and HCl can contribute to formation of rust, the primary interest for subsequent work has centered on HCl. In order to obtain a comparison between the different GC/MS runs on Chemlok, the base chromatogram for mass 36 has been ratioed to the total base reading. Results are summarized in Table 1.

Table I

Comparison of HCl Produced on
Chemloks 205 and 220 by GC/MS Analysis

Chemlok (lot no.)	Temp. (°F)	Mass 36 Ratio to Total Base	Relative HCl at Two Temps.	Relative HCl All Samples
205-14	350	.0174	1.176	3.053
205-14	320	.0148	1.000	2.596
205-16	350	.0152	2.667	2.667
205-16	320	.0057	1.000	1.000
220-35	350	.0830	3.063	14.561
220-35	320	.0271	1.000	4.754

Analysis of Table I, columns 4 & 5 show two things. (1) The relative amount of HCl is higher at the higher temperatures. (2) The relative amount of HCl is 4 to 5 times greater for the Chemlok 220 compared to Chemlok 205.

Upon examination of the initial data, further work was requested to try and characterize the cure and HCl production coincident with a normal 5 to 6 hour curing cycle. This was approached in two ways, and was modified as testing proceeded based on directions from the requestor. The first approach consisted of dipping 2 to 3 inch glass rods in each of the Chemlok samples, allowing the excess Chemlok to drain off, then drying the coated rods at ambient temperature and for a few minutes in a vacuum oven at 140°F to get rid of the solvent. The rods were then placed in glass vials, which were evacuated and sealed with a flame torch under vacuum. The vials were then placed in an oven set at 320°F for 5 hours. They were then removed and the vapors were analyzed by GC/MS, using a Poropak Q column. Table II summarizes the results. While quantitative results were not obtained by this procedure, a rough estimate is given as shown. For comparative purposes, Principal would be greater than 1000 ppm, major 100-1000 ppm, minor 10 to 100 ppm and trace less than 10 ppm.

Table II

GC/MS Analysis of Chemlok
Vapors From 5 Hour Sample

Gas or Vapor	Chemlok Sample 205-14	205-16	220-35
Carbon dioxide	Major	Major	Major
Chloromethane	Major	Minor	Trace
Acetaldehyde	Minor	Minor	Trace
Methyl formate	Minor	-----	-----
Chloroethane	Major	Minor	Trace
Methyl acetate	Minor	Trace	-----
1,2 dichloroethane	Minor	Trace	-----
Dichloromethane	Trace	Trace	-----
Trichloroethylene	Trace	Trace	-----
Tetrachloroethylene	Minor	Minor	Major
2-ethoxyethanol	Minor	Major	Trace
(1-methylethyl) benzene	Minor	Trace	Minor
2 methyl-1 propene	-----	-----	Minor
4 methyl, 2 pentanone	Principal	Principal	Minor
Xylene	Principal	Principal	Principal

Analysis of these results shows several chlorine containing compounds, which could contribute to formation of HCl. The principal constituents suggest that the solvent was not completely gone when the vials were sealed up. HCl was not detected because the column was the type that would not pass it through readily. The second test was run to follow formation of HCl over a 6 hour period. Runs were made at 300° and 340°F. The mass 36 peak was ratioed to the N_2 air peak and a plot of time versus peak height was made. This is shown as Figure 13. As may be noted, HCl is still being formed

after six hours. During the 300°F run, a peak was formed at about 3 hours. The same thing occurred on the 340°F run at around five hours. The significance of these peaks is not known, but was disregarded in comparing the two runs.

In order to compare the two runs, the area under the peaks from 0 to 6 hours was estimated by counting the squares, assuming the base line goes to 0 at 6 hours. This should occur if heat is removed from the system at the 6 hour point. Table III summarizes the hourly results.

Table III

Comparison of Peak Areas of
HCl Produced at 300° and 340°F

Area Time (hrs)	Relative Peak Areas			
	300°F		340°F	
	Area	% of Total	Area	% of Total
1.0	114	32.95	176	42.00
2.0	112	32.37	122	29.12
3.0	63	18.21	59	14.08
4.0	35	10.12	37	8.83
5.0	18	5.20	19	4.53
6.0	4	1.15	6	1.44

Analysis of the table shows that 9% more acid comes off during the first hour at the higher temperature. After two hours, the difference is 5.8% more acid at 340°F. Approximately two-thirds of the acid comes off in the first two hours. One other thing to note is that at 340°F a much sharper peak is shown for the acid peak, which occurs about 5 minutes earlier during the run.

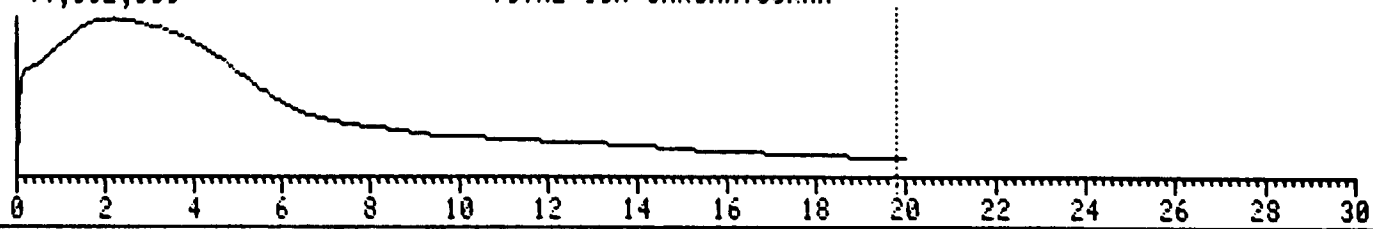
H. G. Pulsipher

HGP/mn

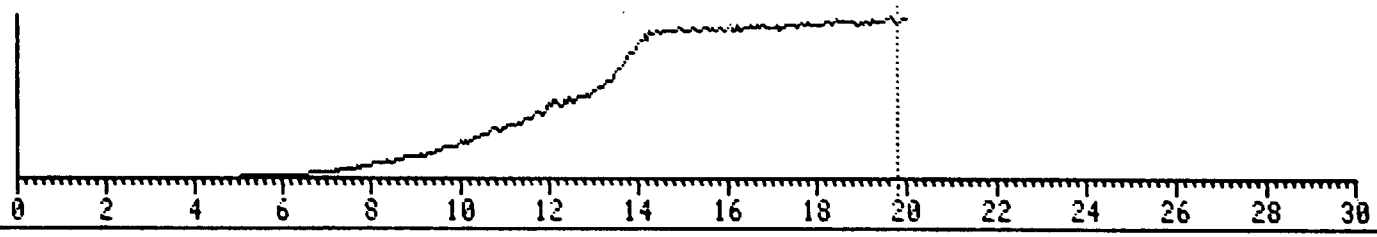
FIGURE 1

AB656 **CHEMLOK 205 LOT 14 ** NOV 3,1980 10:30AM

BASE 44,302,336 TOTAL ION CHROMATOGRAM



MASS 36 CHROMATOGRAM BASE 769,290 LINE TYPE



RETENTION TIME FOR SEARCH 19.80

FIT	PUR	REV	M.WT	ENTRY#	COMPOUND NAME FROM THE NBS LIBRARY USING NBS99 SEARCH METHOD
960	541	541	36	22	Hydrochloric acid
768	76	91	189	11625	Benzamide, 2,6-dichloro-
634	73	97	164	8270	2-Benzothiazolamine, 6-methyl-
606	34	46	175	9778	Pyrido[3,4-d]pyrimidin-4(3H)-one, 6,8-dimethyl-
594	31	52	175	9720	5H-Pyrrolo[1,2-b][1,2,4]triazole, 6,7-dihydro-6-methyl-7-methylene-6

BASE 681,344 SCALE 1.00 RT 19.80 BK 8.00 WT100 % %TI 12.76 SCAN 358

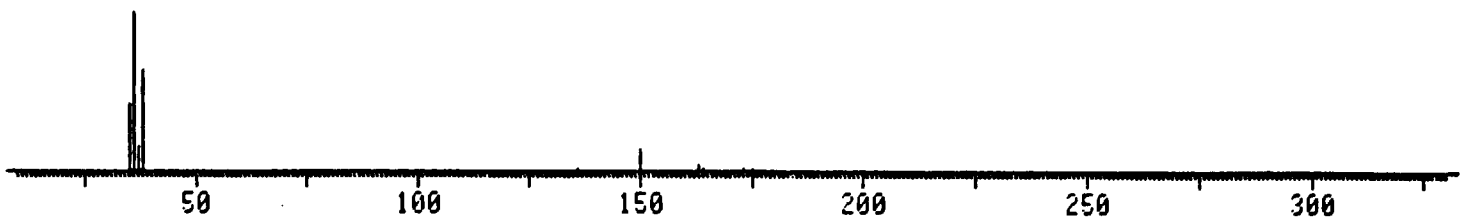


FIGURE 2

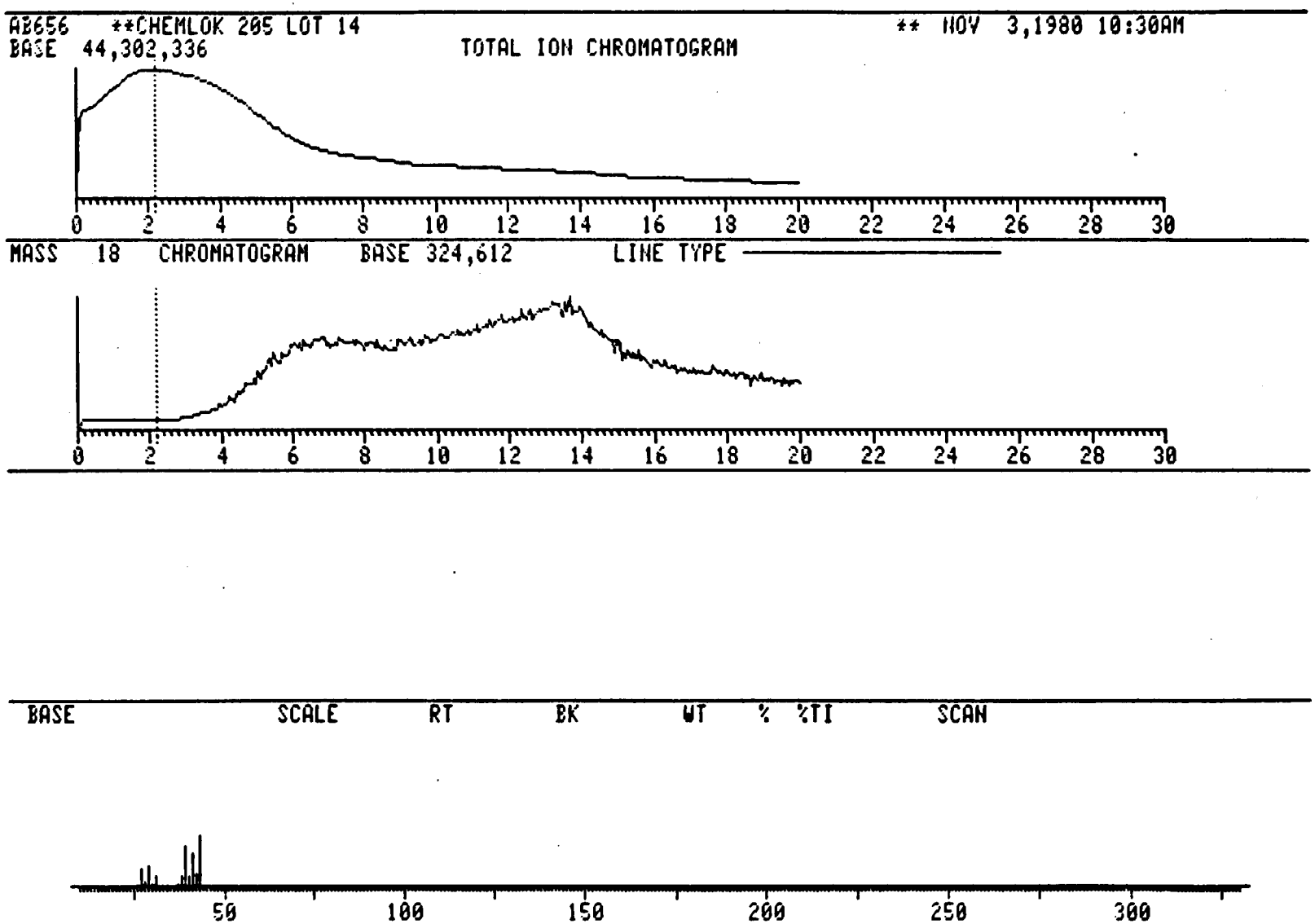
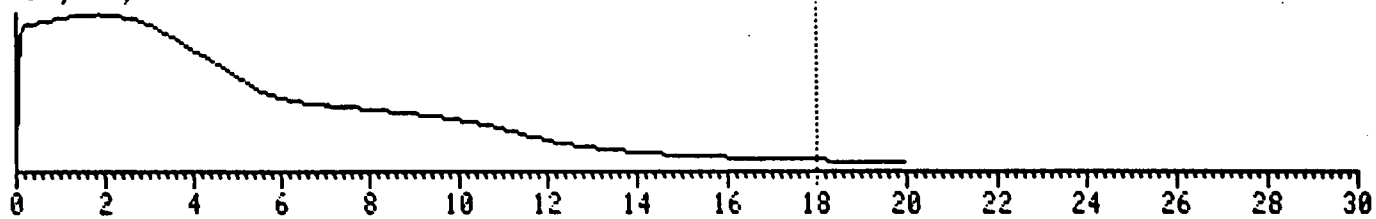

AB656 **CHEMLOK 205 LOT 14
** NOV 3,1980 10:30AM
BASE 44,302,336
TOTAL ION CHROMATOGRAM
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
MASS 18 CHROMATOGRAM BASE 324,612 LINE TYPE
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
BASE SCALE RT BK WT % %TI SCAN
50 100 150 200 250 300

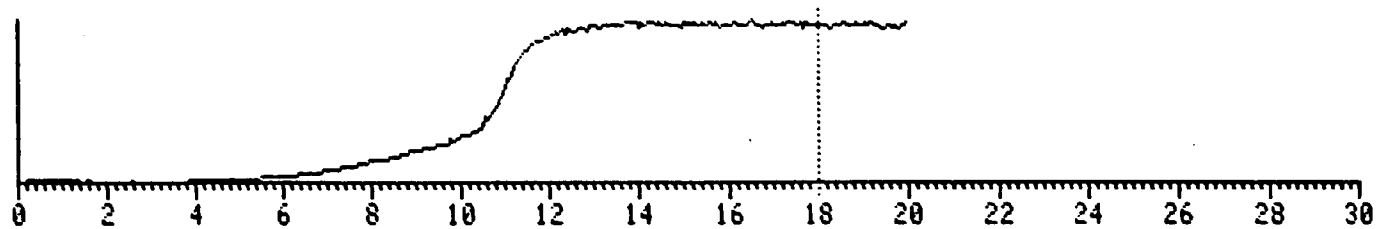
FIGURE 3

AB660 **CHEMLOK 205 LOT 14 320F ** NOV 3,1980 1:08PM

BASE 58,032,128 TOTAL ION CHROMATOGRAM



MASS 36 CHROMATOGRAM BASE 860,214 LINE TYPE



RETENTION TIME FOR SEARCH 18.00

FIT	PUR	REV	M.WT	ENTRY*	COMPOUND NAME FROM THE NBS LIBRARY USING NBS99 SEARCH METHOD
914	909	909	36	22	Hydrochloric acid
761	2	3	68	160	Borane, trifluoro-
330	329	833	255	18649	1-Benzopyrylium, 3,7-dihydroxy-2-(4-hydroxyphenyl)-
309	307	916	67	155	Methanamine, hydrochloride
286	252	849	113	1933	Ethanethiol, 2-amino-, hydrochloride

BASE 711,104 SCALE 1.00 RT 18.00 BK 8.00 WT100 % %TI 16.21 SCAN 326

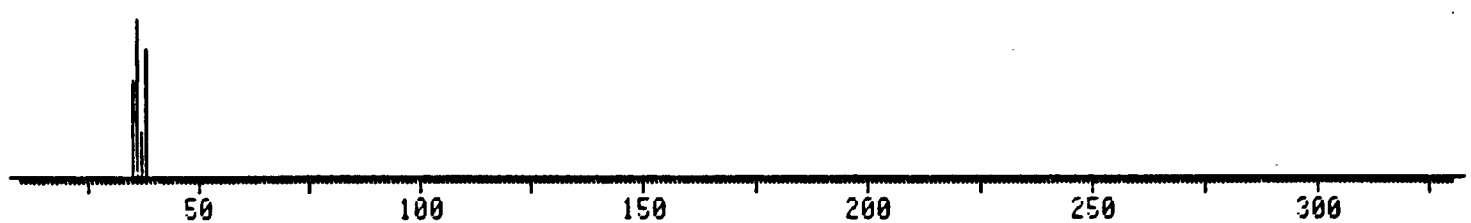
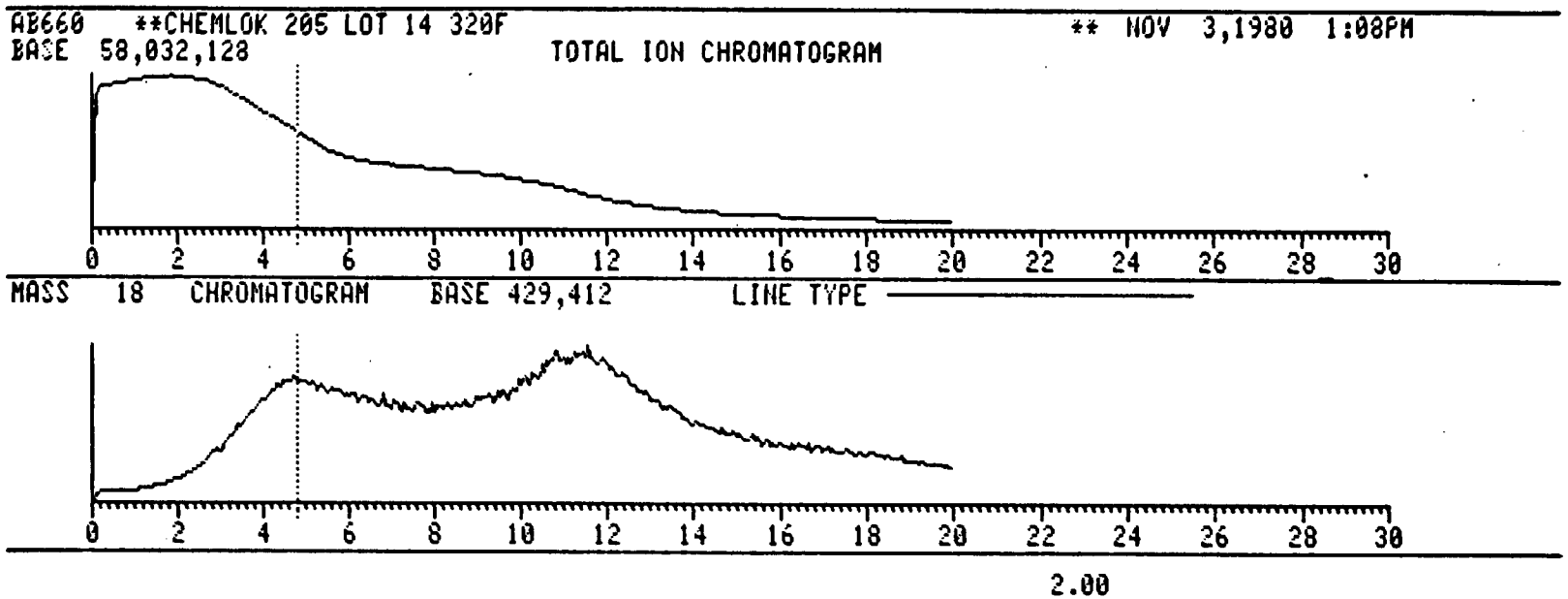


FIGURE 4


AB660 **CHEMLOK 205 LOT 14 320F
** NOV 3,1980 1:08PM
BASE 58,032,128
TOTAL ION CHROMATOGRAM
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
MASS 18 CHROMATOGRAM BASE 429,412
LINE TYPE
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
2.00

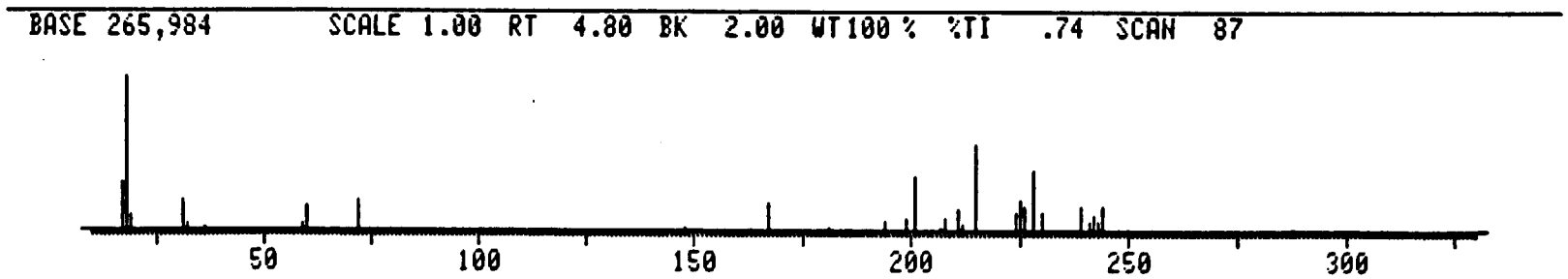
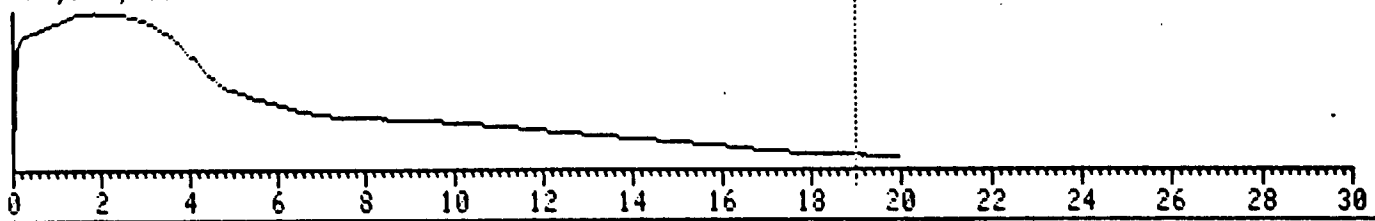

BASE 265,984
SCALE 1.00 RT 4.80 BK 2.00 WT100 % %TI .74 SCAN 87
50 100 150 200 250 300

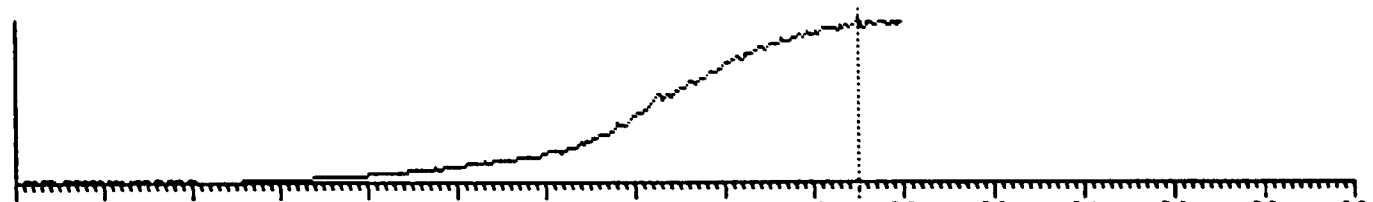
FIGURE 5

AB659 **CHEMLOK 205 LOT 16 350F ** NOV 3,1980 12:39PM

BASE 54,886,400 TOTAL ION CHROMATOGRAM



MASS 36 CHROMATOGRAM BASE 833,521 LINE TYPE



RETENTION TIME FOR SEARCH 19.00

FIT	PUR	REV	M.WT	ENTRY*	COMPOUND NAME FROM THE NBS LIBRARY USING NBS99 SEARCH METHOD
950	861	861	36	22	Hydrochloric acid
712	46	49	64	141	Sulfur dioxide
451	362	529	155	6874	Tetrazolo[1,5-b]pyridazine, 6-chloro-
448	32	59	64	138	Ethene, 1,2-difluoro-
445	26	59	149	5935	Diaziridine, 3-(difluoroamino)trifluoro-

BASE 787,200 SCALE 1.00 RT 19.00 BK 8.00 WT100 % %TI 15.23 SCAN 343

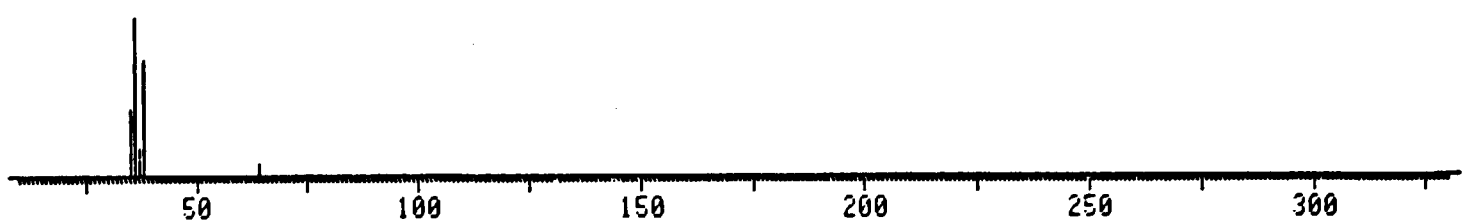


FIGURE 6

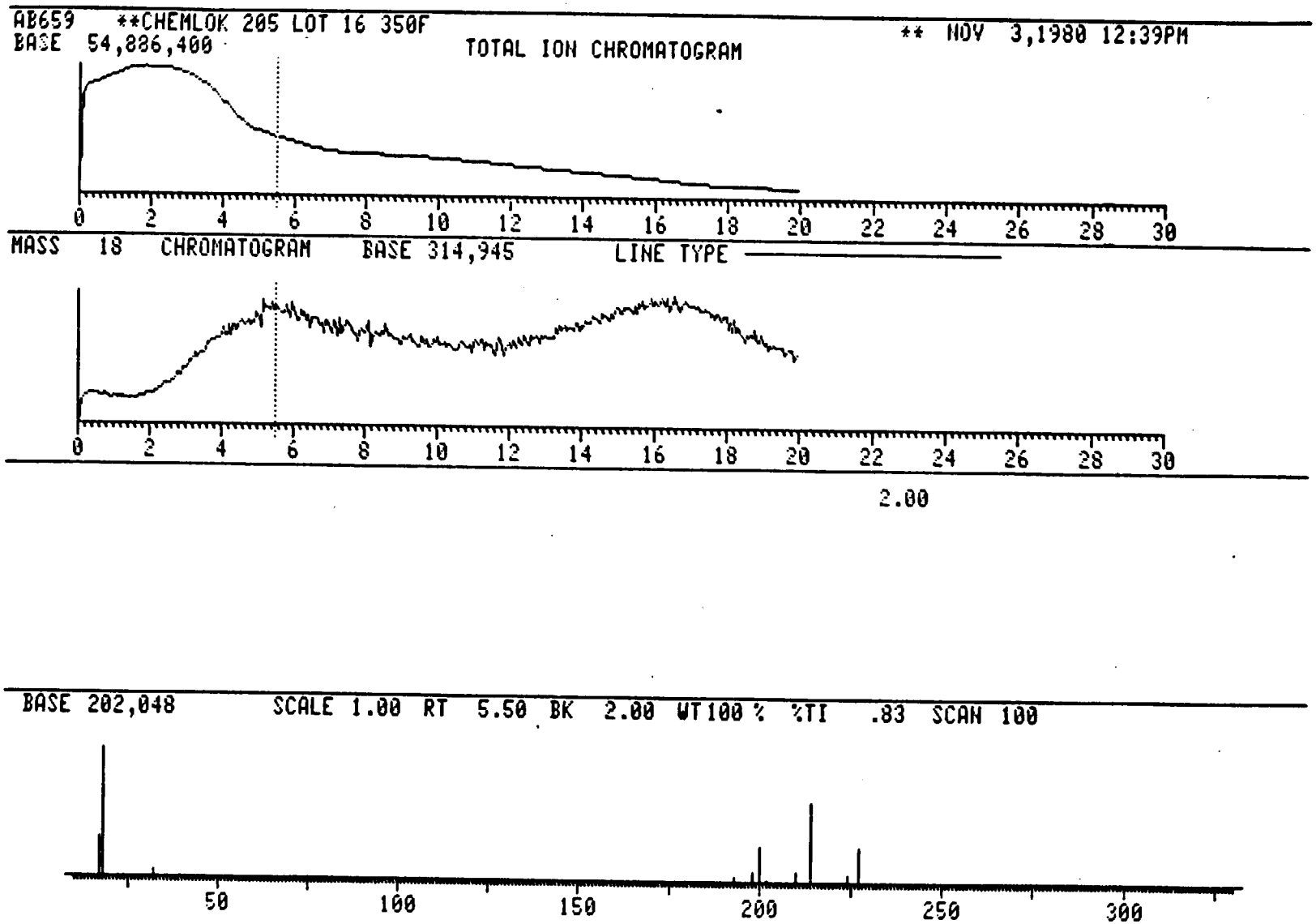
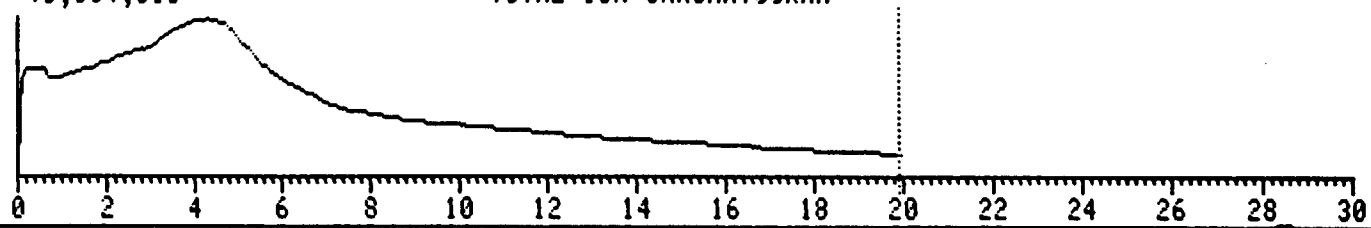
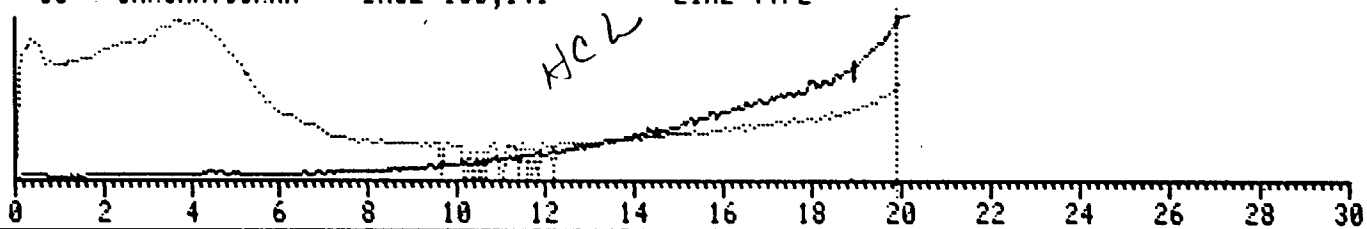

AB659 **CHEMLOK 205 LOT 16 350F
BASE 54,886,400
TOTAL ION CHROMATOGRAM
** NOV 3,1980 12:39PM
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
MASS 18 CHROMATOGRAM BASE 314,945 LINE TYPE
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
2.00
BASE 202,048 SCALE 1.00 RT 5.50 BK 2.00 WT100 % %TI .83 SCAN 100
50 100 150 200 250 300

FIGURE 7

AB658 **CHEMLOK 205 LOT 16 320F ** NOV 3,1980 12:05PM
BASE 40,534,016 TOTAL ION CHROMATOGRAM



MASS 36 CHROMATOGRAM BASE 230,758 LINE TYPE
MASS 38 CHROMATOGRAM BASE 150,141 LINE TYPE



RETENTION TIME FOR SEARCH 19.90

FIT	PUR	REV	M.WT	ENTRY#	COMPOUND NAME FROM THE NBS LIBRARY USING NBS99 SEARCH METHOD
976	870	870	36	22	Hydrochloric acid
746	17	23	207	13800	Benzo[b]thiophene-4-ol, methylcarbamate
641	7	11	212	14335	Benzoic acid, 4-hydroxy-3,5-dimethoxy-, methyl ester
542	522	943	67	155	Methanamine, hydrochloride
474	5	10	227	16033	10H-Phenothiazine, 10-ethyl-

BASE 207,632 SCALE 1.00 RT 19.90 BK 8.00 WT100 % %TI 3.53 SCAN 360

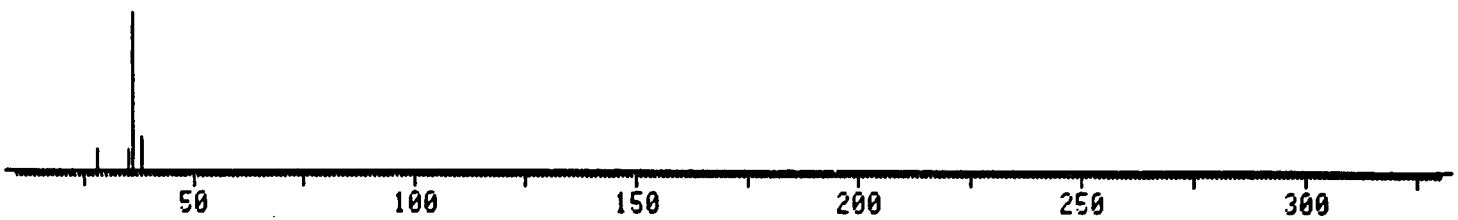
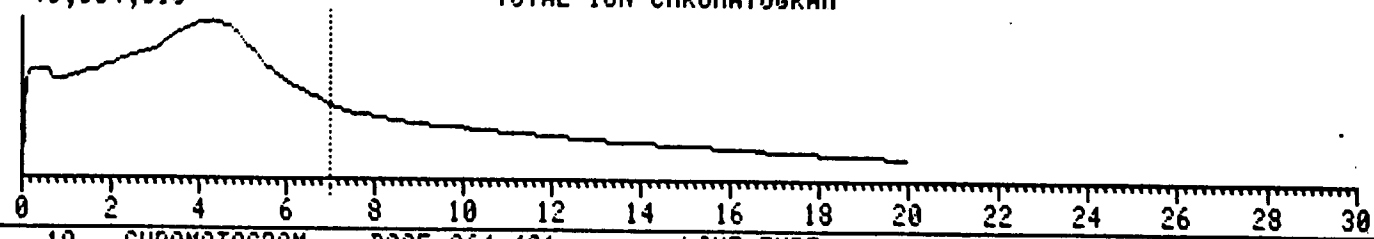


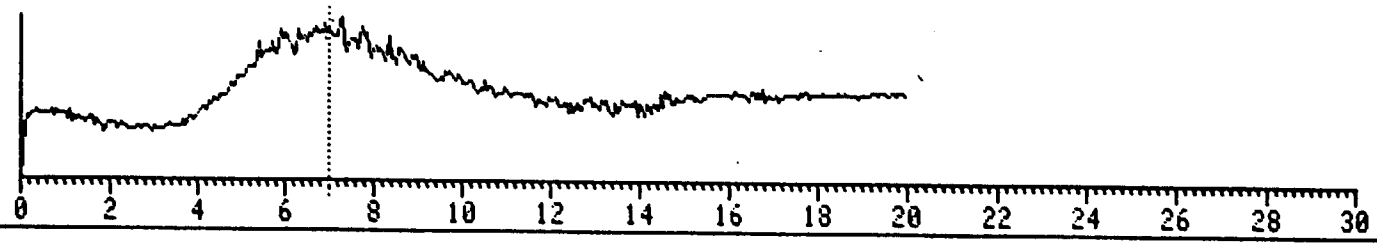
FIGURE 8

AB658 **CHEMLOK 205 LOT 16 320F ** NOV 3,1980 12:05PM

BASE 40,534,016 TOTAL ION CHROMATOGRAM



MASS 18 CHROMATOGRAM BASE 264,421 LINE TYPE



RETENTION TIME FOR SEARCH 7.00

FIT	PUR	REV	M.WT	ENTRY#	COMPOUND NAME FROM THE NBS LIBRARY USING NBS99 SEARCH METHOD
999	24	24	32	18	Oxygen
979	207	207	18	4	Water
628	147	231	76	315	Acetic acid, hydroxy-
608	128	161	130	3525	Hexanedial, 2-hydroxy-
590	138	204	116	2204	Ethanediimidic acid, dihydrazide

BASE 120,064 SCALE 1.00 RT 7.00 BK 4.30 WT100 % %TI .65 SCAN 127

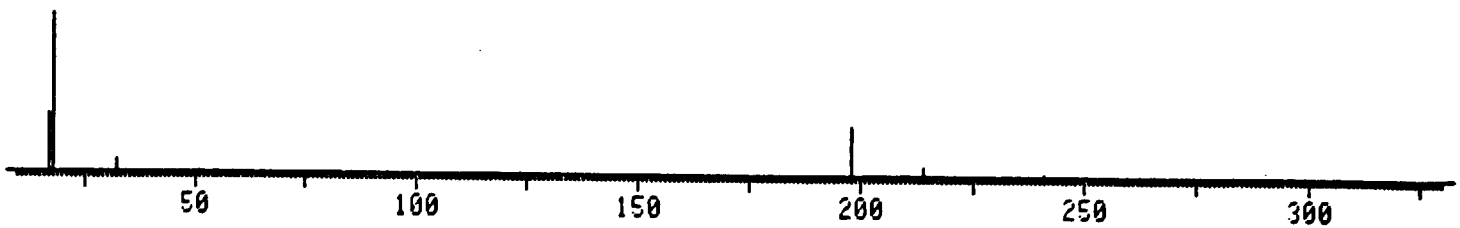
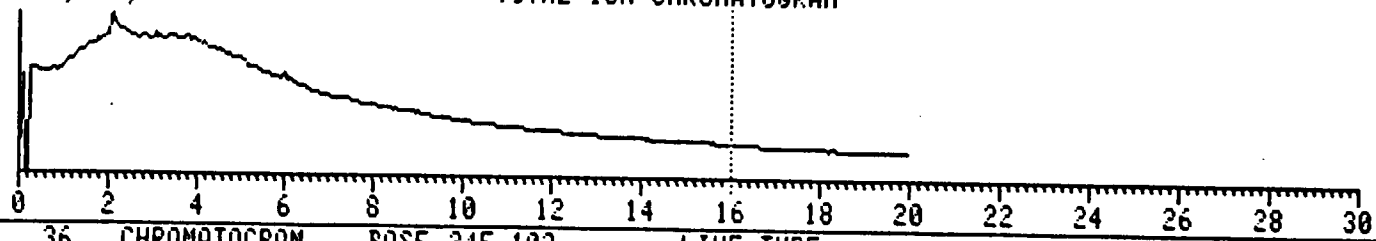
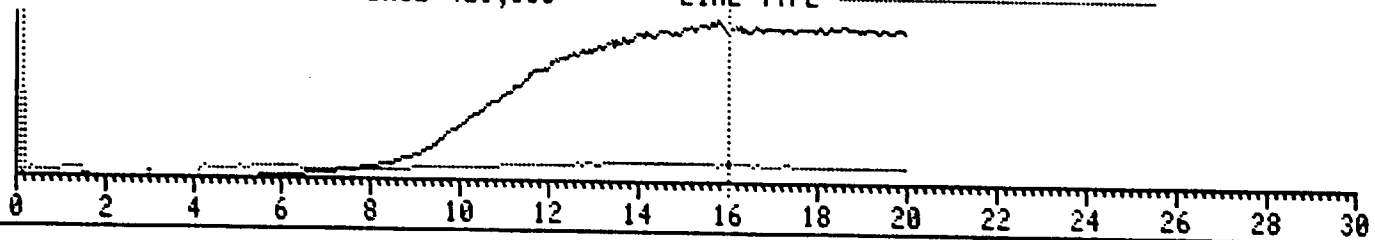


FIGURE 9

AB663 **CHEMLOK 220 LOT 35 350F
BASE 4,157,440 TOTAL ION CHROMATOGRAM ** NOV 4,1980 10:33AM



MASS 36 CHROMATOGRAM BASE 345,103 LINE TYPE
MASS 64 CHROMATOGRAM BASE 421,885 LINE TYPE



RETENTION TIME FOR SEARCH 16.00

FIT	PUR	REV	M.WT	ENTRY#	COMPOUND NAME FROM THE NBS LIBRARY USING NBS99 SEARCH METHOD
999	833	833	36	22	Hydrochloric acid
945	130	136	64	141	Sulfur dioxide
792	13	17	83	426	1H-1,2,4-Triazole, 1-methyl-
625	81	129	149	5935	Diaziridine, 3-(difluoroamino)trifluoro-
562	556	668	118	2380	Thionyl chloride

BASE 295,376 SCALE 1.00 RT 16.00 BK 8.00 WT100 % %TI 33.50 SCAN 289

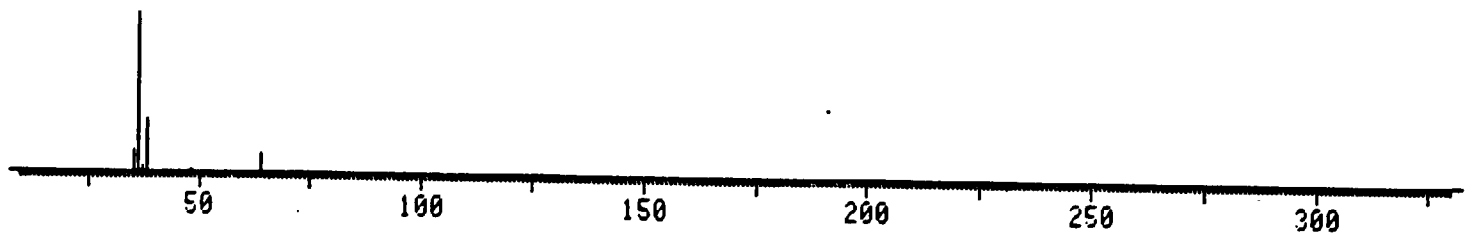
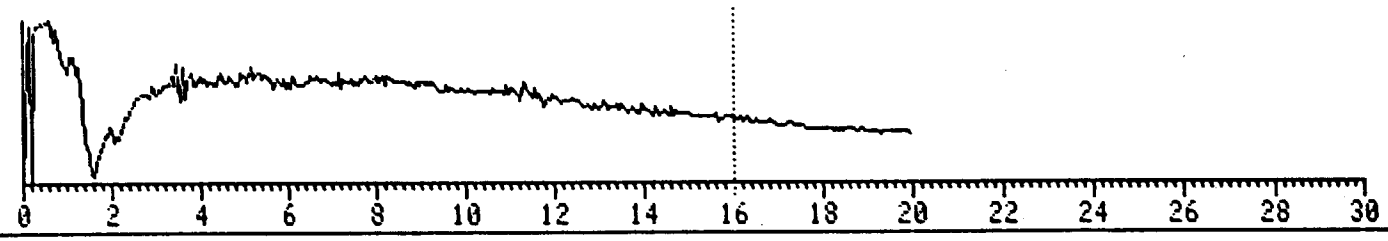


FIGURE 10

AB663 **CHEMLOK 220 LOT 35 350F ** NOV 4,1980 10:33AM

BASE 4,157,440 TOTAL ION CHROMATOGRAM

MASS 18 CHROMATOGRAM BASE 49,780 LINE TYPE



RETENTION TIME FOR SEARCH 16.00

FIT	PUR	REV	M.WT	ENTRY#	COMPOUND NAME FROM THE NBS LIBRARY USING NBS99 SEARCH METHOD
999	833	833	36	22	Hydrochloric acid
945	130	136	64	141	Sulfur dioxide
792	13	17	83	426	1H-1,2,4-Triazole, 1-methyl-
625	81	129	149	5935	Diaziridine, 3-(difluoroamino)trifluoro-
562	556	668	118	2380	Thionyl chloride

BASE 295,376 SCALE 1.00 RT 16.00 BK 8.00 WT100 % %TI 33.50 SCAN 289

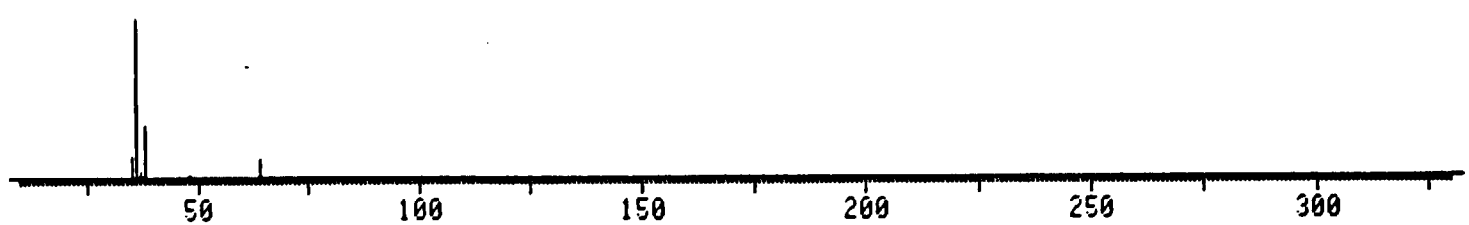
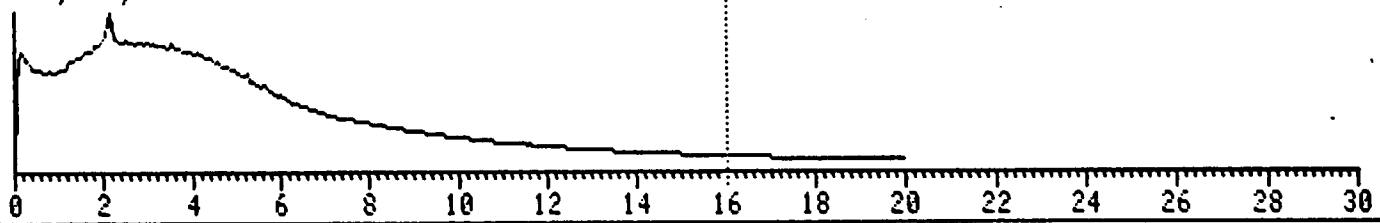


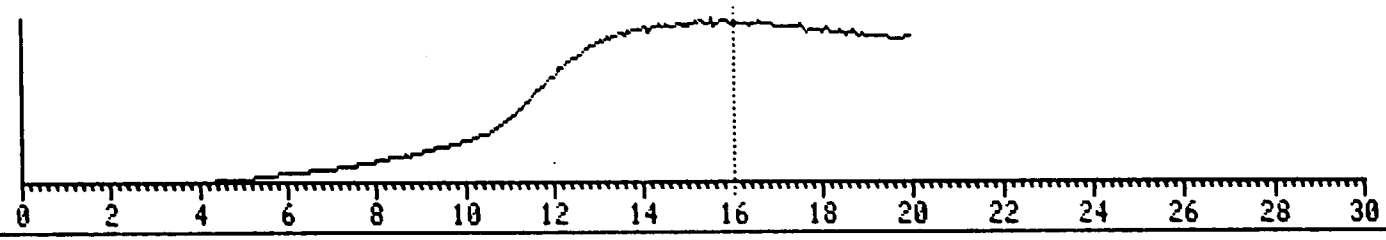
FIGURE 11

AB662 **CHEMLOK 220 LOT 35 320F ** NOV 4,1980 10:01AM

BASE 5,062,656 TOTAL ION CHROMATOGRAM



MASS 36 CHROMATOGRAM BASE 137,272 LINE TYPE



RETENTION TIME FOR SEARCH 16.00

FIT	PUR	REV	M.WT	ENTRY#	COMPOUND NAME FROM THE NBS LIBRARY USING NBS99 SEARCH METHOD
998	965	965	36	22	Hydrochloric acid
456	450	883	67	155	Methanamine, hydrochloride
418	364	758	182	10737	Propanimidamide, N-(1-chloro-1-propenyl)-, monohydrochloride
412	406	890	132	3745	Hydrazine, 1,2-dimethyl-, dihydrochloride
411	9	23	100	1084	Sydnone, 3-methyl-

BASE 79,648 SCALE 1.00 RT 16.00 BK 11.00 WT100 % %TI 15.42 SCAN 290

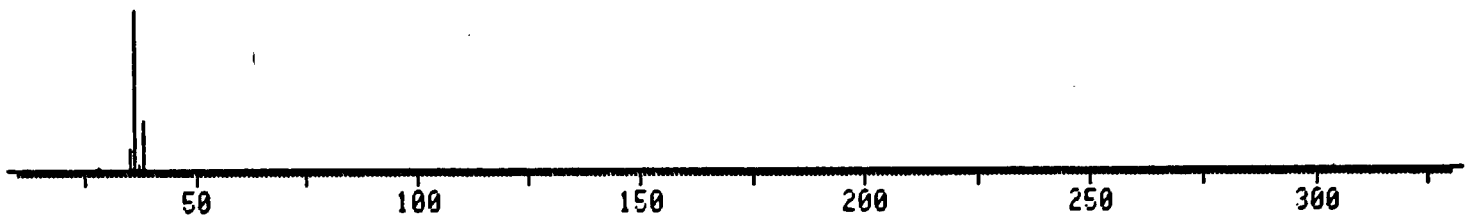
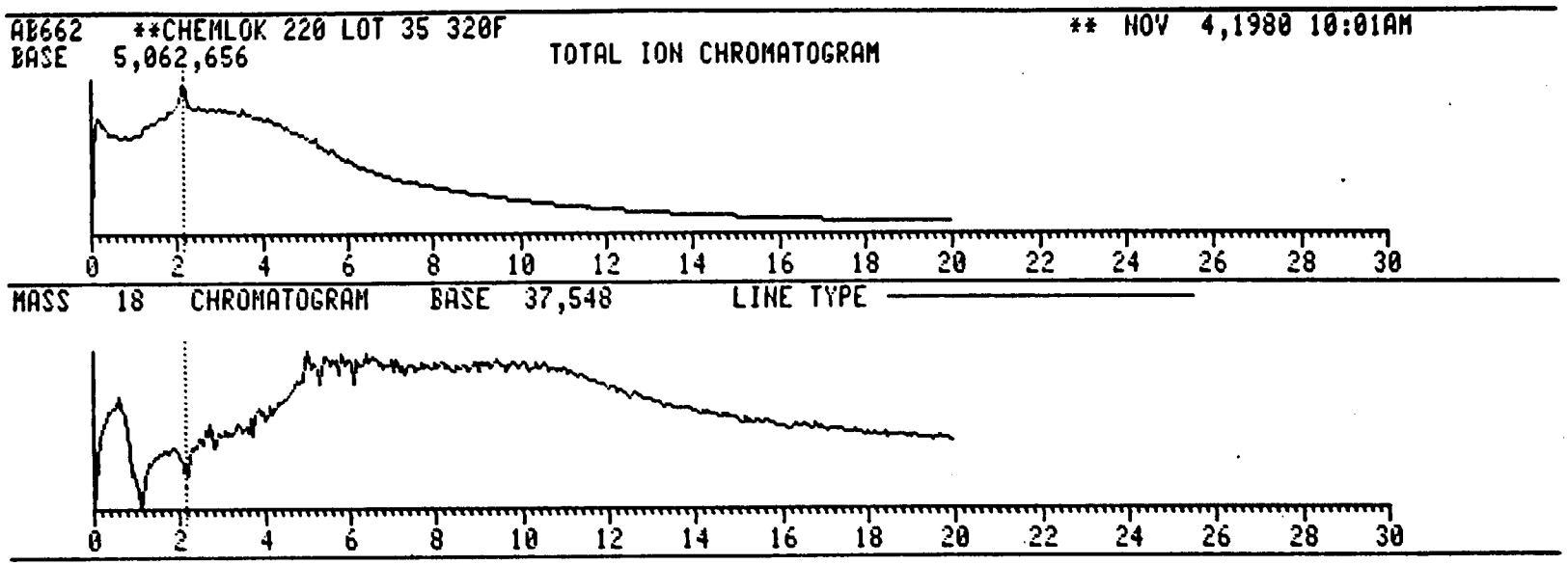


FIGURE 12


AB662 **CHEMLOK 220 LOT 35 320F
** NOV 4,1980 10:01AM
BASE 5,062,656
TOTAL ION CHROMATOGRAM
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
MASS 18 CHROMATOGRAM BASE 37,548
LINE TYPE
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30

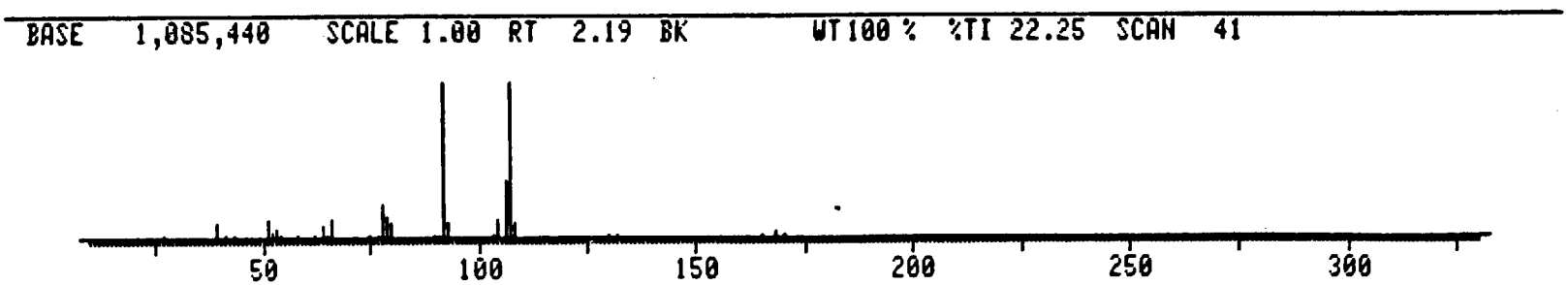
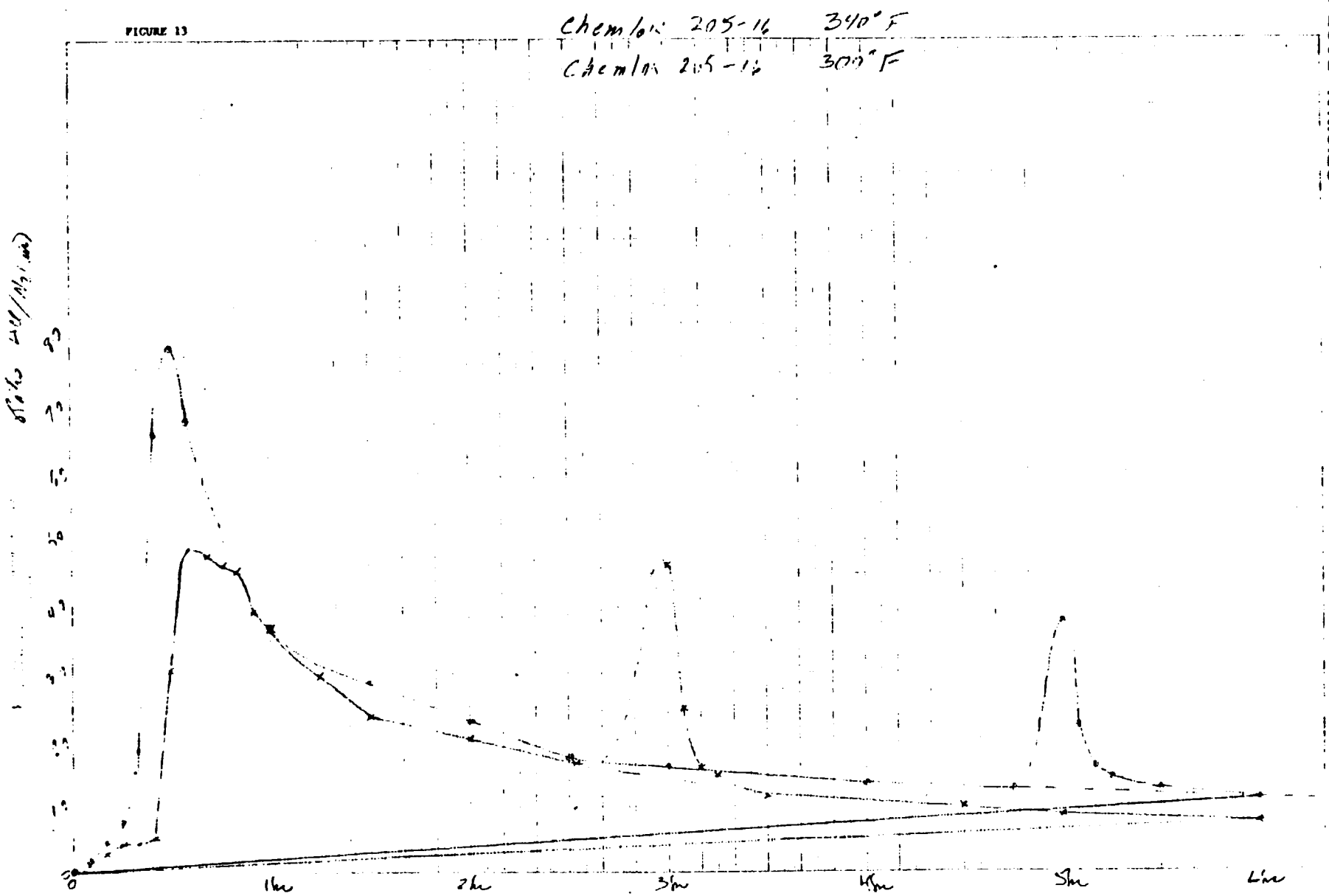

BASE 1,085,440 SCALE 1.00 RT 2.19 BK
WT100 % %TI 22.25 SCAN 41
50 100 150 200 250 300

FIGURE 13



ORIGINAL PAGE IS
OF POOR QUALITY

J. D. McGregor

MDDR-81-0001

TWR-12947

THIOKOL/WASATCH DIVISION
A DIVISION OF THIOKOL CORPORATION
P. O. BOX 524
BRIGHAM CITY, UTAH 84302

Final Report

SRM FLEX BEARING RUST INVESTIGATION

30 January 1981

PREPARED BY:

J. D. McGregor
Plastics Section

APPROVED BY:

P. G. Russell, Supervisor
Plastics Section

for E. L. Gray, Manager
Materials Development Department

George Nichols
SRM Program Office

RESEARCH AND DEVELOPMENT LABORATORIES DIVISION
Materials Development Department

SRM FLEX BEARING RUST INVESTIGATION

J. D. McGregor

Introduction

A task force was formed in April 1979 for the purpose of overcoming an unbond and/or no bond problem being experienced in the molding of the SRM flex bearing. The effort culminated in a new molding cycle for the debulk and cure of the bearing. Flex Bearing 1U51060-11 S/N 0000001 was molded on 29 May 1980 using the cure cycle developed by the task force personnel. Basically, the upper temperature limits had been increased from 315°F to 335°F. The molding and cure cycle went well, however, the maximum temperature may have gone to 345°F for a short period of time. The bearing was stretched in the molding press on 9 June 1980 and inspected for unbonds. A number of people took part in this inspection including Engineering Design and R&D Laboratory personnel. It was concluded that the bearing was well bonded.

The bearing was transferred to T-17 and acceptance tested 24 through 26 June 1980. It was cleaned and preserved on 27 June, wrapped in polyethylene sheeting, and stored in T-17.

The bearing was subsequently returned to M-52 on 18 August 1980 and stretched again the next week, 29 August. Several areas of rust were observed on the bearing during the stretching which resulted in a closer inspection. It was determined that significant unbonds had occurred between the rubber and steel in the region where the rust was observed. The bond had just disappeared, leaving a fine coating of rust on both the rubber pad and steel. This condition had been observed on Production #1 bearing due to local overheating caused by a runaway calrod heater in the mold.

Another stretch test was made on 23 September for the purpose of better defining the location and severity of the rust and unbonds. The bearing was later cut up to determine the full extent of the problem.

Objective

The objective of this program was to determine the cause of the corroded unbonds experienced on SRM flex bearing 1U51060-11 S/N 0000001 and to establish molding processes and procedures which will preclude a reoccurrence.

Summary

A flex bearing was discovered to be unbonded and corroding several weeks after having passed all tests and been accepted. The corrosion and loss of bond at the steel-adhesive interface is caused by the formation of hydrochloric acid within the Chemlok adhesive system during the high temperature cure cycle at molding. The condition requires several weeks to develop and to become apparent. A lower cure temperature during molding reduces the formation of the acid to the level where corrosion and unbonds become insignificant.

Conclusions

1. Flex bearing 1U51060-11 S/N 0000001 developed unbonds between the steel and adhesive system with corrosion (rust) showing on both surfaces.

2. The bearing probably experienced molding temperatures in excess of 340°F.

3. The Chemlok adhesive system produced hydrochloric acid at that cure temperature.

4. The acid mixed with moisture from the air corroded the steel and produced unbonds over a period of several weeks. The corrosion and unbond continue with age.

5. Laboratory specimens have developed corrosion and unbonds with cure temperatures as low as 320°F.

6. The cure cycle for molding flex bearings has been lowered to reduce the formation of hydrochloric acid.

Recommendations

1. Reduce the molding temperature of the flex bearing.

2. Consider pre-curing the Chemlok adhesive before molding to reduce the amount of hydrochloric acid available to corrode the steel.

3. Investigate the possibility of sealing the edges of the bonds to prevent moisture from being absorbed by the acid.

4. Process bearing promptly after acceptance testing to restrict moisture and air penetration at bond lines.

Equipment

1. 20-ton laboratory presses.

2. Gas chromatograph mass spectrometer.

3. Tensile test machine.

Method

A number of tests have been conducted in determining the cause of the corroded unbonds on the flex bearing. The principal specimen in this program is a rubber-adhesive-steel peel specimen as shown in Figure 1. A few specimens of 4 inch tensile discs were also used. The outgassing (or compounds) released by the adhesive system during exposure to the bearing molding temperatures were determined in a gas chromatograph mass spectrometer.

Several sets of peel specimens were fabricated and then stored at room temperature with no load applied. They were checked every day for corrosion and/or unbonds. The checking consists of pushing the rubber away from the bond line with the fingers.

The gas chromatograph was used to determine the chemical compounds coming off the primer and adhesive. Analysis of the gas indicated compounds were released which formed hydrochloric acid.

Discussion

The observation of a rusty unbond on a full scale flex bearing which had successfully passed the acceptance testing was a complete surprise. The O.D. unbond between the aft end ring and first rubber pad extended three-quarters of the circumference of the bearing and measured .75 to 1.0 inch deep. As a point of interest, two small areas (approx. .5 inch deep and 2 inches long) were observed to have heavier corrosion, apparently a result of water and not the unidentified cause of the remaining rusted areas. The I.D. of the bearing had similar unbonds with a depth of about .5 inch except for one 2 inch long area with a depth of 6 inches. The bearing was a "scrapper" so the decision was made to cut it apart, inspect for other unbonds, map, and photograph the known areas. No additional

Discussion (Continued)

unbonds were located. These rusted unbonds were unlike previous experience wherein the unbonds occurred between the Chemlok 220 adhesive and the rubber pad. The rusted unbonds are between the Chemlok 205 primer and the steel.

A number of questions were addressed in the attempt to solve the unbond/corrosion problem. Specifically, they were:

1. Was the problem moisture in the Chemlok or solvent?

2. Did the Chemlok break down and release some corrosive compound during molding of the bearing?

3. Why did it require weeks for this phenomenon to become apparent?

4. Can it be prevented?

Some of the work accomplished during the Flex Bearing Task Force in 1979 and early 1980 appeared to be in contradiction to the observations of the full scale bearing with the problem. QLS specimens on the task force effort, cured at 340°F, proved to be well bonded. Their specific purpose was, however, to evaluate the effects of the high cure temperature on the modulus of the rubber. Consequently, these specimens were tested, reported and the metal components salvaged within days of being molded and they were never stored long enough to develop the corrosion. This was perhaps unfortunate.

The manufacturer of the Chemlok adhesive system, Hughson Chemical, was contacted and made aware of the problem. They had several comments which are of concern. Their spokesman, Mr. Nick Gervase, stated: (1) moisture in the adhesive/solvent system was probably not responsible but to prepare a set of specimens with water in the 205 primer and check it out; (2) the 335 - 345°F cure temperature is too high and probably deteriorated the 205 primer. He further expressed surprise that Thiokol had any success bonding at the time and temperature in use on the flex bearings; (3) suggested the 205 primer thickness be increased to better withstand the high cure temperatures.

The initial tests to reproduce the unbonds in the laboratory assumed that the cause of the problem was water in the Chemlok or the high cure temperature. A set of peel specimens was made with 5% water added to the primer and cured at 340°F for 4 hours. Additional sets were made using a

Discussion (Continued)

50/50 mix of Chemlok 205 primer and MEK solvent, duplicating the on-line condition of spraying diluted primer. In addition, some sets were made with undiluted Chemlok direct from the can. These specimens were cured at 320, 330 and 340°F. The specimens were individually inspected after molding for rust, unbonds or other anomalies and then held in storage (desk top) and examined periodically until the corroded unbonds appeared. The first sign of rust occurred after 26 days on both the 205/water and 50-50 205/MEK specimens. By the end of 6 weeks, all the 340°F cured specimens had rusted unbonds. Some were considerably more corroded than others. These results indicated that the high cure temperature did have an effect on the composite corroding and unbonding. Some of the specimens were cut apart with a knife and in areas where the steel had been scraped clean by the knife, there was no unbond apparent. However, after 3 - 4 days, the steel began to rust and within a couple of more days, the unbonds had begun. This implies that exposure to air is also a factor in the rusted unbond phenomenon.

A set of metal specimens painted with Chemlok 205 primer only, was heated at 340° F for 4 hours and had no apparent rusting after 1 month. Later, a set was fabricated using 220 adhesive only. The rubber did not adhere to the steel but they were held together enough for the test. The rusting was severe; considerably more than was observed on normal 205/220 specimens. It is apparent that the 220 adhesive has more of an effect on the corrosion than the 205 primer.

Another set of specimens was molded at 320, 330 and 340°F for 4 hours. The first to rust was one of the 340°F cured specimens after 21 days. The 320 and 330°F specimens did not rust until after 4 weeks.

The gas chromatograph revealed that a number of chlorine-containing compounds were released from the Chemlok components and formed hydrochloric acid. Most of the acid was released in the first two hours of a five hour test. In addition, it was determined that the adhesive, Chemlok 220, produced more acid than the primer, Chemlok 205. The acid is the cause of the corrosion and subsequent loss of adhesion. It apparently requires several days to absorb enough moisture from the air to cause the corrosion. The acid production curves are shown on Table I.

Now that the cause had been established, more meaning was placed on the specimen testing. The peel specimens were made under better conditions and evaluated under closer control. In addition, a series of

Discussion (Continued)

4 inch diameter disc specimens were fabricated. They were molded in two sets; 4 each at 320°F for 6 hours, and 4 each at 350°F for 4 hours. Half of each set was conditioned "as molded" and the other half had the flash removed, cleaned, and the steel sand blasted and coated with Chemlok 205/220 as a protective coating. The specimens were tested after 30 and 60 days. The "as molded" specimens were rusted after 30 days and all specimens were rusted after 60 days. This discounted the theory that the Chemlok would provide protection to keep the moisture in the air from combining with the hydrochloric acid and thus causing corrosion. Some other material might provide the protection but not Chemlok 205/220. The results of the disc tests are shown in attached photos.

Another set of peel specimens was fabricated and used two different lots of Chemlok 205 primer. It was observed that one lot apparently released more hydrochloric acid than the other inasmuch as the corrosion on one group was greater than the other. It also appeared that the corrosion reaction appeared to stop on the 320°F cured specimens after approximately 6 weeks. The 340°F cured specimens continued to rust and unbond until after two months there was but a very small bond. The results of these specimens are shown on Table II.

A few specimens were fabricated with a processing change which incorporated a preheat of the Chemlok 205/220 prior to molding. The specimens were cured at 330°F for 4 hours and there is no evidence of corrosion after 2 months. That experiment appeared so good that another set has been made and cured at 340°F. The two month waiting period is a month away from the completion of this report so cannot be reported as complete.

Two full scale flex bearings have been molded since determining the cause of the rust/unbond problem The control temperature was 320° ± 15°, (a 15° temperature decrease from the task force temperature), with a minimum 290°F for 2 hours on the lagging thermocouple. There is no evidence of corrosion on either bearing to date.

It is concluded that the cause of the problem was hydrochloric acid formed in the Chemlok adhesive during cure of the bearing and the reducing of the temperature limit to 320°F will reduce the formation of acid to a level that corrosion and subsequent unbonding does not occur. In addition, several precautions are being taken to promptly process flex bearings after acceptance testing.

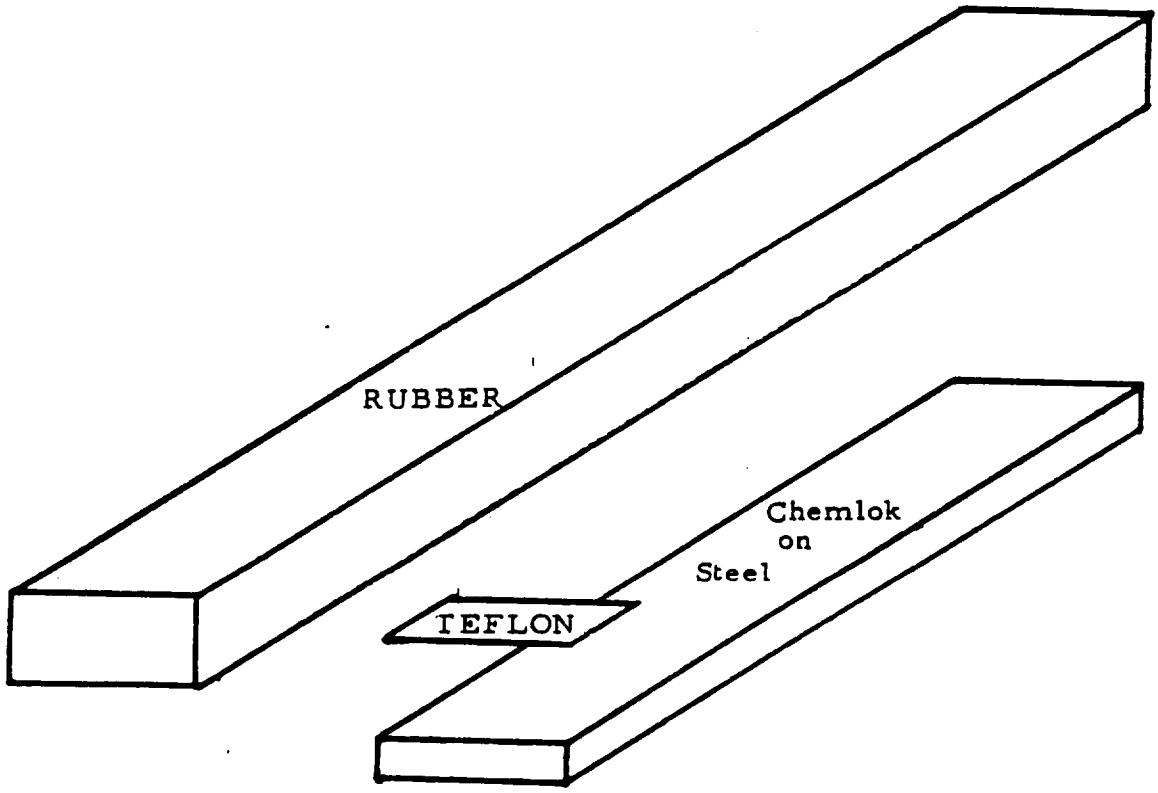


FIGURE 1

PEEL SPECIMEN

TABLE I

ACID PRODUCTION CURVES

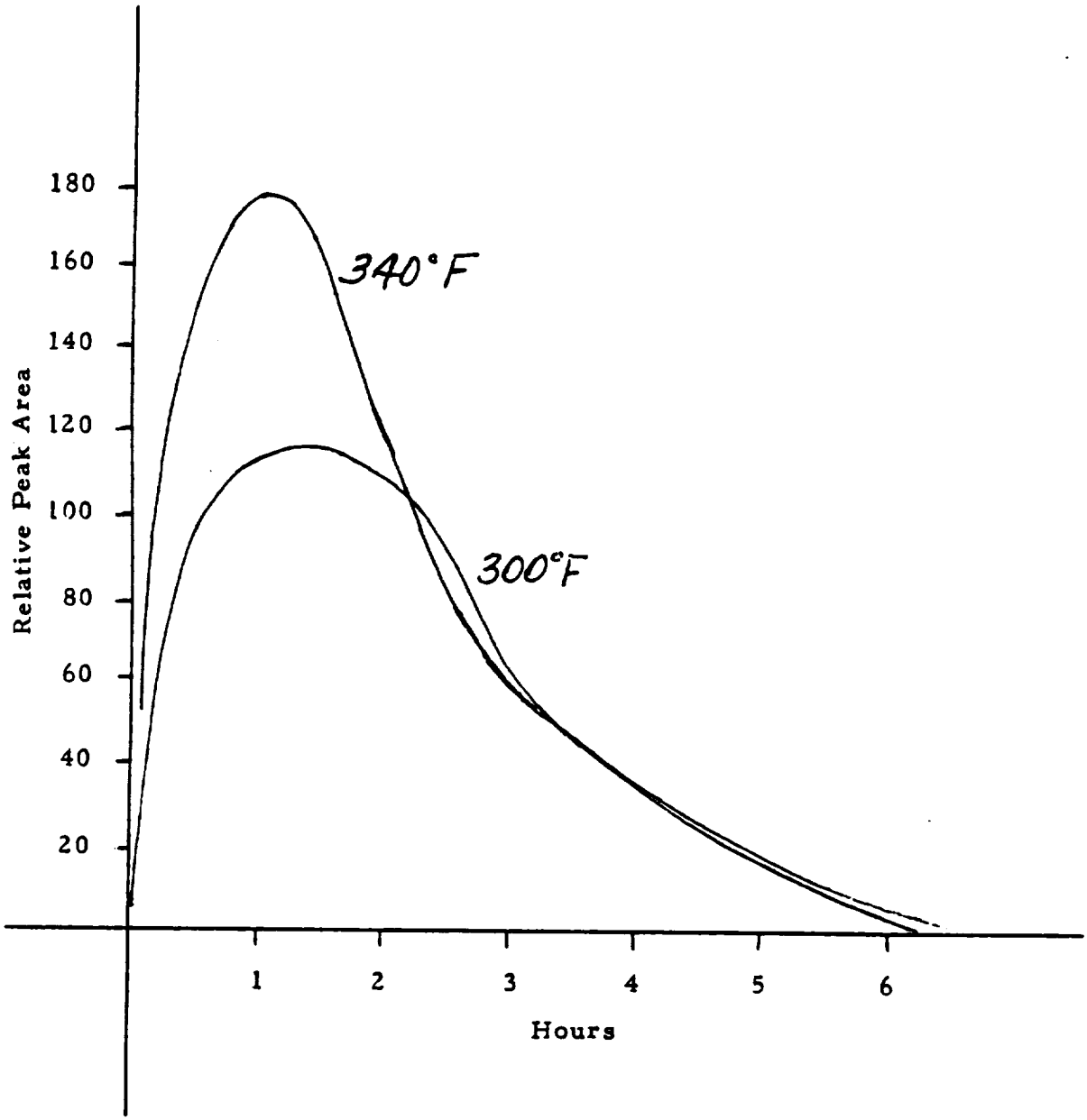


TABLE II

PEEL TEST SPECIMEN MATRIX

SPECIMENS 5 each/set	Date Molded	Cure Temp.	Hours	205 Lot No.	2 Dec.	8 Dec.	15 Dec.	22 Dec.	5 Jan.	15 Jan.
Set 1	4 Nov.	340	4	14			3	4	5	5
2		330	4	14	2	2	3	5	5	5
3		330	5	14		4	4	4	5	5
4		320	5	14		2	3	4	5	5
5	7 Nov.	340	4	16	2	4	4	5	5	5
6		330	4	16		3	3	3	3	3
7		330	5	16		2	2	3	3	3
8		320	5	16		1	1	1	1	2
9	11 Nov.	330	6	16			1	2	2	4
10		320	6	16		1	1	4	4	4

NOTE: The numbers listed under the date headings represent the number of specimens observed to be affected on that date.

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MORTON THIOKOL, INC.

Wasatch Operations

Interoffice Memo

11 December 1987
2422-FY88-131

TO: Tim Sizemore

CC: M. Kuwana, P. Russell,
J. McGregor, F. deLeon

FROM: C. L. Denton

SUBJECT: Unbonds in Chemlok 205/220 Due to HCl Generation During Cure

Studies run in 1980 by J. D. McGregor (TWR-12947) showed cure temperatures in excess of 320°F during flex bearing manufacture caused rusting between rubber and steel. Testing was done to 380°F. The Chemlok adhesives at elevated temperatures suffered degradation and generated Cl^- ion. With time; two-six weeks; and exposure to moisture; the edges of the samples; rust was generated with subsequent unbonding. Both rusting and unbonds increased with time. The solution then was to keep cure temperatures at $\leq$315°F.

Questions were raised about the Cl^- content of various lots of Chemlok 205 and 220 and would they cause rusting and unbonds at todays cure cycle limits.

Results

Samples were made with the lowest and highest % Cl^- Chemlok 205s and 220s. and exposed to four time-temperature cycles expected by current planning. No rusting and no unbonds were produced in 19 weeks of storage at ambient temperatures of 70 $\pm$ 10°F and relative humidity of 30 $\pm$ 15%.

Conclusions

Unbonds; due to Chemlok degradation and subsequent HCl production and rusting; are not to be expected with the current flex bearing cure parameters.

Recommendations

Do not change current cure parameters in flex bearing manufacture.

C-4

Discussions

It is known that the chlorine ion content of Chemlok adhesives vary. It is also know that cure times during flex bearing debulk and cure also vary. The question was, "Can these combinations cause unbonds between rubber and steel?"

Five lots of Chemlok 205 and two lots of Chemlok 220 were located in-house. Each was exposed to 320°F for 5 hours and analyzed for chlorine ion, LWR 5334754. We took the "worst" (highest Cl^- content) set of Chemlok 205/220, Lot 0029/0014, 0.902%/0.974%; and the best (lowest Cl^- content) set of Chemloks 205/220, 0007/0007, 0.4706/0.409%.

Normal peel samples were made using 5891-0015 TR3005A rubber, tycement and both the best and worst sets of Chemlok.

Sets of samples were exposed to four temperature conditions:

Best Conditions Chemlok Lot 205/220	Temperature Exposure @ 310°F	Identification
0007/0007	200 min. @ 295°F + 210 min. @310°F	A, 1-8
0007/0007	65 min. @ 295°F + 210 min. "	B, 1-8
0007/0007	+ 210 min. "	C, 1-8
0007/0007	+ 410 min. "	D, 1-8
Worst Conditions		
0029/0014	200 min. @ 295°F + 210 min. "	E, 1-8
0029/0014	65 min. @ 295°F + 210 min. "	F, 1-8
0029/0014	+ 210 min. "	G, 1-8
0029/0014	+ 410 min. "	H, 1-8

All samples were then stored in M-54 at ambient temperture and humidity. Once a week the bond zones were stretched, looking for rust and or unbonds. ~~In 19 weeks none~~ occurred.

The samples are in M-54 on my table and are available for personal examination through 8 January '88. They will be destroyed after that.

C. L. Denton

/sher