Committee D-2 ON PETROLEUM PRODUCTS AND LUBRICANTS

Chairman: N. DAVID SMITH. North Carolina Dept. of Agric., 2 West Edenton St., P.O. Box 27647. Raleigh. NC 27611 (919-733-3313)
FAX: 919-715-0524
First Vice-Chairman: SUSAN E. LITKA. UOP Research Center. 50 East Algonquin Rd., P.O. Box 5016. Des Plaines. IL 60017-5016
(708-391-3390)
Second Vice-Chairman: KURT H. STRAUSS. 69 Brookside Rd., Portland. ME 04103 (207-773-4380) FAX: 207-775-6214
Secretary: KENNETH O. HENDERSON. Castrol North America. Automotive Div., 240 Centennial Ave., Piscataway. NJ 08854
(908-980-3630) FAX: 908-980-9519
Assistant Secretary: W. JAMES BOVER. Exxon Biomedical Sciences. Inc., Mettlers Rd., CN2350. East Millstone. NJ 08875-2350 (908-873-6318)
FAX: 908-873-6009
Staff Manager: EARL R. SULLIVAN (215-299-5514)

Reply to: Michael S. Griggs
The Lubrizol Corporation
29400 Lakeland Boulevard
Wickliffe, OH 44092-2298

January 29, 2002

To: Members of the Single Cylinder Oil Test Engine (SCOTE) Surveillance Panel and guest attending the January 23, 2002 meeting.

Enclosed are the minutes of the SCOTE Surveillance panel meeting held in San Antonio, Texas. Please forward any corrections or additions to my attention.

Michael S. Griggs
Secretary, SCOTE Surveillance Panel

MEETING MINUTES

SINGLE CYLINDER DIESEL SURVEILLANCE PANEL

HELD JANUARY 23-24, 2002
PERKINELMER
SAN ANTONIO, TEXAS

ACTION ITEMS AND SIGNIFICANT PROCEDURE CHANGES

1. Retain "over range" and under range" terminology as applied to QI calculations. - Scott Parke

2. Continue with 1P alpha and beta values for QI calculations and simultaneously calculate QI's using the TMC proposed alpha and beta values (attachment 5) for candidate tests until about May 1st. TMC will issue the spread sheet format. - Cat 1R test labs, Scott Parke

3. Modify the Cat 1R TGA analyses schedule to 360, 432, and 504 hours. - Cat 1R test labs

4. Take a 30 ml sample using published purge procedures (Secretary's note- the original 30 ml purge has been revised to 60 ml) at off sample hours. ICP analysis of sample is at lab's discretion. - Cat 1R test labs

5. Remove the oil pressure delta parameter from the 1R data dictionary. Labs may continue to take measurement at their discretion. – Scott Parke

6. Eliminate the use of dispersant engine cleaner for all Cat tests. - Test labs

7. Investigate requirements of D235 Part I for Stoddard solvent- Mike Griggs

8. Perform major engine inspections prior to the first calibration test scheduled after 15,000 hours of test time. - Cat 1R test labs

9. In the event of a cylinder head or jug failure during the calibration period, a previously calibrated cylinder head/jug assembly that has been used on a successful 1R calibration test within the past 2 years may be used without recalibration. - Cat 1R test labs

10. Provide Sierra mass airflow meter calibration instructions and vendor information to 1R test labs. - Jim McCord

11. Ensure that oil weigh scale time constants are between 20-30 seconds. – Test labs

12. E-mail the HDEOCP chairman with the 1M-PC correction factor proposals. Conduct an e-mail ballot and teleconference for Feb 7th. - Mike Zaiontz, Jim McCord

1.0 CALL TO ORDER AND MEMBERSHIP CHANGES

1.1 Chairman Mike Zaiontz opened the meeting at 8:30 am. The attendance list is attachment 1.

1.2 Riccardo Conti replaced Tom Hitchner for Exxon/Mobil. Jennifer Van Mullekom replaced Phil Scinto for Lubrizol.

1.3 Chairman Mike Zaiontz announced that Jim McCord would officially assume chairmanship of the SCOTE Surveillance Panel beginning with the next meeting/teleconference. Chris Mazuca of PerkinElmer has assumed engineering responsibilities for all Cat SCOTE tests.

2.0 MEETING MINUTES

2.1 The meeting minutes for the August 21, 2001 meeting were previously approved in an earlier teleconference.

2.2 Secretary's note- Meeting meetings are published on the ASTM TMC website in Adobe pdf format. Individuals desiring hardcopy minutes by mail should contact the secretary.

3.0 CAT 1R QI LIMIT EVALUATION

3.1 Mike Zaiontz presented the proposed Cat 1R QI limits (attachment 3), which came from a study of 18 tests conducted by PerkinElmer and SWRI.

3.2 The goals of the study were to assess the control capability of each parameter, reduce QI false alarms, and to base QI control limits on a process capability of a minimum of 3 sigma.

3.3 Mike Zaiontz explained that table 1 (attachment 3, page 2/3) lists the 18 test lumped standard deviations of each controlled parameter. Table 2 compares the standard deviations with the test procedure specification to define a process capability (spec/std dev). The table defines those parameters with a spec/std dev ratio > 6.0 as being 6 sigma capable.

3.4 Table 3 is analogous to table 2 in that it computes a process capability for each controlled parameter using the ratio of the current QI control limit to the parameter standard deviation. Mike Zaiontz's desire was to set a 3.0 process capability limit from which his proposed QI control limits would be calculated as shown in table 4. Table 4 proposes an increase in QI control limits for 8 of the 12 parameters.

3.5 Following Mike Zaiontz's presentation, Scott Parke provided an historical perspective on QI experiences with the 1P test. He reminded the panel that only 8 negative QI's have occurred for all 1P tests. His position was that labs were not unduly placed at risk with negative QI's. On the other hand, Mike Zaiontz and other panel members felt that a great deal of money and effort has gone into managing strict QI's and that negative QI's should be meaningful. Generally, two viewpoints evolved from the ensuing discussions. First, the methodology by which QI's are generated (best test=1.0 and worst acceptable test=0.0) provides excellent discrimination for process control capabilities amongst labs. Second, negative a QI is associated with an invalid test when actual control of the questionable parameter may be deemed perfectly acceptable.

3.6 Phil Scinto commented that the more positive the QI, the better the test and recommended against changing QI's. He added that if labs are losing lots of test, then adjustments would have to be made. Phil Scinto and Bob Campbell suggested that the entire TMC data set be looked at for setting QI limits.

3.7 Scott Parke led into a discussion of the matrix data and briefly described the traditional way of generating QI constants. He used the example of coolant flow (see attachment 4). Scott laid out the coolant flow plots for each of the 18 matrix tests in order of highest to lowest QI. The tests with the worst coolant flow control was set to QI=0.0. Attachment 4 shows the QI's assigned to each lab for each controlled parameter but only includes plots of the best and worst tests. Scott Parke pointed out that in his analysis for intake air pressure, speed, and fuel flow control; he deemed some tests to have unacceptable control and were cut off below the minimum acceptable "worst" tests. These unacceptable tests have negative QI's.

3.8 Scott Parke presented attachment 5, which summarizes the 1R quality index calculation constants. He explained that fuel flow had tighter limits for the 1R than the 1P and that the 14th test set the 0.0 QI threshold. Bob Campbell expressed concern that fuel flow was an indirect measurement and that he would like to see fuel flow compared to torque to understand whether it was an actual fuel flow control problem or a measurement issue. Scott Parke agreed to reevaluate fuel flow.

3.9 Mike Zaiontz commented that if the panel chooses to do nothing about revising QI's, then 1P QI limits would be used. Alternatively, the panel could accept the TMC proposed QI limits with adjustments to fuel flow and inlet air pressure. Jim McCord made a motion to retain 1P limits for the time being. Scott Parke reiterated the importance of revising the QI limits to provide discrimination in process control capabilities. Mike Griggs suggested that a two tier system to evaluate process control capability could strike a compromise between the differing viewpoints. He explained that one tier would maintain tight QI limits to provide discrimination but a second tier would use a more relaxed limit representative of acceptable control. Labs that experience negative QI's in tier one would be compelled by procedure to investigate possible causes for degraded process control but would not have to address test validity. QI's that are negative in the second tier would require the labs to make a validity assessment.

3.10 Jim McCord modified his motion as follows so that more information could be gathered concerning QI's;

Continue with the 1P alpha and beta constants for QI calculations and simultaneously calculate QI's using the TMC proposed alpha and beta constants for all reference and candidate tests until about May 1, 2002.

The motion carried 7/0/0.

4.0 CAT 1R CYLINDER LINER WEAR STEP

4.1 Mike Zaiontz reported that the Mack T-10 Liner Wear Step task force agreed that wear step measurements would be done using the Precision Devices Incorporated (PDI) instrument. He reminded the panel that the 1R test adopted the T-10 method but uses only 4 of the 12 points measured and that 1R wear step is to be reported in millimeters.

4.2 Several panel members felt that liner wear in the 1R test was low and questioned the value of the measurement. The panel consensus was to continue with the measurement.

4.3 Mike Griggs asked the panel if TGA soot and IR oxidation were still of value since those analyses were adopted specifically for the 1Q-EGR test. Al Hahn commented that they were still important as a troubleshooting tool. The panel generally agreed with Al but thought 6 TGA measurements, particularly early in the test, were of little value. The panel agreed to take TGA's at 360, 432, and 504 test hours. The IR oxidation analyses remain unchanged.

4.4 Jim McCord asked the panel for clarification on the requirement to take additional 30 ml oil samples for ICP analysis. The panel agreed that labs are to take a 30 ml oil sample at off sample hours using the published purge procedures. The ICP analysis of the sample is optional.

5.0 CAT 1R PROCEDURE/TEST REPORT FORMAT/DATA DICTIONARY

5.1 Ben Weber gave the panel a brief overview of progress towards the 1R procedure. He commented that an electronic version of the procedure had been e-mailed to the panel members. Ben also stressed that timely inputs from panel members, prior to the procedure review with Lyle Bowman, was optimal for a successful ballot.

5.2 The panel proceeded with a page by page review of the procedure version issued January 2002. Changes are as follows:

5.3 *Section 6. Apparatus and Installation* – Delete the name "Edward Lupie" in footnote 19

5.4 *Section 6.2.2.1 1Y3976 Exhaust Barrel* – Change text to allow the use of ASME coded exhaust barrels without specifying modification details. The panel noted that only one of the Caterpillar approved barrel manufactures has made the barrel modification.

5.5 *Section 6.2.5 Engine Oil System* – Delete requirement to measure oil pressure delta and remove the parameter from the data dictionary/test report. Labs may continue to measure oil pressure delta if desired.

5.6 *Section 7.4 Dispersant Engine Cleaner* – The panel agreed to eliminate the use of dispersant engine cleaner based a consensus that Stoddard solvent alone is effective. Delete footnote 27 (dispersant engine cleaner supplier) and change Table A9.1 Flushing Instruction Sheet.

5.7 *Section 7.14 Stoddard Solvent* – Ben Weber questioned the panel as to whether there were different versions of Stoddard Solvent in use. Mike Griggs agreed to look at specification D235 Part I to determine the Stoddard solvent requirements.

5.8 *Section 8.1 Oil Samples and Additions* – Add text to reflect requirement to take 30 ml samples at each off sample interval (72, 108, 180, 216, 288, 324, 396, 468 hours). A purge is required (60 ml purge was accepted during the 2-7-02 SCOTE teleconference). Analysis of the sample is at the lab's discretion. Secretary's note- Subsequent to this meeting, Jim McCord advised that the intent of this procedure included replacing the 30 ml sample with an equivalent weight of new oil.

5.9 *Section 9.2 Complete Engine Inspection* – Labs are required to perform a major engine inspection prior to the first calibration test scheduled after 15,000 test hours. This requirement precludes interruption of a reference cycle. Also, test hours are easier to track than total engine time.

5.10 *Section 7.12 REO 217* – Delete requirement to use REO 217 oil when any copper components are changed. Jim McCord advised the panel the Mike Zaiontz had a rocker pin failure with a part identified with the new specified date code on the box.

5.11 *Section 9.7 Cylinder Head* – Several panel members expressed concern about the requirement to recalibrate a stand anytime the head or jug is replaced. Al Hahn stressed the importance of keeping the head and jug together as an assembly. The panel compromised on the following: In the event of a cylinder head or jug failure during the calibration period, a previously calibrated cylinder head/jug assembly that has been used on a successful 1R calibration test within the past 2 years may be used without recalibration.

5.12 *Section 9.13 Engine Timing* – The ECM EPROM part number (Personality Module Part Number) is 169-5028. The EPROM release date is October 1998.

5.13 *Section 10.3 Coolant Flow* – Add text allowing calibration of the Barco venturi to ensure that it still conforms to the published calibration. This is an alternative to replacing the venturi.

5.14 *Section 10.5 Air Flow* – The Sierra Model 780 air flow meter was specified for the 1P procedure and, without modification, has insufficient air flow measuring capacity at 1R conditions. Jim McCord mentioned that the air flow meter can be upgrade to measure higher air flows. He suggested that the upper span range be set around 425 kg/hr. Jim agreed to supply labs with details of the upgrade as well as his local vendor information.

5.15 *Section 10.9 Test Stand Calibration* – Change the calibration period from 365 days to 1 year. Secretary's note- Section 13.3.3 should reflect a 1 year calibration period rather than nine months.

5.16 *Section 10.9.1 Re-calibration Requirements* – Change paragraph 4 to specify "cylinder head or jug not meeting the requirements specified in Section 9.7".

5.17 *Section 11.1 Engine Break-in Procedure* – Record the oil weight in the oil scale as the full mark at the end of the fourth hour.

5.18 *Section 11.6.1 Engine Coolant* – Delete the last sentence regarding removal of the coolant tower cap.

5.19 *Section 12.1 Test Validity* – Mike Griggs questioned if there was a limit to the copper level in the oil. Scott Parke replied that limits don't exist for any of the Cat tests but labs have the discretion to invalidate tests with high copper.

5.20 *Section 12.2.2 Oil Consumption* – Include text to reflect the requirement to calculate the difference between end of test oil consumption (average of 468 and 594 hour data points) and the initial average oil consumption (0-252 hour interval).

5.21 *Section 12.2.3.4 Weighted Average* – Change "128" to "12" in the weighted average equation (eq. 2).

5.22 *Table A2.1 Instrument Locations* – Designate oil filter pressure delta instrument locations as optional.

5.23 *Table A2.4 Maximum Allowable System Time Constants* – Ben Weber requested the labs to verify that the oil weigh scale time is between 20 –30 seconds.

5.24 *Table A2.5 Measurement and Reporting Resolutions* – The usefulness of the "tolerance" (tol.) column was questioned in view of QI requirements. Mike Griggs commented that tolerances are useful to define design requirements.

5.25 *Table A2.6 Quality Index Calculation Values* – Replace quality index L and U values with α (alpha) and β (beta), respectively. Secretary's note- Scott Parke no longer requires labs to send exhaust back pressure data from the matrix tests.

5.26 *Table A6.3 Oil Sampling Procedure* – The sampling procedure needs to include the requirement to take 30 ml samples at oil add intervals where the 120 ml samples are not required. The 30 ml sample should be replaced with an equivalent weight of new oil.

5.27 *A7.2 Example of Fax Copy* – Change "P" to "R" in "1P" and "WDP" (4 places).

5.28 *Figure A9.4 Modifications of Engine Side Covers I* – Add actual dimensions in place of "TBD"

5.29 *Table A10.1 Warm-up, Cool-down & Testing Conditions* – In the fuel rack position number, move the decimal point one place to the right for each test step (e.g. 10.6 becomes 106). Delete the “mm” for the units. Coolant flow tolerance is changed from ± 3 to ± 2 L/min. Add a ± 1 kPa tolerance to exhaust back pressure.

5.30 *A11. Piston and Liner Rating Modifications* – Change “1P” to “1R” in the first sentence. Substitute a drawing of the 1R piston for the 1P piston shown.

6.0 CAT 1R HIGH COPPER

6.1 Jim McCord reported that PerkinElmer had recently experienced a rocker pin failure that resulted in high copper.

6.2 The pin failure occurred on a rocker assemble that came from a box with a package date after January 2000. Rocker arms with a package date earlier than January 2000 are not allowed to be used. Following a brief discussion on package date codes, there was speculation as to whether the package date code on the problematic rocker arm was accurate (i.e. wrong box).

7.0 CAT 1R CALIBRATION OIL 1005-1 TARGETS

Scott Parke advised the panel the he had e-mailed information regarding the test targets that were set for the first 20 test. There were no questions or issues on this.

8.0 CAT 1R PC-9 CALIBRATION OIL (OIL A) AVAILABILITY

Scott Parke reported that PC-9 oil A is now available.

9.0 CAT 1R RESEARCH REPORT STATUS

Al Hahn advised the panel that Dave Tharp will take care of the research report.

10.0 CAT 1M-PC SEVERITY / CORRECTION FACTOR EVALUATION

10.1 Chairman Zaiontz reconvened the panel Thursday, January 24th at 08:30 to open discussions on 1M-PC severity and the evaluation of an industry correction factor.

10.2 Scott Parke presented attachment 6 which is a 1M-PC Statistical Analysis Summary that examines the various interactions between lab, hardware and chronology on deposits. His analysis (based on a 0.05 P value) concluded the following:

Demerits have changed at era 2-1-98 cutoff. Back in 1998, the panel elected to let lab severity adjustments take care of severity.

The data shows TGF and WTD to be liner dependent. Scott Parke cautioned the panel against drawing conclusions regarding liner dependency because there actually may be a time dependency. When the pre-1998 data is disregarded, then the WTD liner dependency disappears but TGF dependency remains.

TGF and WTD dependency on labs disappears when the pre-1998 data is disregarded.

TGF is dependent on era 10-1-95 cut off.

Scott Parke concluded that while a TGF correction factor based on liner is warranted, the TMC could not advocate a WTD industry correction factor from a purist standpoint because no link to a cause could be found. He commented that, in hindsight, it was probably a mistake for the panel to be content with not finding the cause for the 1998 WTD severity shift.

10.3 Ed Outten presented RSI candidate data (EWMA plots) for WTD and TGF (attachment 9, pages 15-16) to show the effect of severity adjustments.

10.4 Scott Parke asked the panel what do we do to fix the problem. Bob Campbell responded by presenting attachment 10 which is his 1M-PC industry correction factor proposal. He pointed out that labs were passing 7% fewer references with the new liners and that the percentage of "OC" tests failing has increased for TGF and WTD. Bob proceeded to show the difference between the current TGF and WTD targets and the current statistics on the new liner runs (n=28). His data showed that the new liner runs were 43.2 demerits and 18 TGF percent more severe than current targets. Bob proposed that the panel institute immediately an industry correction factor on WTD and TGF for all tests run on 1Y3995 liners using a WTD correction factor of -43.2 and a TGF correction factor of -18.

10.5 Following Bob Campbell's presentation, there was lengthy discussion on the relative severity between labs. Ed Outten presented attachment 9, pages 5 and 6, to show that lab B exhibited the largest shift in TGF. Mike Zaiontz presented attachment 11 (current lab severity adjustments) and pointed out that lab B was most severe on TGF. Bob Campbell suggested to the panel that the lab severity adjustments currently in place are the clues to the need for WTD and TGF correction factors. Scott Parke added that all labs have TGF severity adjustments in the same direction.

10.6 Scott Parke presented attachment 7 which is the industry operationally valid data. He described two options for applying correction factors. The first option is to apply a minimum correction factor of –10.5 for TGF and –32.99 to correct to the EWMA action limit. Mike Zaiontz expressed a concern that this would penalize labs near target. The second option suggested by Scott was to correct back to target using correction factors of –17.9 for TGF and –40.9 for WTD.

10.7 Scott Parke proceed to show the panel the specific lab affects of applying the maximum correction factors (attachment 8). He explained that by applying the correction factors, labs are returned to target with the exception of lab B. Lab B would still have a TGF lab severity adjustment of –12 due to being the most severe. Ben Weber commented that he feels that Lab B may be showing a lab affect. Scott Parke pointed out that the relative positions of the labs did not change with the correction factors applied. Scott Parke summarized his presentation with attachment 11 which compares lab severity adjustments with and without the correction factors. Ben Weber reiterated his concern that Lab B, which has a –12 TGF severity adjustment after the correction factor is applied, is showing a lab affect.

10.8 Ed Outten offered an additional proposal to the 1M-PC severity issue by suggesting that the test should be declared out of control. Al Hahn questioned where this would lead to. He asked the panel what approach can be used to fix the problem and added that nothing more could be done to improve the new liners. There followed lengthy discussions regarding the implications of declaring a test out of control. It was brought out that one implication was that ACC registered testing stops under an out of control status. Also, several members voiced skepticism towards bringing the test back into control.

10.9 Scott Parke summarized the situation saying that we see every lab, without exception, being severe and that we need to find a tangible cause for the severity or arbitrarily assign correction factors. A third option would be to continue to let lab severity adjustments do the job as decided in 1998. He commented that he would like to see a tangible cause assigned (i.e. "what happened in 1998"). His second choice would be to arbitrarily assign correction factors.

10.10 Scott Parke advised the panel that new reference oil (873-2) is coming on line and that he does not expect any oil component changes. There is about a years supply (approximately 30 tests) of the 873-1 batch. When the new oil is in place, new test targets will be calculated. This effectively makes the current severity problem go away. Mike Zaiontz and Ben Weber suggested that this is a good opportunity to transition to a more modern oil such as a mutigrade. Bob Campbell added that this suggestion should be forwarded to the HDEOCP. Ed Outten suggested that TMC oil 811 (10W40), which is a borderline pass oil in the 1G2 test, might be one step closer to a more acceptable oil. He acknowledged that it is not ideal but should be acceptable in the 1M-PC. Ben

Weber suggested that Mike Zaiontz contact potential oil suppliers for alternative oils.

10.11 Following a brief recess, Mike Zaiontz advised the panel the several representatives from other stakeholders were missing from the discussions. He recommended that an e-mail ballot be sent out and that a conference call be held. A conference call was scheduled for 2-7-02 at 13:00 CST. Mike Zaiontz agreed to proceed with the request for a new oil. Ed Outten mentioned that the HDEOCP would choose the oil.

10.12 Mike Zaiontz summarized the following proposals that would be communicated in his e-mail:

1) Apply the correction factors (i.e. 17.9 and 40.9) as shown in attachment 11
2) Apply the minimum correction factor (i.e. 10.5 and 32.99)
3) Declare the test out of control
4) Do not use correction factors but retain individual lab severity adjustments

10.13 Ben Weber suggested that a panel action should be to review labs as well as go through rebuilds. He suggested the formation of a lab visitation group. Scott Parke commented that this was done in 1998. Ben recommended that this be done on a recurring basis.

11.0 OLD/NEW/OTHER SCOTE BUSINESS

Scott Parke announced that Cat 1R oil A (TMC 820-2) targets exist based on the 7 matrix tests and that they are in the LTMS manual.

Secretary's note: TMC 820-2 statistics are:
WD- 341.2 mean, 36.2 sd
TGC- 34.11 mean, 10.28 sd
TLC- 22.82 mean, 10.50 sd
Initial OC- 8.3 mean, 1.7 sd
EOT OC- 7.9 mean, 2.6 sd

12.0 NEXT MEETING

The next meeting will be via teleconference on February 7, 2002 at 13:00 CST.

Att1 1/5

SCOTE SURVEILLANCE PANEL
Attendance Roster

*** Please indicate any corrections that should be made to members name, address, etc ***

Member	status	Indicate Presence with Signature	Alternate
Name: Albert, Floyd Company: Equilon Enterprises LLC Address: Room #L 121B 3333 Highway 6 South Houston, TX 77082 Phone: 713-544-8055 Fax: 713-544-7732 :-mail: fealbert@equilontech.com	NV		
Name: Bond, Stacy Company: PerkinElmer Address: 5404 Bandera Road San Antonio, TX 78238 Phone: 210-523-4604 Fax: 210-523-4607 e-mail: stacy.bond@perkinelmer.com	NV		
Name: Buck, Ron Company: Test Engineering, Inc. Address: 127 18 Cimarron Path San Antonio, TX 78249-3417 Phone: 210-690-1958 Fax: 210-690-1959 e-mail: rbuck@testeng.com	NV		
Name: Burnett, Don Company: Chevron Phillips Chem. Co. LP Address: 1301 McKinney St. #2310 Houston, TX 77010-3030 Phone: Fax: e-mail: deburne@ppco.com	NV		
Name: Campbell, Bob Company: Ethyl Corporation Address: 500 Spring Street P.O. Box 2158 Richmond, VA 23219 Phone: 804-788-5340 Fax: 804-788-6358 e-mail: bob_campbell@ethyl.com	V		
Name: Carlson, Jon Company: Lubrizol Corporation Address: 4801 N.W. Loop 410, Ste. 430 San Antonio, TX 78229 Phone: 210-520-8013 Fax: 210-520-1983 e-mail: jomc@lubrizol.com	NV		
Name: Sutherland, Mark Company: Oronite Technology Group Address: Chevron Chemical Company 4502 Centerview Ste. 210 San Antonio, TX 78228 Phone: 210-731-5606 Fax: 210-731-5699 e-mail: @chevron.com	V		

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SCOTE SURVEILLANCE PANEL
Attendance Roster

*** Please indicate any corrections that should he made to members name, address, etc ***

Member	Status	Indicate Presence with Signature	Alternate
Name: Fetterman. Pat Company: Infineuum, USA L.P. Address: PO Box 735 Linden, NJ 07036 Phone: 908-474-3099 Fax: 908-474-3363 e-mail: pat.fetterman@infineum.com	V	E.F. Outten for Pat Fetterman	
Name: Griggs, Mike Company: The Lubrizol Corporation Address: 29400 Lakeland Blvd. Wickliffe, OH 44092.2298 Phone: 440-347-2905 Fax: 440347-4096 e-mail: msg@lubrizol.com	V	MS Griggs	
Name: Gutzwiller, Jim Company: Infineum Address: 4335 Piedras Dr., W. Suite 101 San Antonio, TX 78228 Phone: 210-732-8123 ext. 13 Fax: 210-732-8480 e-mail: james.gutzwiller@infineum.com	NV		
Name: Hahn, Al Company: Caterpillar, Inc./Tech Center Address: Bldg. L/P.O. 1875 Peoria, IL 61656-1875 Phone: 309-578-3617 Fax: 309-578-4232 e-mail: hahn_al_c@cat.com	V	AHH	
Name: Riccardo Conti Company: Exxon/Mobil R&E Products Research & Technology Address: 600 Billingsport Road Paulsboro, NJ 08066-0480 Phone: 856-224-2681 Fax: 856-224-3904 e-mail: riccardo.conti@exxonmobil.com	V	R. Conti	
Name: Kennedy, Steve Company: Exxon/Mobil R&E Address: 600 Billingsport Road Paulsboro, NJ 08066 Phone: 856-224-2432 Fax: 856-224-3678 e-mail: steven.kennedy@exxonmobil.com	NV		
Name: McCord, James Company: SWRI Address: 6220 Culebra Rd. San Antonio, TX 78228-0510 Phone: 210-522-3439 Fax: e-mail: jmccord@swri.edu	V	James McCord	

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SCOTE SURVEILLANCE PANEL
Attendance Roster

*** Please indicate any corrections that should be made to members name, address, etc ***

Member	status	Indicate Presence with Signature	Alternate
Name: Nycz, David S. Company: Caterpillar, Inc. Address: Box 610 Mossville, IL 61552-0610 Phone: 309-578-3003 Fax: 309-578-6457 e-mail: nycz_david_s@cat.com	NV		
Name: Parke, Scott Company: ASTM/TMC Address: 6555 Penn Avenue Pittsburgh, PA 15206-4489 Phone: 412-365-1036 Fax: 412-365-1047 e-mail: sdp@tmc.astm.cmri.cmu.edu	V	[signature]	
Name: Passut, Charlie Company: Ethyl Corporation Address: 500 Spring Street P.O. Box 2158 Richmond, VA 23219 Phone: 804-788-6372 Fax: 804-788-6388 e-mail: charles_passut@ethyl.com	NV		
Name: Ralph Perna Company: Equilon Address: Room #MF 104 3333 Highway 6 South Houston, TX 77082 Phone: 713-544-7844 Fax: 713-544-7162 e-mail: rperna@equilontech.com	NV		
Name: Rumford, Robert H. Company: Haltermann Products Address: P.O. Box 429 Channelview, TX 77530-0429 Phone: 832-376-2213 Fax: 281-457-2768 e-mail: rhrumford@haltermann-usa.com	NV		
Name: Rutherford, Jim Company: Chevron Oronite Address: 100 Chevron Way Richmond, CA 94802 Phone: 510-242-3410 Fax: 510-242-1930 e-mail: jaru@chevron.com	NV		
Name: Scinto, Phil Company: The Lubrizol Corporation Address: 29400 Lakeland Blvd. Wickliffe, OH 44092-2298 Phone: 440-347-2161 Fax: 440-347-2014 e-mail: prs@lubrizol.com	NV	Phil, R Scinto	

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SCOTE SURVEILLANCE PANEL
Attendance Roster

(Visitors Page)

Member	Status	Indicate Presence with Signature	Alternate
Name: Stevens, Carl Company: Ashland, Inc. Address: 22nd Front Street Ashland, KY 41101 Phone: 606-329-5198 Fax: 606-329-3009 e-mail: cstephens@ashland.com	NV		
Name: Tharp, David Company: Caterpillar, Inc. Address: Phone: 309-675-6122 Fax: e-mail: tharpde@cat.com	NV		
Name: van Dam, Wim Company: Oronite Additives Division Address: Chevron Chemical Company 100 Chevron Way, 60-1214 Richmond, CA 94802 Phone: 510-242-1404 Fax: 510-242-3172 e-mail: wvda@chevron.com	NV		
Name: Zaiontz, Mike Company: PerkinElmer Address: 5404 Bandera Road San Antonio, TX 78238 Phone: 210-647-9483 Fax: e-mail: mike.zaiontz@perkinelmer.com	V		
Name: Jen Van Mullekom Company: The Lubrizol Corp Address: 29400 Lakeland Blvd Wickliffe OH 44092 Phone: (440) 347-2603 Fax: (440) 347-2014 e-mail: jwht@lubrizol.com			
Name: Ben Weber Company: SwRI Address: Phone: Fax: e-mail: BWeber@SwRI.edu	NV	Ben Weber	
Name: Chris Mazuca Company: Perkin Elmer Address: Phone: Fax: e-mail: Chris.mazuca@perkinelmer.com		Chris Mazuca	

Att! 5/5

SCOTE SURVEILLANCE PANEL
Attendance Roster

(Visitors Page)

Member	status	Indicate Presence with Signature	Alternate
Name: BETO ARAIZA Company: TEST ENGINEERING INC Address: 12718 CIMARRON PATH S. A- TX 78249 Phone: 210-877-0222 Fax: 210 690-1959 e-mail: BARAIZA@TEI-NET.COM	NV	[signature]	
Name: ALFREDO MONTEZ Company: CHEVRON ORONITE Address: Phone: Fax: e-mail: ammn@chevrontexaco.com	✓	[signature]	
Name: Company: Address: Phone: Fax: e-mail:			
Name: Company: Address: Phone: Fax: e-mail:			
Name: Company: Address: Phone: Fax: e-mail:			
Name: Company: Address: Phone: Fax: e-mail			
Name: Company: Address: Phone: Fax: e-mail:			

Att a 1/1

Caterpillar SCOTE Surveillance Panel Meeting

Date/Time: January 232002 (08:30 – 17:00)
January 24, 2002 (08:30 – 12:00)

Location: PerkinElmer Automotive Research
5404 Bandera Road
San Antonio, Texas 78238

AGENDA

Day 1:
Wednesday. January 23 (08:30 – 17:00)

1. Membership

2. Cat 1 R QI Limit Evaluation

3. Cat 1 R Cylinder Liner Wear Step
   Mack T10 Task Force Results

4. Cat 1 R Procedure/Test Report Format/Data Dictionary

5. Cat 1R High Copper
   Lab experience with 2000 year date rocker arms

6. Cat 1R Calibration Oil 1005-I
   Severity and Precision Review for N=20

7. Cat 1R, Availability of PC-9 Category Calibration Oil (Oil A)

8. Cat 1 R Research Report Status

Day 2:
Thursday. Januarv 24.2002 (08:30 – 12:00)

1. Cat 1 MPC Severity
   Evaluation of Industry Correction

2. Other SCOTE Business

Proposed Cat 1R QI Limits

Background

Quality Index (QI) is a mathematical technique of assessing control precision. Like its predecessors, % Off and % Out, QI is a test validity criteria. QI can range from a maximum of 1.0 (perfect control) to negative infinity (poor control). The validity threshold is 0.0. Every controlled parameter has an associated QI. A test with any controlled parameter with a QI < 0.0, at EOT, is subject to be invalid.

Goals

1. Assess control capability of each parameter
2. Reduce -QI false alarms
3. Base QI control limits on a process capability of ≥ 3 sigma

Cat 1R -- PC-9 Matrix
Controlled Parameter Study

Table 1
Process Control Standard Deviation

	Engine Speed (RPM)	Fuel Flow (g/h)	Humidity (g/Kg)	Coolant Flow (L/m)	Coolant (°C)	Oil (°C)	Inlet Air (°C)	Fuel (°C)	Oil (kPa)	Inlet Air (kPaA)	Fuel (kPa)	Exhaust (kPaA)
18 Tests (2 Labs)	0.901	0.408	0.475	1.021	0.183	0.297	0.242	0.353	1.552	0.565	1.225	0.372

Table 2
Process Control Capability

	Engine Speed (RPM)	Fuel Flow (g/h)	Humidity (g/Kg)	Coolant Flow (L/m)	Coolant (°C)	Oil (°C)	Inlet Air (°C)	Fuel (°C)	Oil (kPa)	Inlet Air (kPaA)	Fuel (kPa)	Exhaust (kPaA)
Test Procedure Specification (±)	3.0	1.0	1.7	2.0	3.0	3.0	3.0	3.0	20.0	1.0	20.0	1.0
Parameter Standard Deviation (Table 1)	0.901	0.408	0.475	1.021	0.183	0.297	0.242	0.353	1.552	0.565	1.225	0.372
Process Capability (Spec/Stdev)	**3.3**	**2.5**	**3.6**	**2.0**	16.4	10.1	12.4	8.5	12.9	**1.8**	16.3	**2.7**
6-Sigma Capable?	**N**	**N**	**N**	**N**	Y	Y	Y	Y	Y	**N**	Y	**N**

Att 3 2/3

Cat 1R -- PC-9 Matrix
Controlled Parameter Study

Table 3
Quality Index (QI) Capability

	Engine Speed (RPM)	Fuel Flow (g/h)	Humidity (g/Kg)	Coolant Flow (L/m)	Coolant (°C)	Oil (°C)	Inlet Air (°C)	Fuel (°C)	Oil (kPa)	Inlet Air (kPaA)	Fuel (kPa)	Exhaust (kPaA)
Current QI Control Limit (±)	1.470	1.030	1.020	1.940	0.622	1.202	0.640	1.116	10.616	0.551	3.529	0.850
Process Capability (Limit/Stdev)	**1.63**	**2.52**	**2.15**	**1.90**	3.40	4.05	**2.64**	3.16	6.84	**0.98**	**2.88**	**2.28**
Table 4 Proposed Quality Index (QI) Limits												
Proposed QI Control Limit (±)	**2.703**	**1.224**	**1.424**	**3.061**	OK	OK	**0.725**	OK	OK	**1.694**	**3.675**	**1.117**
Process Capability (Limit/Stdev)	**3.000**	**3.000**	**2.998**	**2.998**	OK	OK	**2.996**	OK	OK	**2.998**	**3.000**	**3.003**

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Coolant Flow

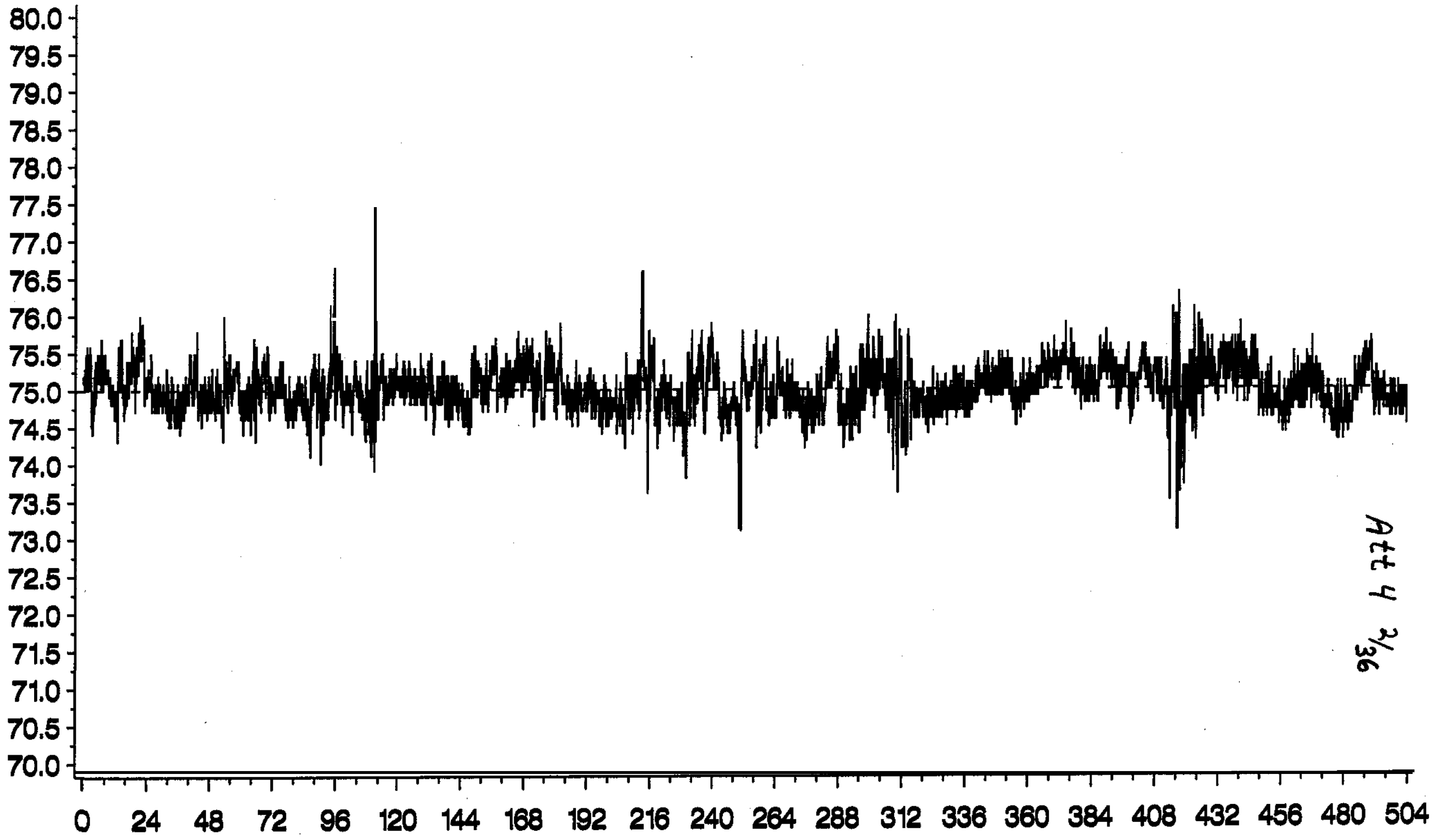
Lab	CMIR	Plot #	Zero test	# of 6 minute data points	QI (using 1P-derived α and β)	Δ (β-α) if this test were zero test	QI (using calculated α and β)
B	41554	1		5039	0.973	0.6397	0.964
B	41547	2		5039	0.963	0.7455	0.951
G	41539	3		5041	0.912	1.1481	0.883
F	41546	4		5040	0.898	1.2389	0.864
A	41573	5		5038	0.881	1.3378	0.842
A	41538	6		5040	0.837	1.5668	0.783
D	41968	7		5040	0.833	1.5865	0.777
G	41542	8		5039	0.832	1.5900	0.776
A	41537	9		5040	0.832	1.5919	0.776
D	41543	10		5040	0.810	1.6913	0.747
A	41760	11		5040	0.795	1.7563	0.727
A	41535	12		5040	0.788	1.7856	0.718
A	41536	13		5040	0.783	1.8078	0.711
G	41761	14		5040	0.735	1.9980	0.647
G	41540	15		5039	0.480	2.7983	0.307
G	41541	16		5039	0.331	3.1727	0.109
G	41570	17		5039	0.253	3.3527	0.005
F	41545	18	*	5040	0.249	3.3618	0.000

	Target	Round to	Spec Min	Spec Max	α	β	Δ (β-α)
1P-Derived Values	75	0.1	70	80	73.06	76.94	3.88
Calculated 1R Values	75	0.1	70	80	73.32	76.68	3.36

Coolant Flow Plot No. 1

ID = 1 QI = 0.964

Number of points plotted = 5039

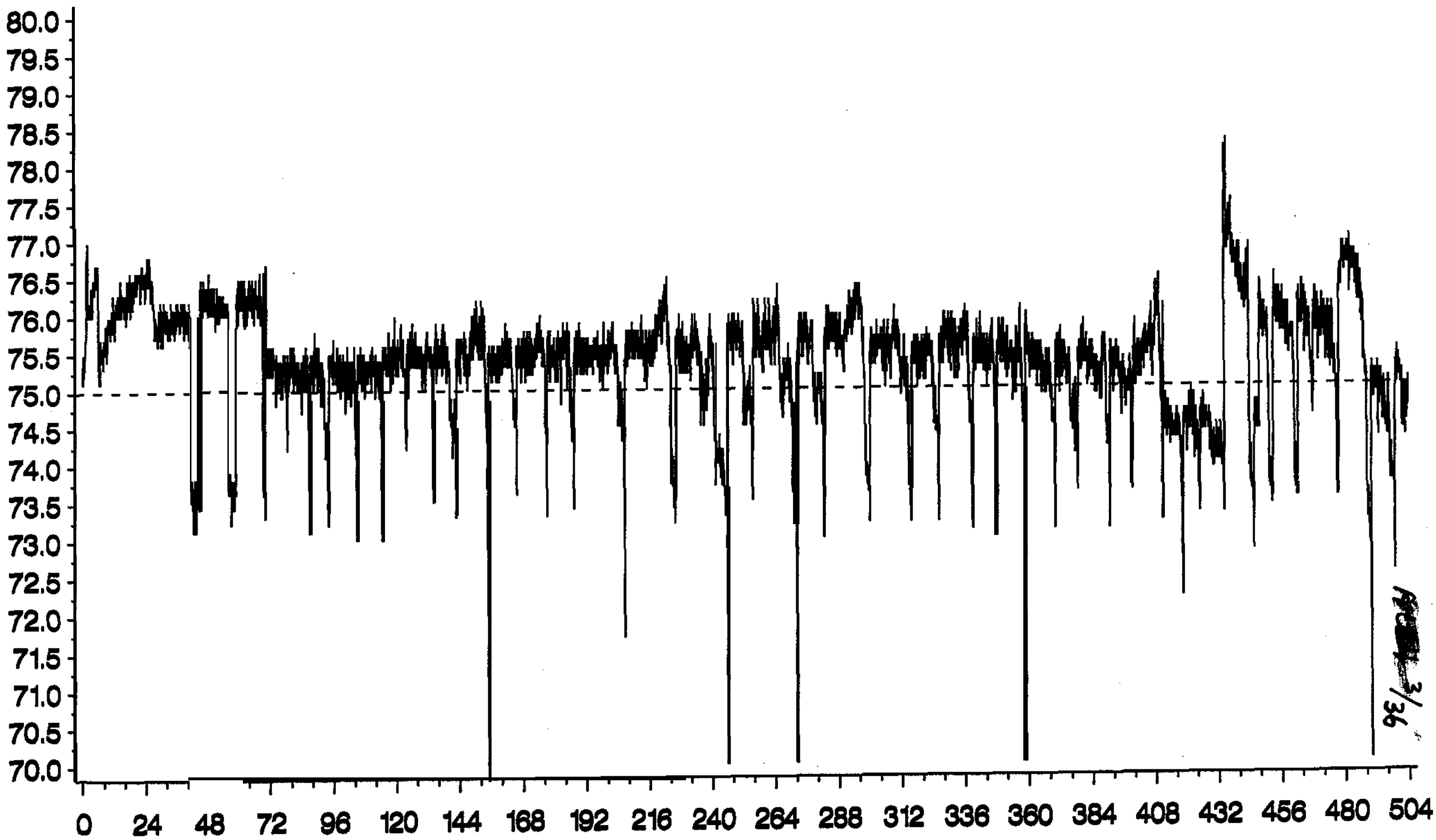


Att 4 2/36

Coolant Flow Plot No. 18

ID = 18   QI = 0.000

Number of points plotted = 5040



Coolant Out Temp

Lab	CMIR	Plot #	Zero test	# of 6 minute data points	QI (using 1P-derived α and β)	Δ (β-α) if this test were zero test	QI (using calculated α and β)
A	41538	1		5040	0.997	0.0731	0.977
A	41536	2		5040	0.989	0.1284	0.928
A	41573	3		5038	0.982	0.1658	0.879
B	41547	4		5039	0.981	0.1701	0.873
B	41554	5		5039	0.980	0.1733	0.868
A	41760	6		5040	0.979	0.1810	0.856
A	41535	7		5040	0.975	0.1942	0.834
A	41537	8		5040	0.962	0.2426	0.741
D	41968	9		5040	0.961	0.2447	0.737
F	41545	10		5040	0.948	0.2835	0.647
F	41546	11		5040	0.943	0.2967	0.613
G	41761	12		5040	0.930	0.3285	0.526
G	41540	13		5039	0.930	0.3287	0.525
G	41541	14		5039	0.921	0.3496	0.463
G	41542	15		5039	0.919	0.3535	0.451
G	41570	16		5039	0.908	0.3751	0.382
G	41539	17		5041	0.858	0.4680	0.038
D	41543	18	*	5040	0.852	0.4771	0.000

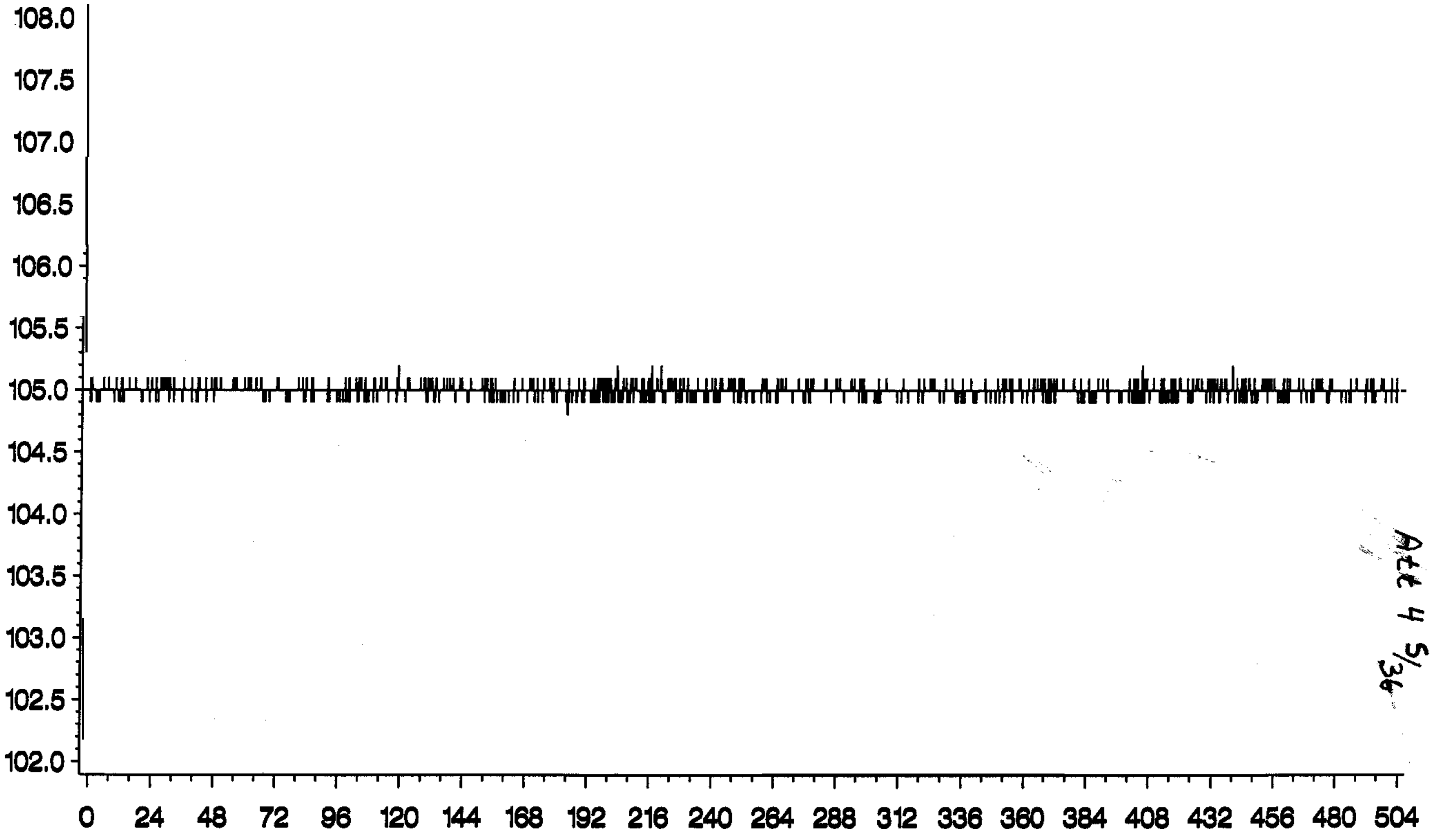
	Target	Round to	Spec Min	Spec Max	α	β	(β-α)
1P Derived Values	105	0.1	102	108	104.38	105.62	1.24
Calculated 1R Values	105	0.1	102	108	104.77	105.24	0.47

Att 4 4/36

Coolant Out Temp Plot No. 1

ID = 1 QI = 0.977

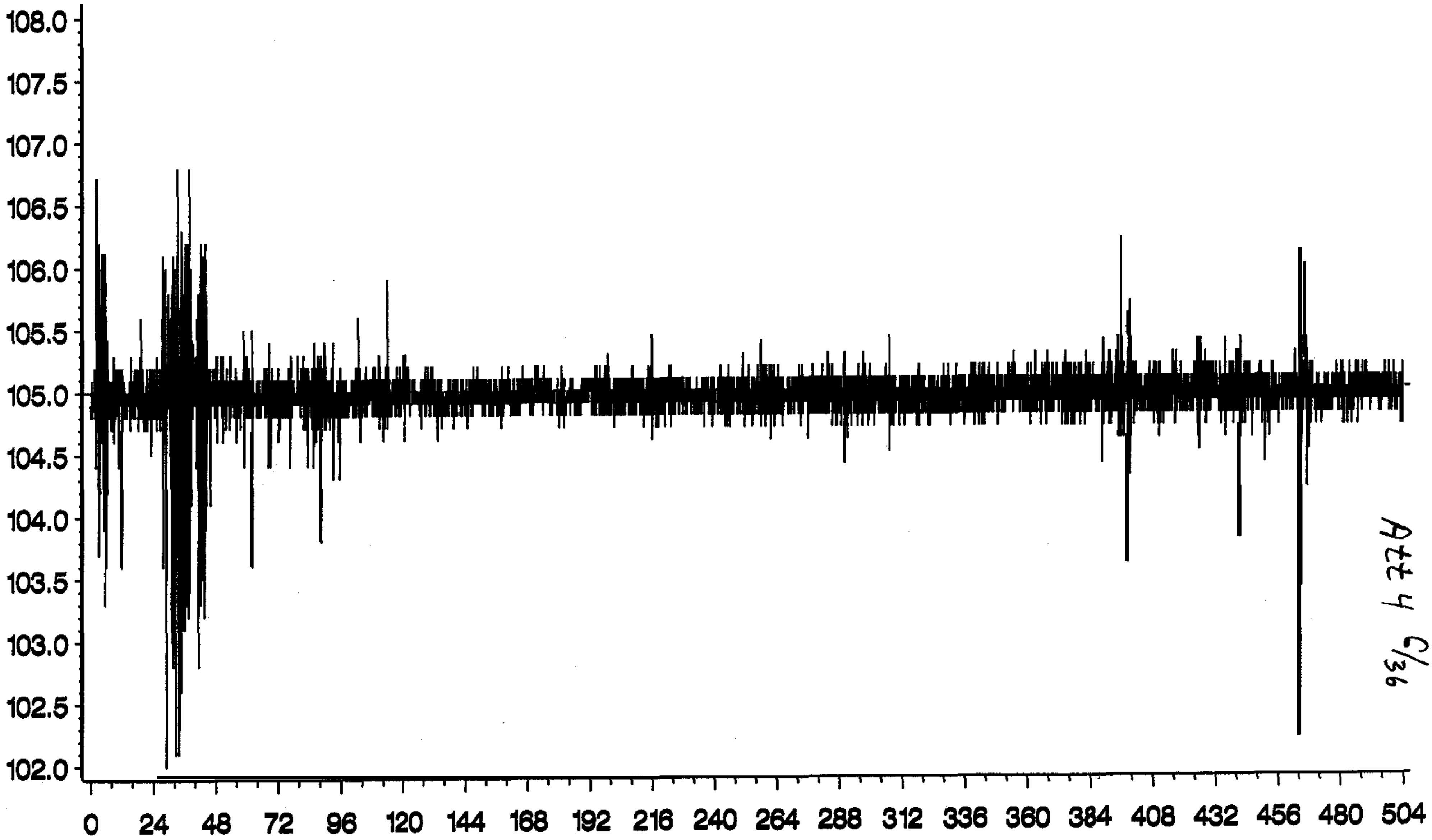
Number of points plotted = 5040



Coolant Out Temp Plot No. 18

ID = 18 QI = 0.000

Number of points plotted = 5040



Fuel Flow

Lab	CMIR	Plot #	Zero test	# of 6 minute data points	QI (using 1P-derived α and β)	Δ (β-α) if this test were zero test	QI (using calculated α and β)
G	41542	1		5039	0.973	0.3397	0.938
B	41554	2		5039	0.967	0.3761	0.924
G	41570	3		5039	0.942	0.4967	0.868
B	41547	4		5039	0.942	0.4971	0.868
A	41573	5		5038	0.925	0.5649	0.829
G	41541	6		5039	0.912	0.6114	0.800
A	41535	7		5040	0.902	0.6445	0.778
A	41536	8		5040	0.876	0.7257	0.718
F	41545	9		5040	0.871	0.7393	0.708
A	41538	10		5040	0.852	0.7913	0.665
A	41760	11		5040	0.846	0.8072	0.652
F	41546	12		5040	0.828	0.8535	0.610
A	41537	13		5040	0.772	0.9843	0.482
G	41540	14	*	5039	0.559	1.3676	0.000
G	41539	15		5041	0.374	1.6294	-0.419
D	41968	16		5040	0.248	1.7862	-0.706
D	41543	17		5040	0.144	1.9054	-0.941
G	41761	18		5040	-2.084	3.6178	-5.998

	Target	Round to	Spec Min	Spec Max	α	β	Δ (β-α)
1P-Derived Values	240	0.1	239	241	238.97	241.03	2.06
Calculated 1R Values	240	0.1	239	241	239.32	240.69	1.37

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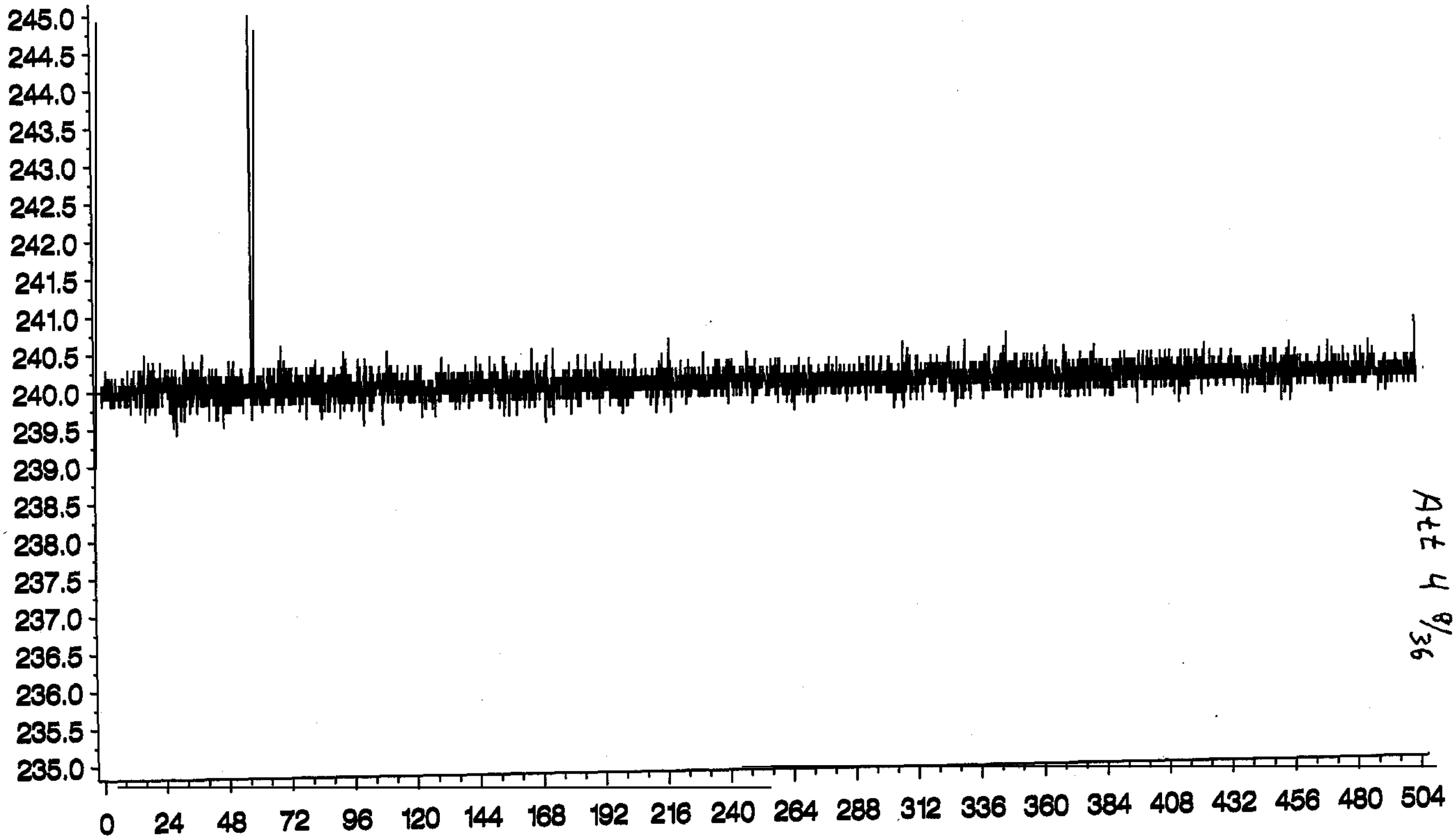
Fuel Flow Plot No. 1

ID = 1 QI = 0.938

Number of points plotted = 5039



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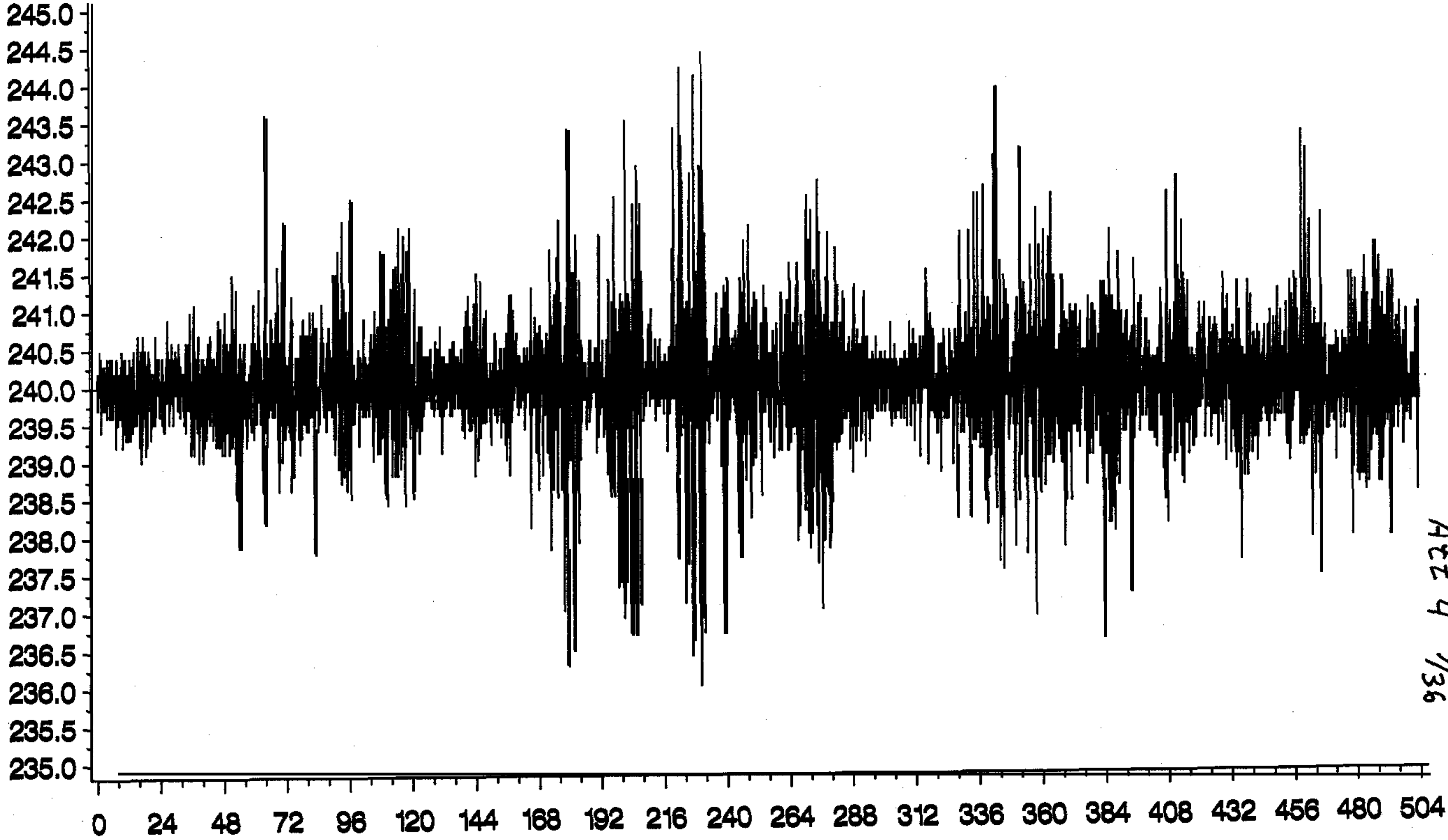
Fuel Flow Plot No. 14

ID = 14 QI = −0.002

Number of points plotted = 5039



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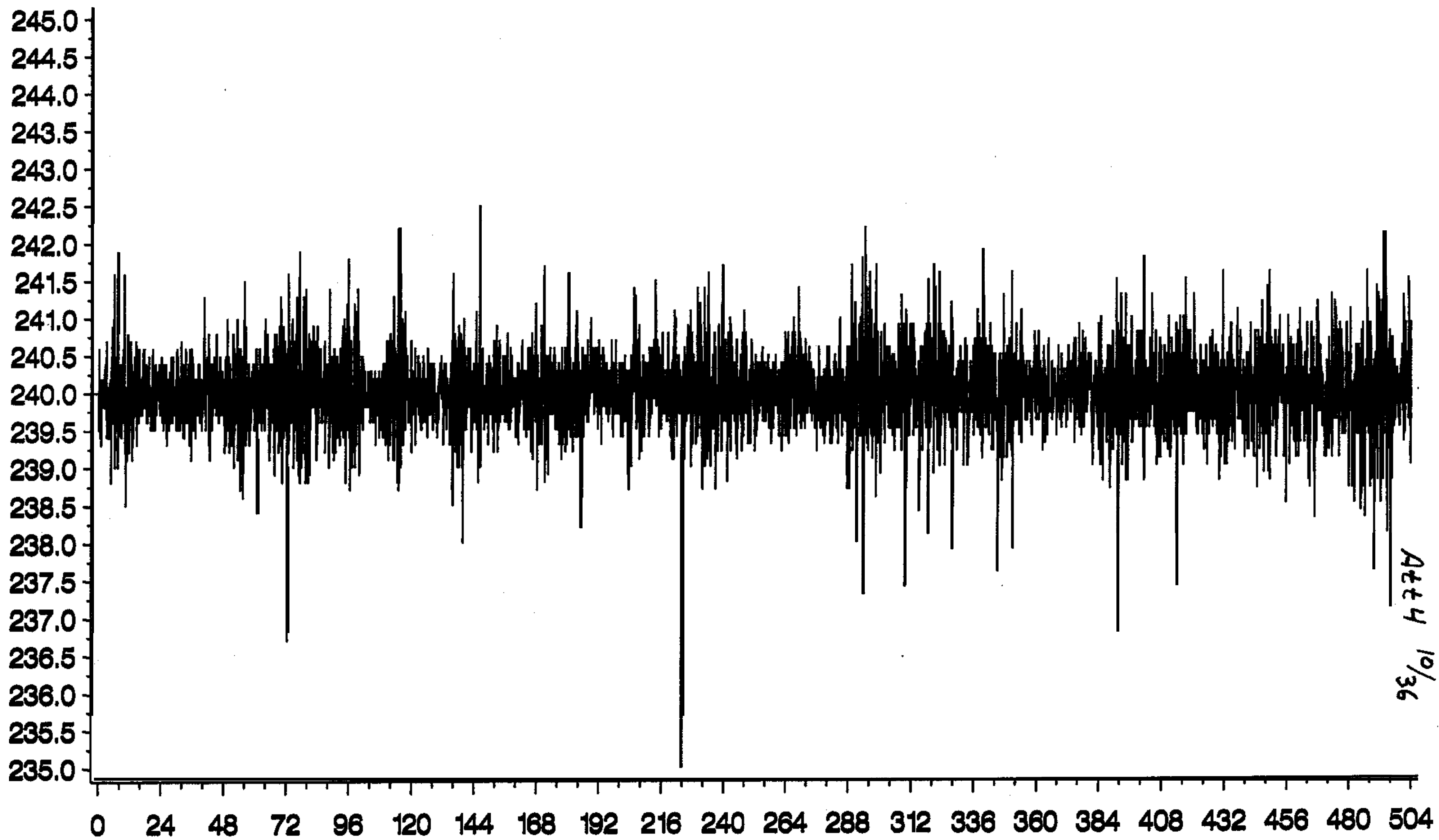
Fuel Flow Plot No. 18

ID = 18   QI = −6.014

Number of points plotted = 5040



Fuel Temp

Lab	CMIR	Plot #	Zero test	# of 6 minute data points	QI (using 1P-derived α and β)	Δ (β-α) if this test were zero test	QI (using calculated α and β)
B	41547	1		5039	0.997	0.1272	0.996
G	41542	2		5039	0.991	0.2100	0.989
G	41539	3		5041	0.990	0.2282	0.988
D	41968	4		5040	0.985	0.2698	0.983
G	41541	5		5039	0.985	0.2729	0.982
B	41554	6		5039	0.983	0.2903	0.980
G	41570	7		5039	0.982	0.2966	0.979
D	41543	8		5040	0.977	0.3385	0.973
A	41538	9		5040	0.959	0.4536	0.951
F	41545	10		5040	0.951	0.4933	0.942
A	41535	11		5040	0.945	0.5224	0.935
F	41546	12		5040	0.942	0.5383	0.931
A	41537	13		5040	0.886	0.7541	0.864
A	41573	14		5038	0.869	0.8064	0.844
G	41540	15		5039	0.682	1.2575	0.622
A	41760	16		5040	0.541	1.5109	0.454
G	41761	17		5040	0.323	1.8350	0.194
A	41536	18	*	5040	0.160	2.0443	0.000

	Target	Round to	Spec Min	Spec Max	α	β	Δ (β-α)
P-Derived Values	42	0.1	39	45	40.89	43.12	2.23
Calculated IR Values	42	0.1	39	45	40.98	43.02	2.04

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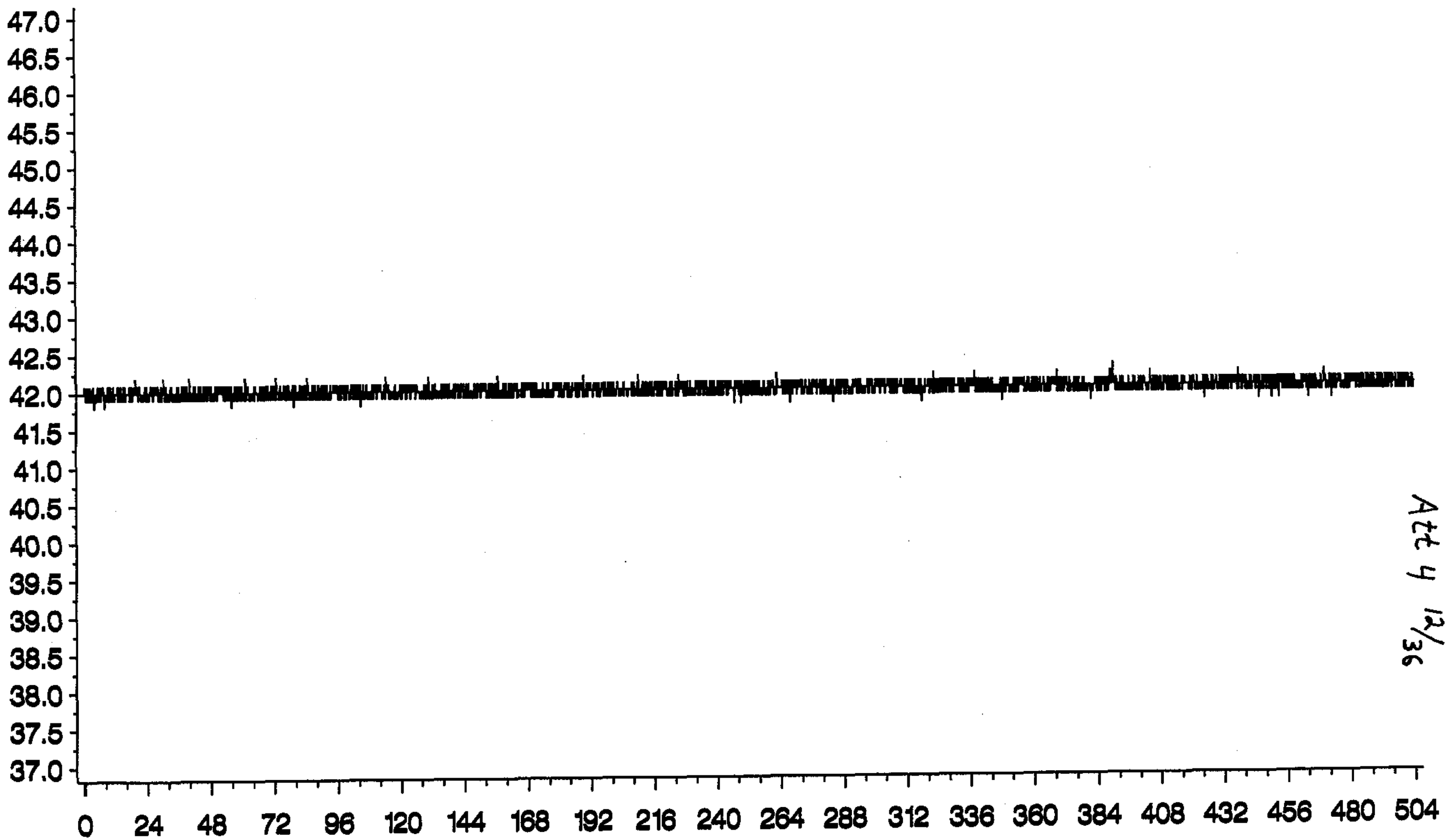
Fuel Temperature Plot No. 1

ID = 1 QI = 0.996

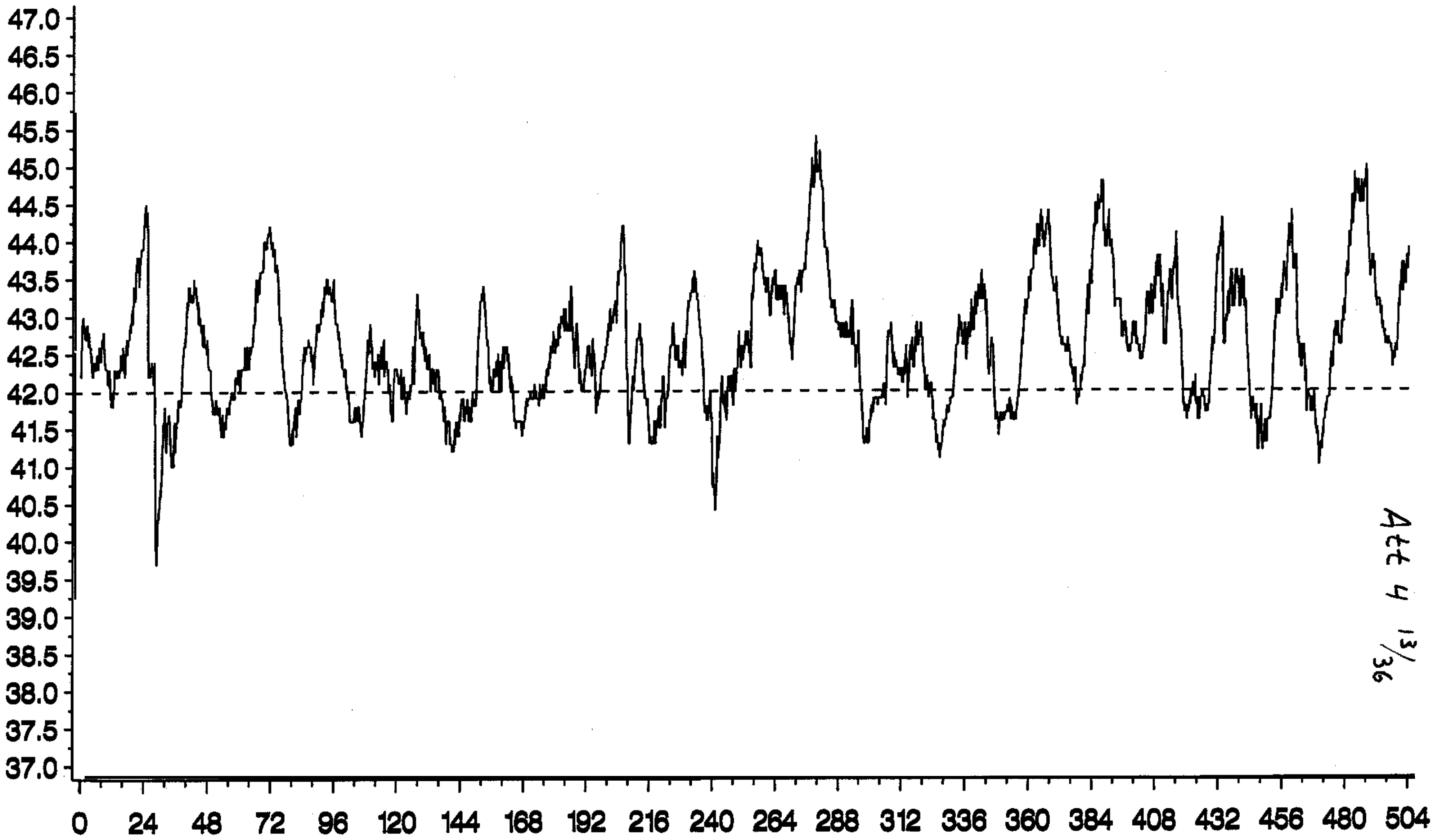
Number of points plotted = 5039



Fuel Temperature Plot No. 18

ID = 18 QI = −0.000

Number of points plotted = 5040



Fuel Pressure

Lab	CMIR	Plot #	Zero test	# of 6 minute data points	QI (using 1P-derived α and β)	Δ (β-α) if this test were zero test	QI (using calculated α and β)
B	41554	1		5039	0.945	1.6590	0.914
B	41547	2		5039	0.943	1.6844	0.911
D	41543	3		5040	0.937	1.7766	0.901
A	41535	4		5040	0.905	2.1738	0.852
A	41573	5		5038	0.885	2.3976	0.820
A	41537	6		5040	0.882	2.4244	0.816
D	41968	7		5040	0.873	2.5114	0.803
A	41536	8		5040	0.853	2.7036	0.771
A	41538	9		5040	0.827	2.9333	0.731
G	41539	10		5041	0.810	3.0797	0.703
G	41542	11		5039	0.804	3.1226	0.695
G	41761	12		5040	0.797	3.1818	0.684
G	41540	13		5039	0.759	3.4657	0.625
G	41570	14		5039	0.745	3.5637	0.603
G	41541	15		5039	0.742	3.5855	0.598
A	41760	16		5040	0.706	3.8257	0.542
F	41546	17		5040	0.650	4.1768	0.455
F	41545	18	*	5040	0.358	5.6558	0.000

	Target	Round to	Spec Min	Spec Max	α	β	Δ (β-α)
1P-Derived Values	275	1	255	295	271.47	278.53	7.06
Calculated 1R Values	275	1	255	295	272.12	277.81	5.61

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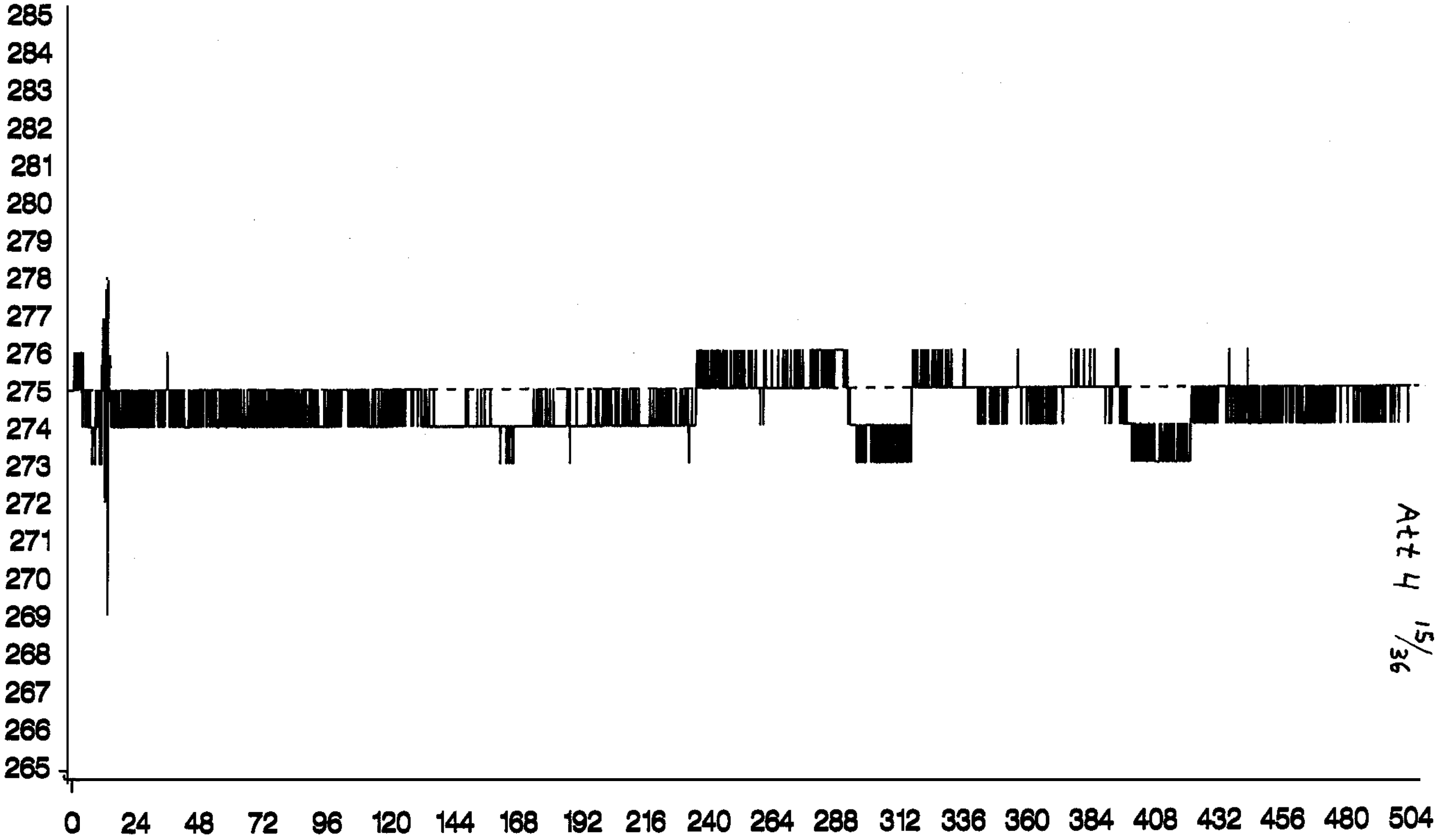
Fuel Pressure Plot No. 1

ID = 1   QI = 0.913

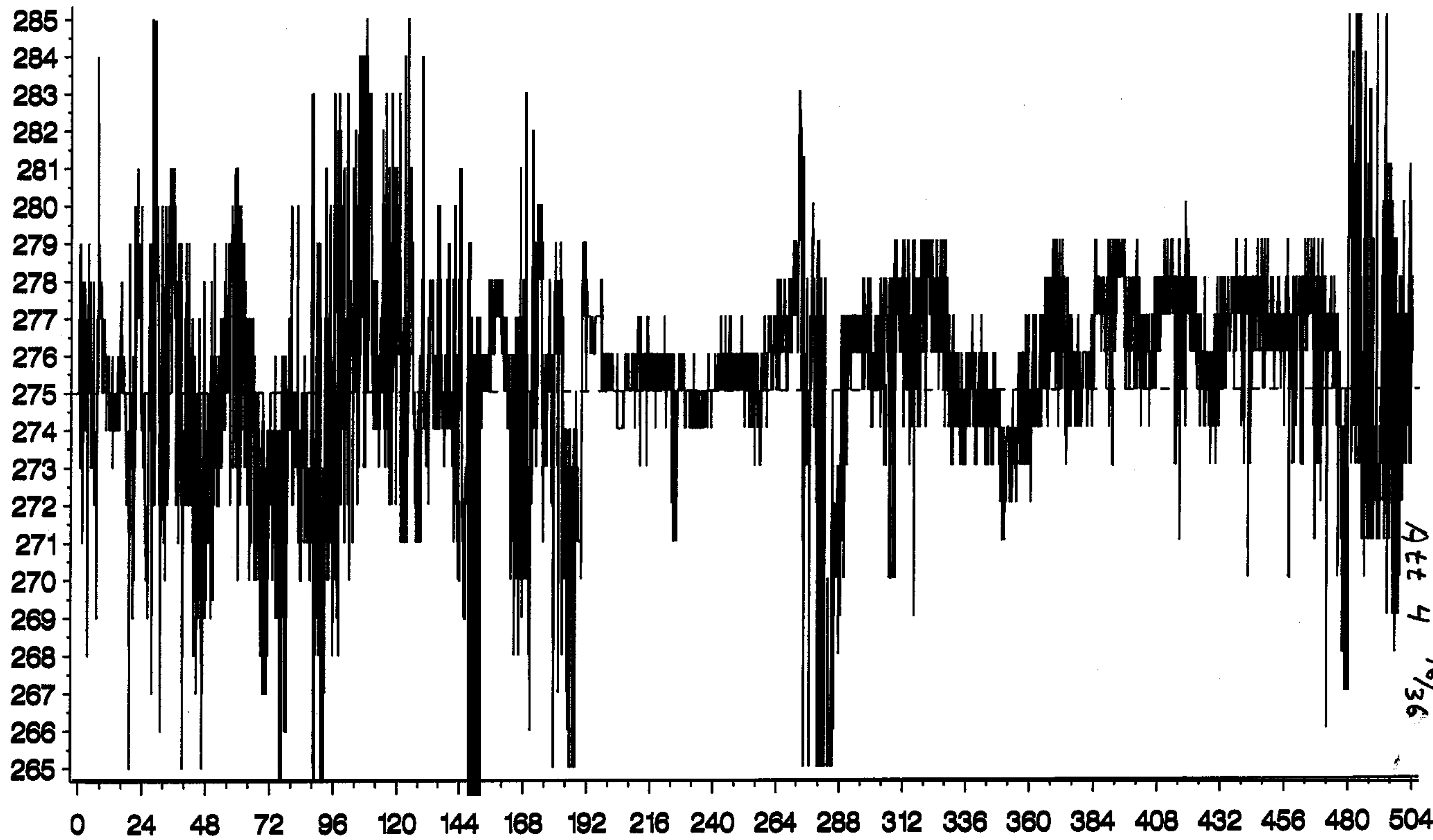
Number of points plotted = 5039



Fuel Pressure Plot No. 18

ID = 18 QI = −0.016

Number of points plotted = 5040



Humidity

Lab	CMIR	Plot #	Zero test	# of 6 minute data points	QI (using 1P-derived α and β)	Δ (β-α) if this test were zero test	QI (using calculated α and β)
F	41546	1		5040	0.983	0.2681	0.961
F	41545	2		5040	0.972	0.3390	0.938
B	41547	3		5039	0.966	0.3746	0.925
B	41554	4		5039	0.924	0.5632	0.830
G	41541	5		5039	0.917	0.5889	0.814
G	41540	6		5039	0.916	0.5913	0.813
G	41539	7		5041	0.916	0.5929	0.812
A	41538	8		5040	0.807	0.8972	0.569
A	41573	9		5038	0.806	0.8976	0.568
A	41760	10		5040	0.804	0.9040	0.562
G	41761	11		5040	0.770	0.9793	0.486
G	41542	12		5039	0.769	0.9802	0.485
G	41570	13		5039	0.767	0.9849	0.480
D	41968	14		5040	0.584	1.3165	0.072
A	41537	15		5040	0.566	1.3434	0.033
A	41536	16		5040	0.566	1.3446	0.032
A	41535	17		5040	0.557	1.3581	0.012
D	41543	18	*	5040	0.551	1.3663	0.000

	Target	Round to	Spec Min	Spec Max	α	β	Δ (β-α)
1P-Derived Values	17.8	0.1	16.1	19.5	16.78	18.82	2.04
Calculated 1R Values	17.8	0.1	16.1	19.5	17.12	18.48	1.36

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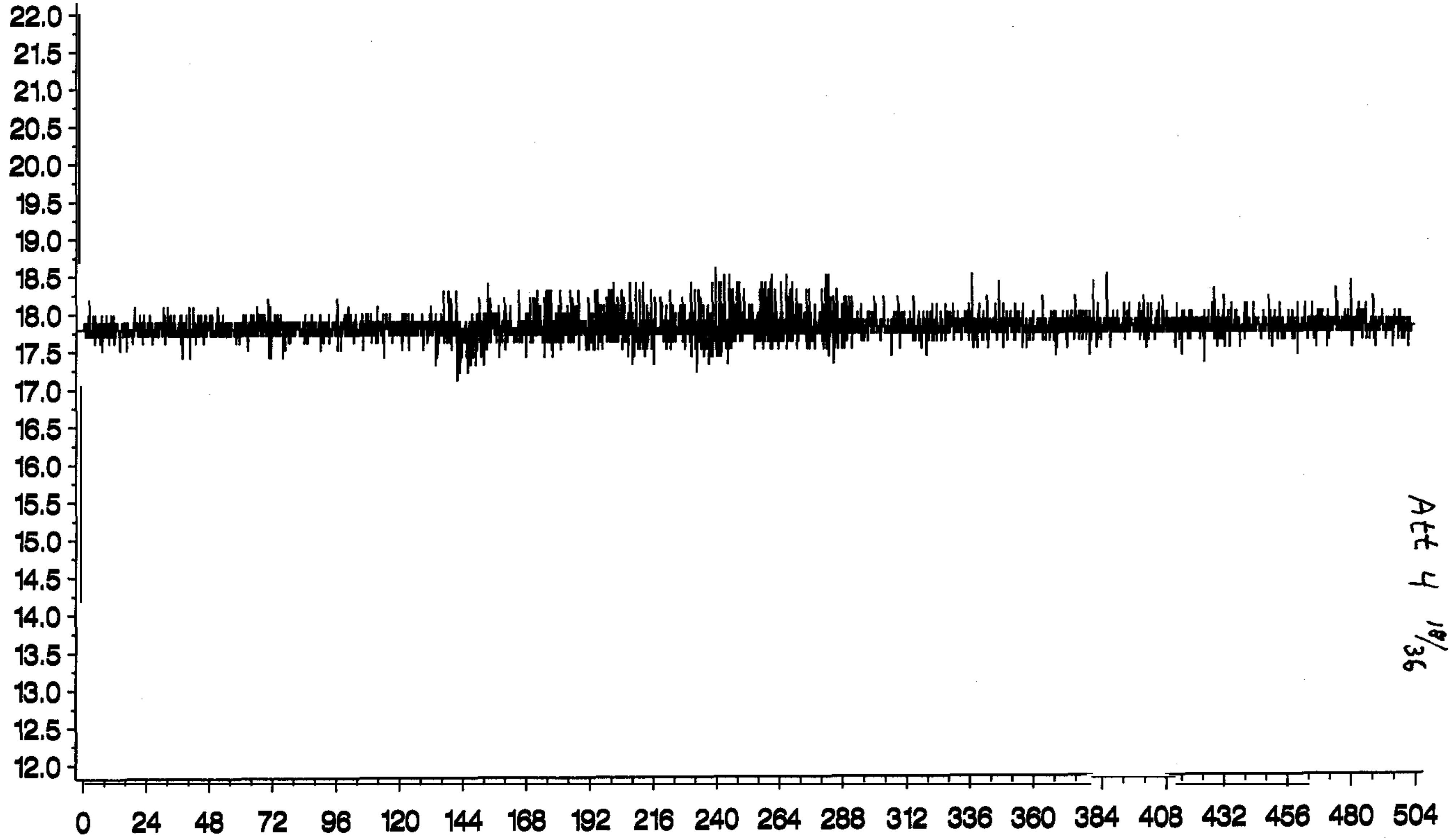
Humidity Plot No. 1

ID = 1 QI = 0.962

Number of points plotted = 5040



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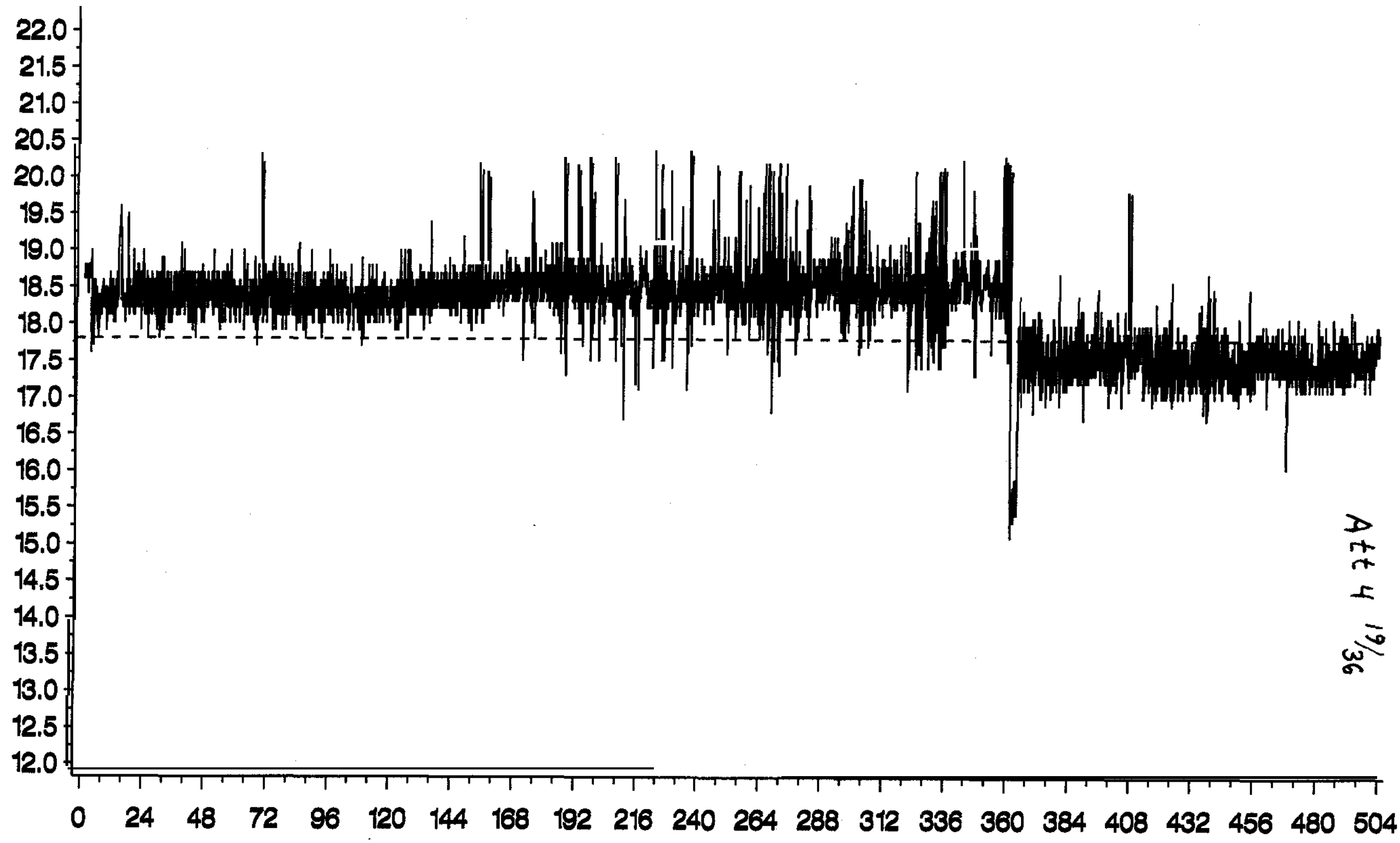
Humidity Plot No. 18

ID = 18 QI = 0.000

Number of points plotted = 5040



Intake Air Pressure

Lab	CMIR	Plot #	Zero test	# of 6 minute data points	QI (using 1P-derived α and β)	Δ (β-α) if this test were zero test	QI (using calculated α and β)
F	41545	1		5040	0.982	0.1468	0.983
F	41546	2		5040	0.973	0.1791	0.975
B	41554	3		5039	0.955	0.2335	0.957
A	41537	4		5040	0.889	0.3668	0.895
A	41573	5		5038	0.887	0.3695	0.893
B	41547	6		5039	0.720	0.5821	0.735
D	41543	7		5040	0.635	0.6645	0.655
D	41968	8		5040	0.493	0.7831	0.521
A	41538	9		5040	0.346	0.8893	0.382
A	41535	10		5040	0.198	0.9853	0.241
G	41540	11	*	5039	-0.058	1.1313	0.000
A	41536	12		5040	-0.207	1.2084	-0.141
G	41539	13		5041	-0.251	1.2302	-0.183
A	41760	14		5040	-0.647	1.4117	-0.557
G	41542	15		5039	-0.837	1.4911	-0.737
G	41541	16		5039	-1.211	1.6355	-1.090
G	41570	17		5039	-2.921	2.1781	-2.707
G	41761	18		5040	-4.594	2.6017	-4.289

	Target	to	Min	Max	α	β	Δ (β-α)
1P-Derived Values	292	0.1	291	293	291.45	292.55	1.1
Calculated 1R Values	292	0.1	291	293	291.44	292.57	1.13

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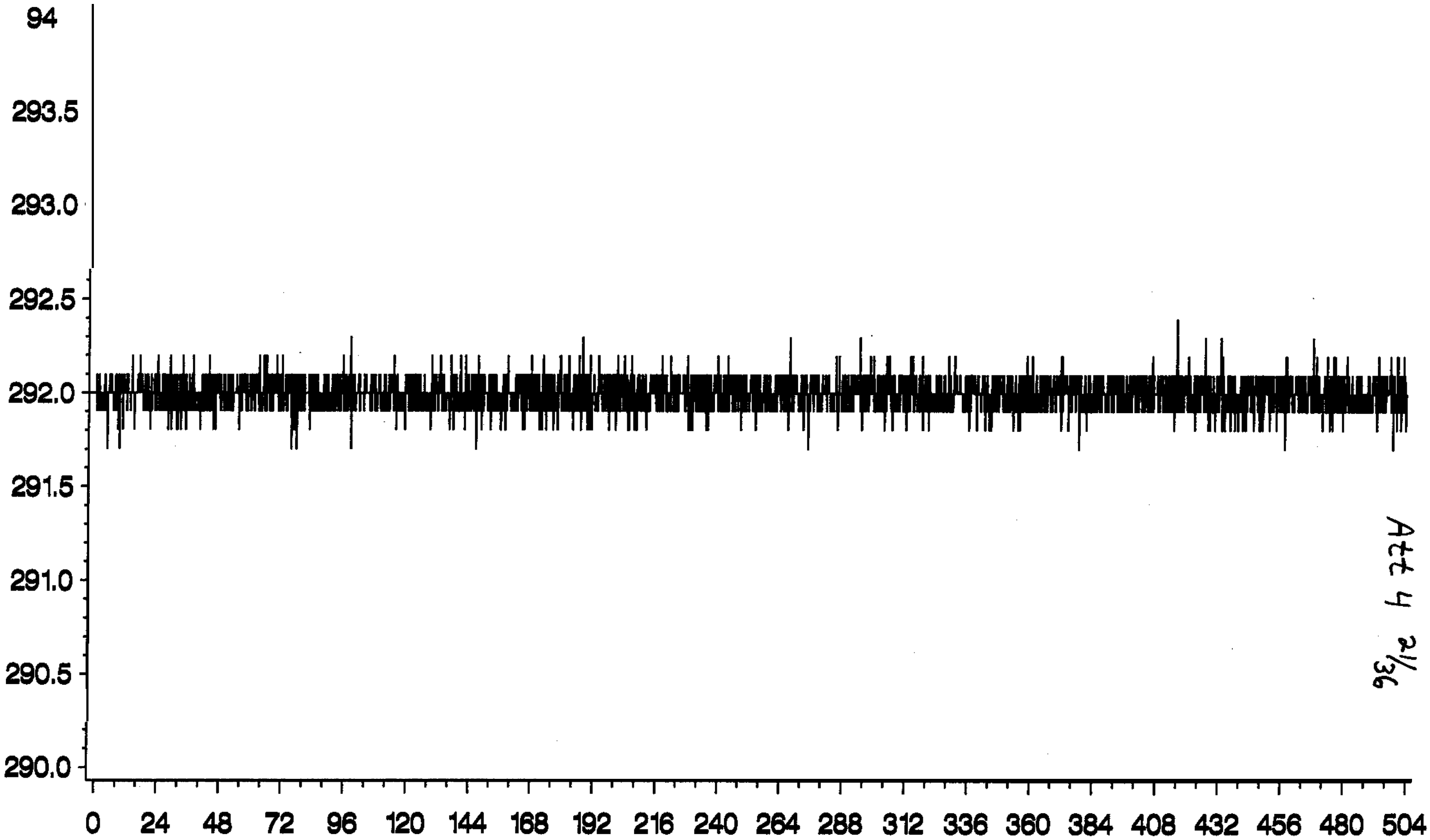
Intake Air Pressure Plot No. 1

ID = 1 QI = 0.983

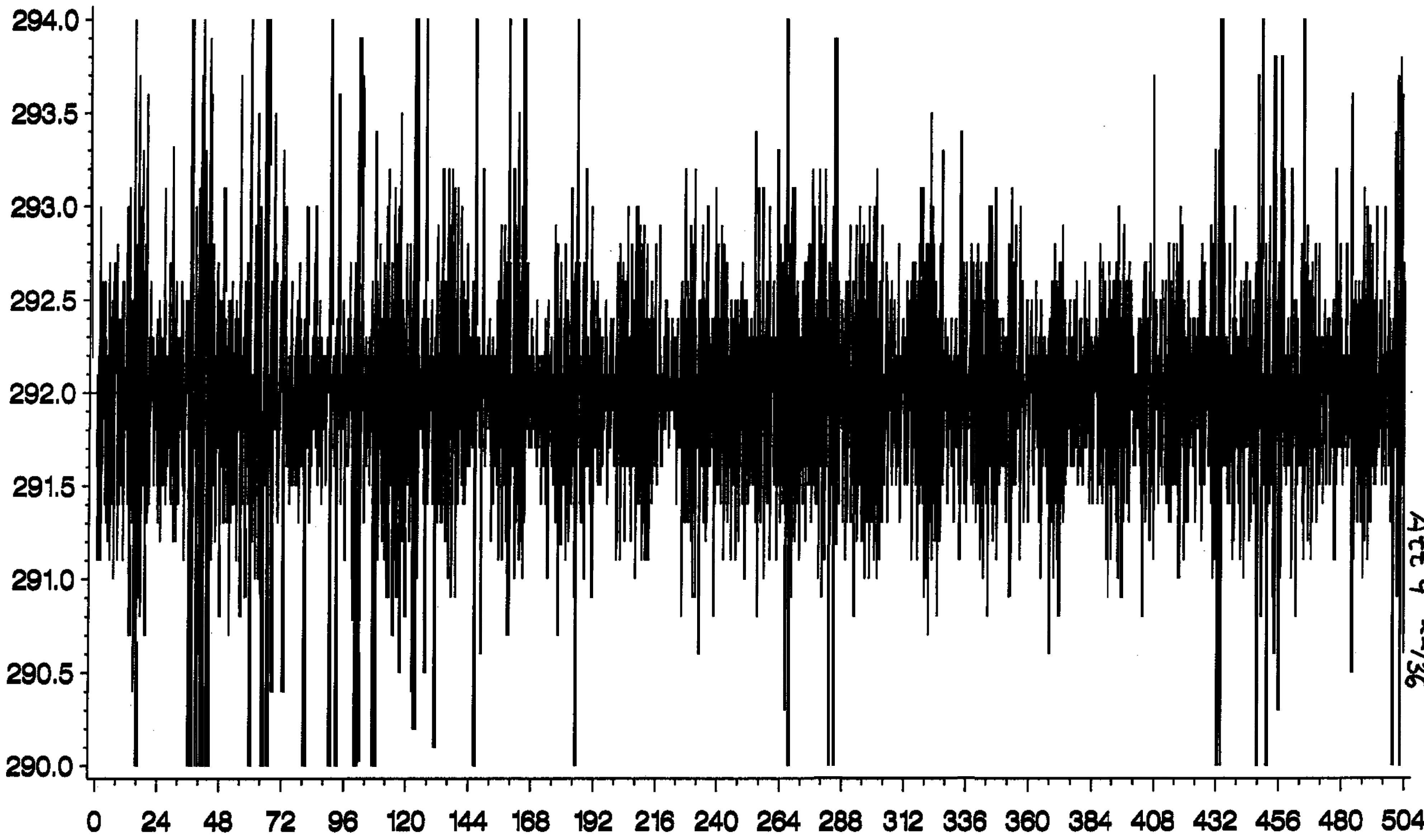
Number of points plotted = 5040



Intake Air Pressure Plot No. 11

ID = 11 QI = −0.002

Number of points plotted = 5039

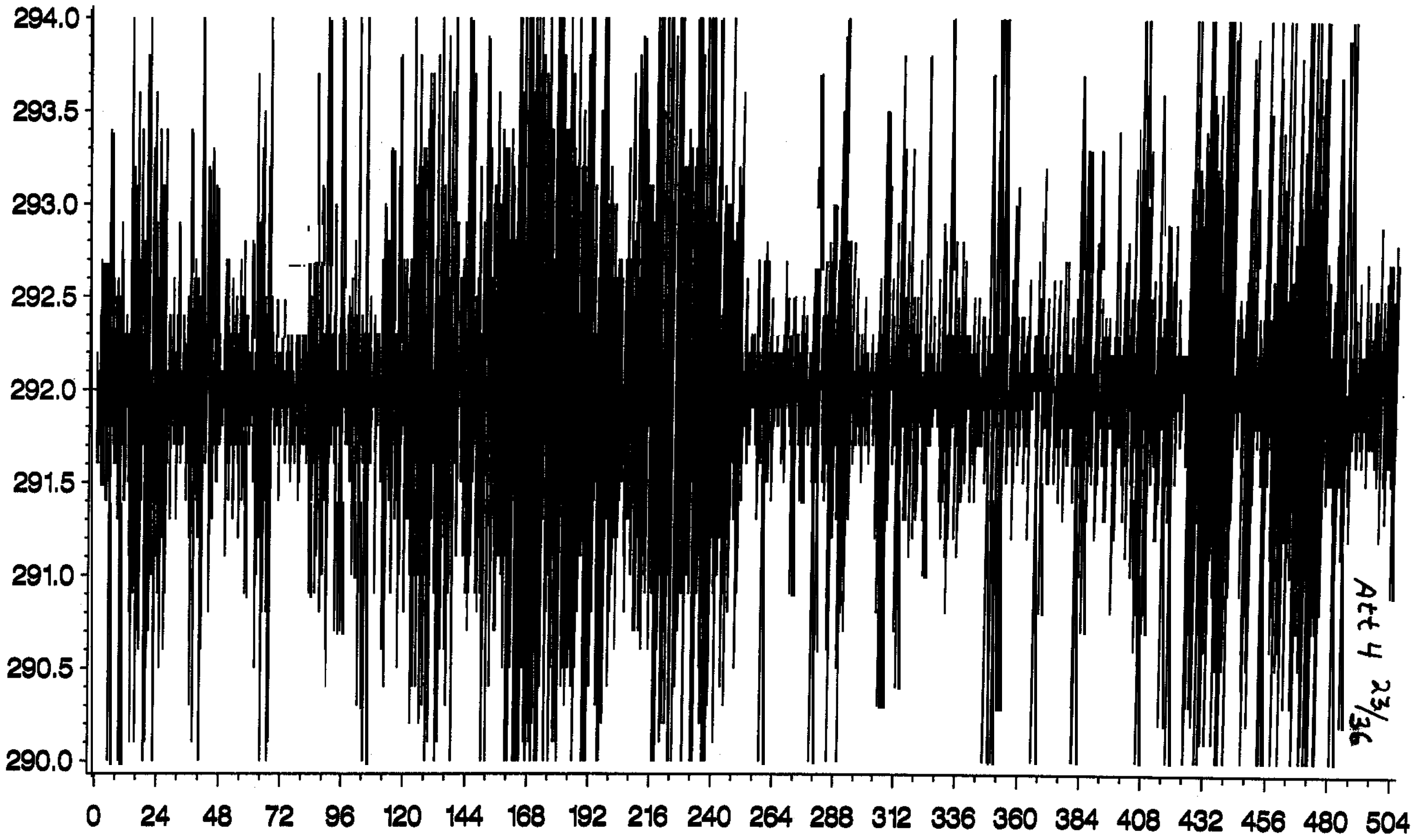


Att 4 22/36

Intake Air Pressure Plot No. 18

ID = 18 QI = −4.299

Number of points plotted = 5040



Intake Air Temp

Lab	CMIR	Plot #	Zero test	# of 5 minute data points	QI (using 1P-derived α and β)	Δ (β-α) if this test were zero test	QI (using calculated α and β)
B	41554	1		5039	0.986	0.1504	0.981
B	41547	2		5039	0.986	0.1527	0.980
F	41545	3		5040	0.981	0.1750	0.974
D	41543	4		5040	0.976	0.1966	0.968
D	41968	5		5040	0.975	0.2006	0.966
F	41546	6		5040	0.959	0.2577	0.944
G	41761	7		5040	0.933	0.3316	0.908
G	41570	8		5039	0.931	0.3354	0.905
A	41760	9		5040	0.909	0.3859	0.875
G	41540	10		5039	0.905	0.3950	0.869
A	41573	11		5038	0.897	0.4102	0.859
A	41537	12		5040	0.887	0.4301	0.845
A	41538	13		5040	0.886	0.4323	0.843
A	41536	14		5040	0.878	0.4470	0.832
A	41535	15		5040	0.867	0.4662	0.817
G	41541	16		5039	0.760	0.6266	0.670
G	41542	17		5039	0.757	0.6305	0.666
G	41539	18	*	5041	0.274	1.0908	0.000

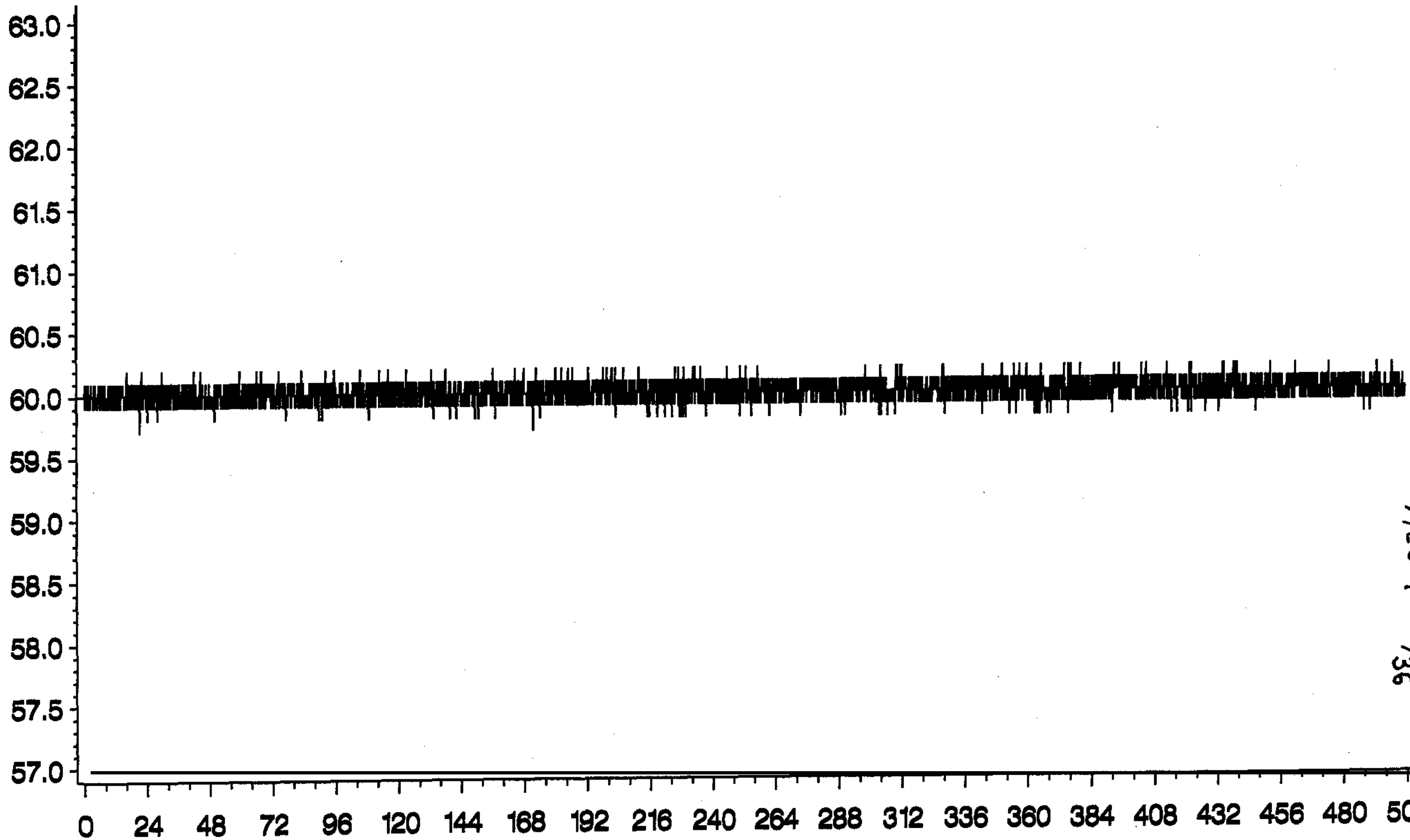
	Target	Round to	Spec Min	Spec Max	α	β	Δ (β-α)
1P-Derived Values	60	0.1	57	63	59.36	60.64	1.28
Calculated TR Values	60	0.1	57	63	59.46	60.55	1.09

Att 4 24/36

Intake Air Temp Plot No. 1

ID = 1 QI = 0.981

Number of points plotted = 5039

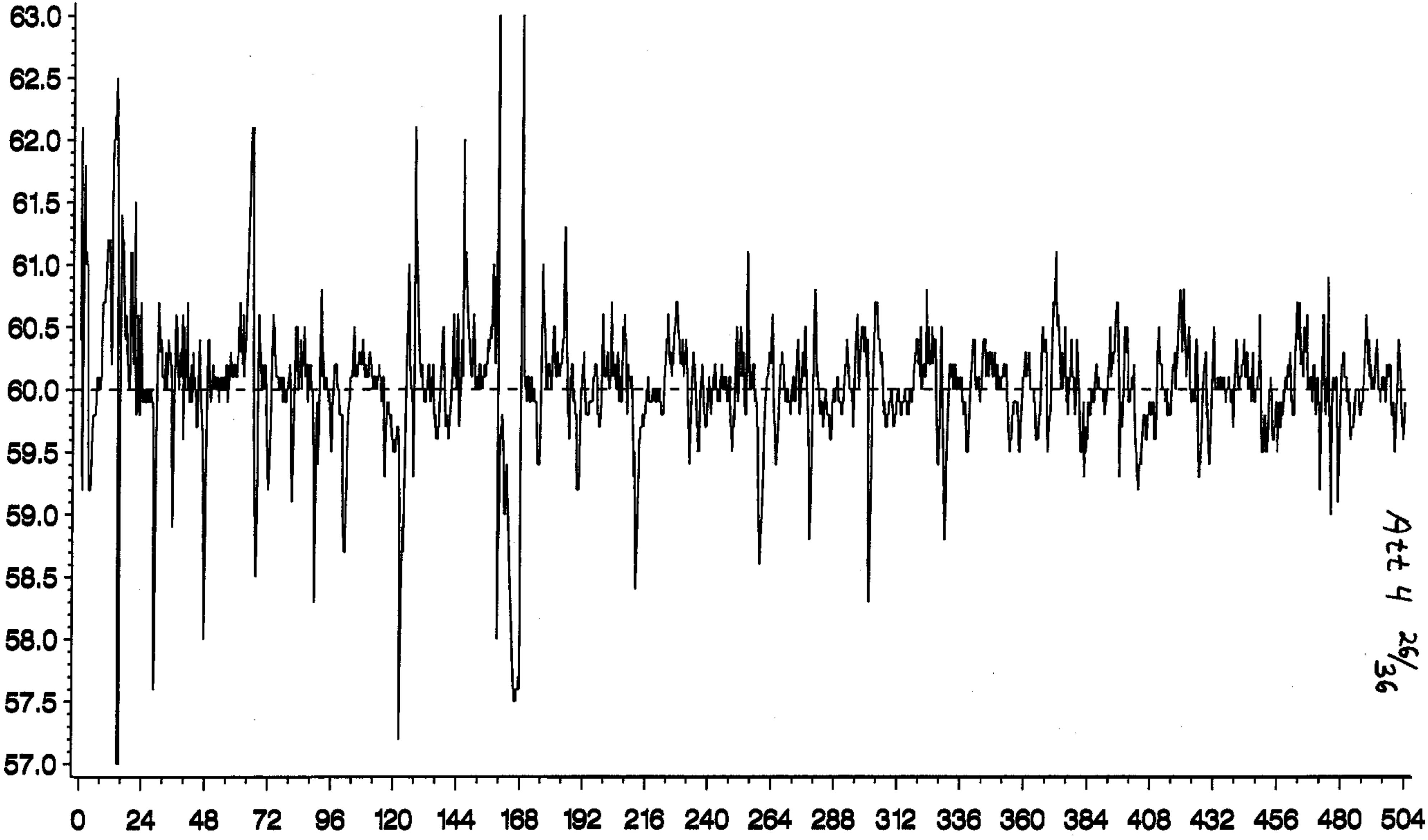


Att 4 25/36

Intake Air Temp Plot No. 18

ID = 18 QI = −0.004

Number of points plotted = 5041



Oil Manifold Pressure

Lab	CMIR	Plot #	Zero test	# of 6 minute data points	QI (using 1P-derived α and β)	Δ (β-α) if this test were zero test	QI (using calculated α and β)
A	41535	1		5040	0.996	1.3132	0.991
G	41540	2		5039	0.995	1.4441	0.990
A	41538	3		5040	0.995	1.4712	0.989
A	41536	4		5040	0.994	1.6420	0.986
A	41537	5		5040	0.991	1.9644	0.981
G	41761	6		5040	0.986	2.5029	0.969
A	[illegible]	7		5039	0.971	3.6304	0.934
F	41545	8		5040	0.953	4.6281	0.892
G	41570	9		5039	0.952	4.6434	0.892
G	41541	10		5039	0.948	4.8497	0.882
G	41542	11		5039	0.923	5.9036	0.825
F	41546	12		5040	0.921	5.9836	0.820
G	41539	13		5041	0.920	6.0080	0.819
D	41543	14		5040	0.904	6.5933	0.781
B	41547	15		5039	0.861	7.9161	0.685
D	41968	16		5040	0.850	8.2184	0.660
B	41554	17		5039	0.782	9.9102	0.506
A	[illegible]	18	*	5040	0.559	14.1040	[illegible]

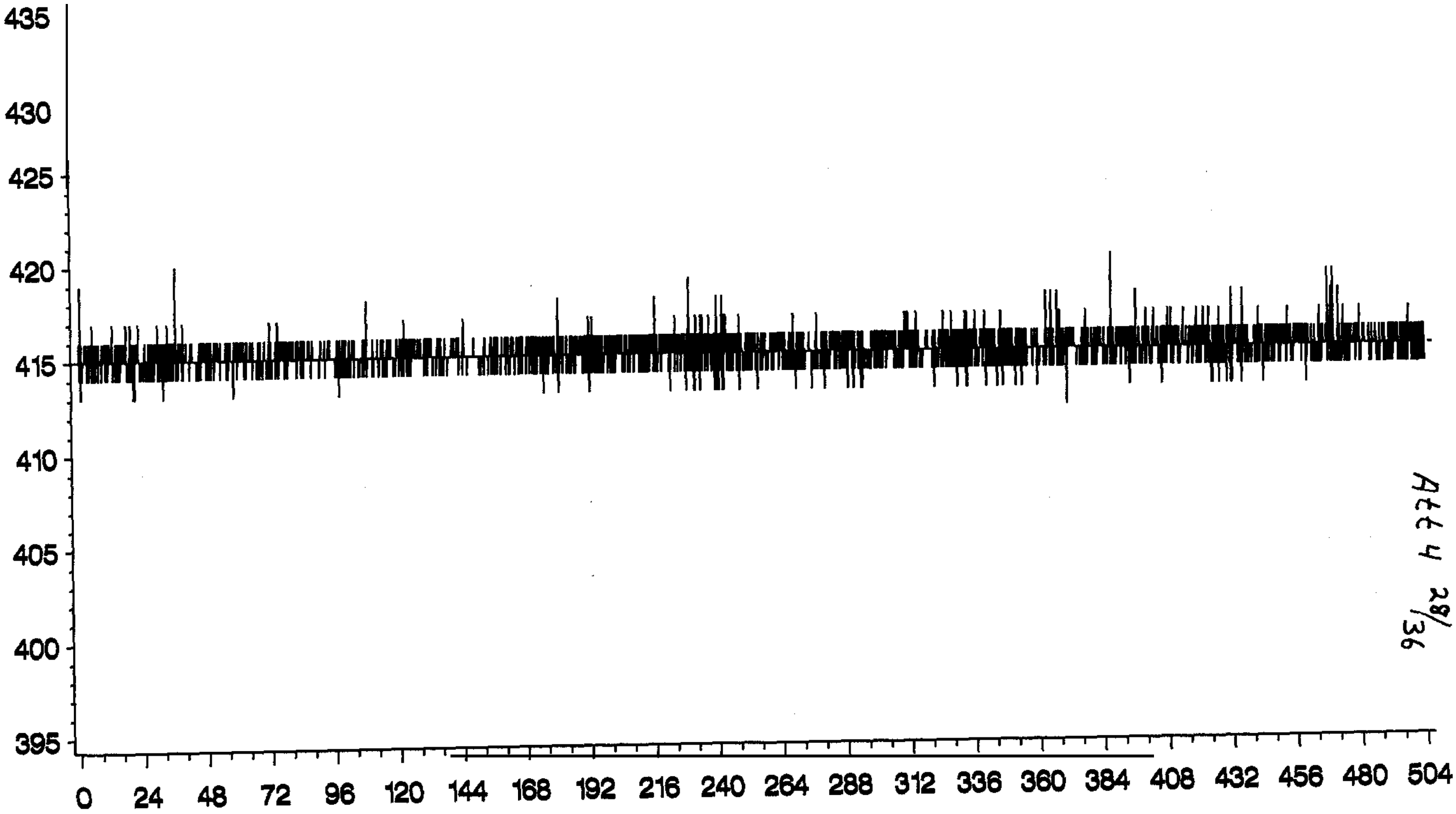
	Target	Round to	Spec Min	Spec Max	α	β	Δ (β-α)
1P-Derived Values	415	1	395	435	404.38	425.62	21.24
Calculated 1R Values	415	1	395	435	407.94	422.06	14.12

Att 4 27/36

Oil Manifold Pres Plot No. 1

ID = 1 QI = 0.991

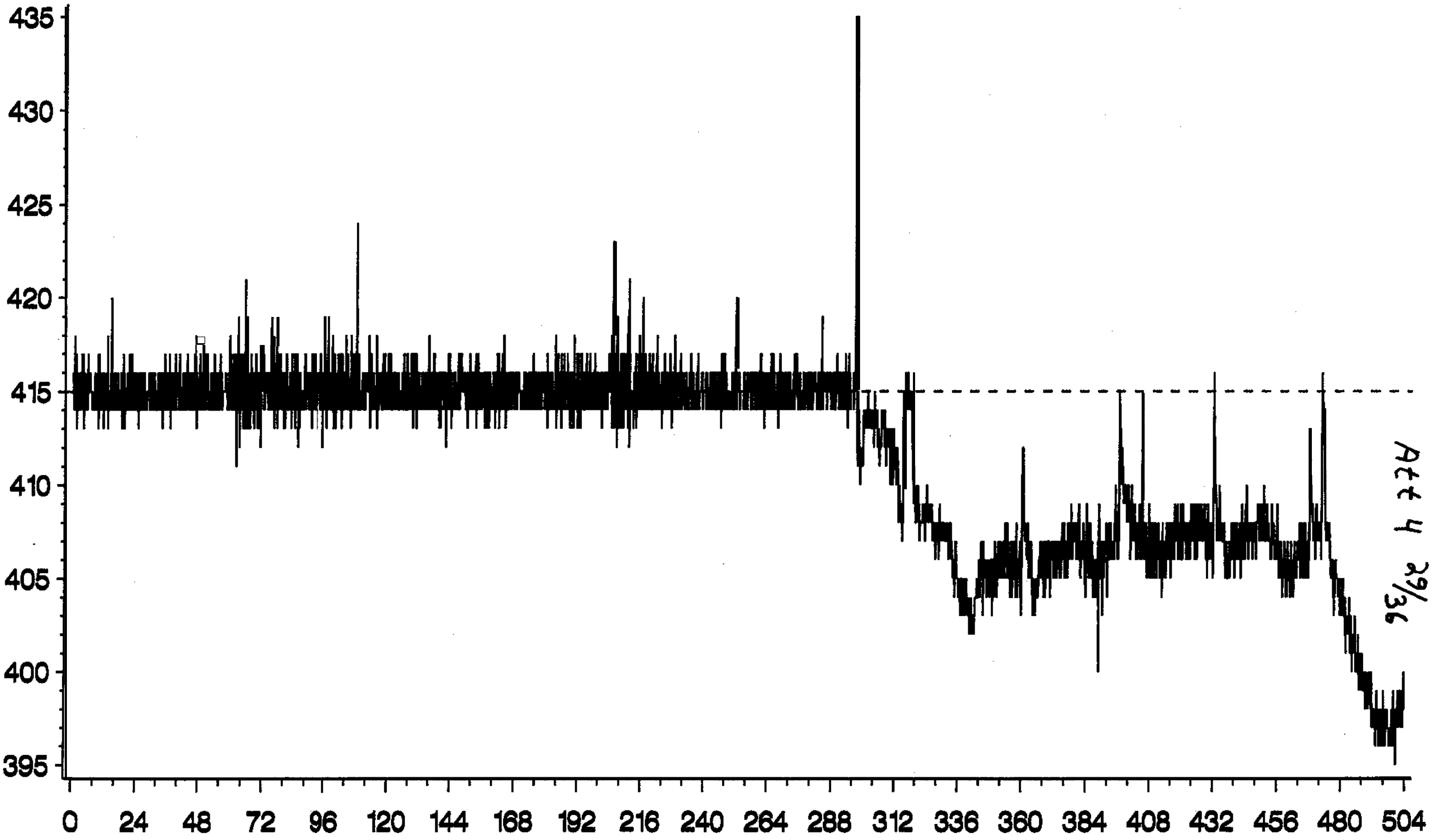
Number of points plotted = 5040



Oil Manifold Pres Plot No. 18

ID = 18   QI = 0.002

Number of points plotted = 5040



Att 4 29/36

Oil Manifold Temp

Lab	CMIR	Plot #	Zero test	# of 6 minute data points	QI (using 1P-derived α and β)	Δ (β-α) if this test were zero test	QI (using calculated α and β)
G	41761	1		5040	0.998	0.1011	0.989
G	41542	2		5039	0.998	0.1043	0.988
G	41541	3		5039	0.998	0.1091	0.987
G	41570	4		5039	0.997	0.1419	0.978
A	41535	5		5040	0.983	0.3139	0.891
F	41545	6		5040	0.978	0.3535	0.861
F	41546	7		5040	0.977	0.3634	0.853
A	41538	8		5040	0.974	0.3835	0.837
D	41968	9		5040	0.966	0.4451	0.780
A	41537	10		5040	0.952	0.5233	0.696
G	41540	11		5039	0.939	0.5935	0.609
B	41554	12		5039	0.909	0.7223	0.421
B	41547	13		5039	0.907	0.7303	0.408
G	41539	14		5041	0.899	0.7638	0.352
A	41536	15		5040	0.894	0.7805	0.324
A	41760	16		5040	0.884	0.8170	0.259
A	41573	17		5038	0.844	0.9468	0.005
D	41543	18	*	5040	0.844	0.9492	0.000

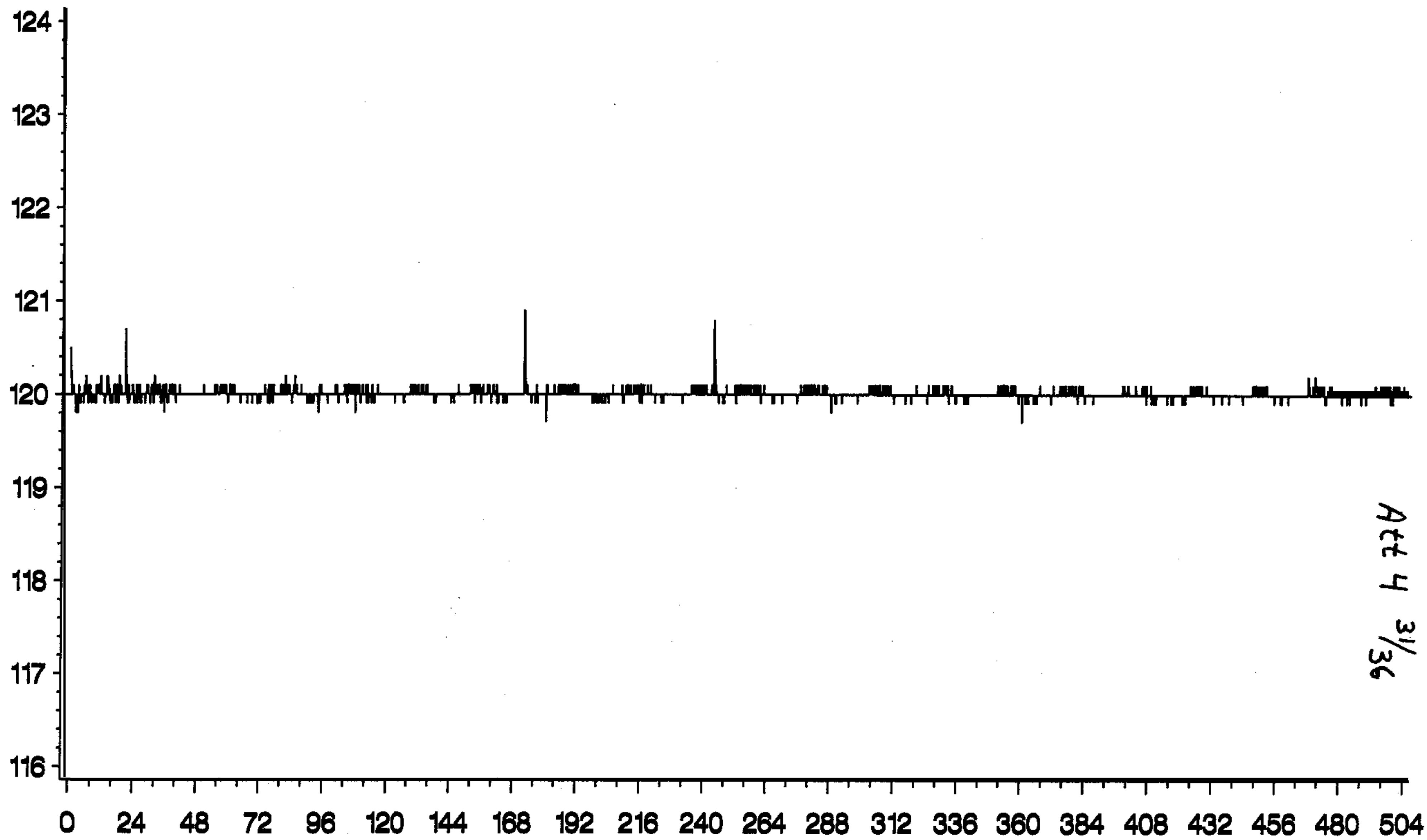
	Target	Round to	Spec Min	Spec Max	α	β	Δ (β-α)
1P-Derived Values	120	0.1	117	123	118.8	121.2	2.4
Calculated 1R Values	120	0.1	117	123	119.53	120.48	0.95

Att 4 30/36

OIl Manifold Temp Plot No. 1

ID = 1 QI = 0.988

Number of points plotted = 5039

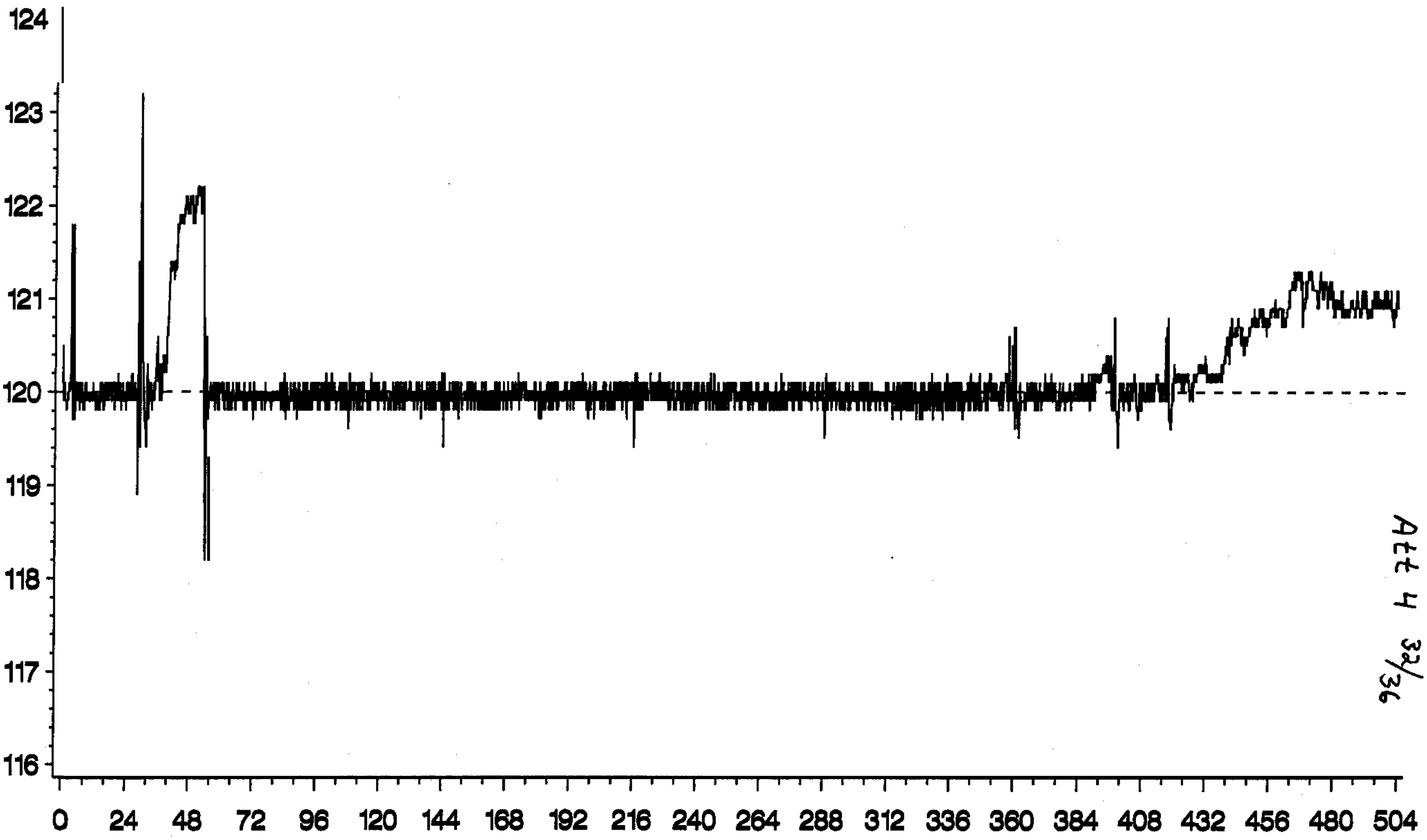


Att 4 31/36

Oil Manifold Temp Plot No. 18

ID = 18 QI = 0.000

Number of points plotted = 5040



Att 4 32/36

Speed

Lab	CMIR	Plot #	Zero test	# of 6 minute data points	QI (using 1P-derived α and β)	Δ (β-α) if this test were zero test	QI (using calculated α and β)
D	41968	1		5040	0.998	0.1409	0.997
D	41543	2		5040	0.984	0.3769	0.979
B	41554	3		5039	0.901	0.9268	0.871
B	41547	4		5039	0.892	0.9654	0.860
G	41541	5		5039	0.827	1.2223	0.776
A	41537	6		5040	0.821	1.2450	0.767
F	41545	7		5040	0.800	1.3163	0.740
G	41539	8		5041	0.780	1.3791	0.714
G	41570	9		5039	0.777	1.3880	0.711
G	41542	10		5039	0.771	1.4070	0.703
A	41573	11		5038	0.602	1.8544	0.484
G	41761	12		5040	0.599	1.8610	0.480
F	41546	13		5040	0.540	1.9944	0.403
G	41540	14		5039	0.506	2.0654	0.359
A	41769	15		5040	0.402	2.2727	0.224
A	41538	16		5040	0.310	2.4430	0.104
A	41536	17	*	5040	0.230	2.5806	0.000
A	41535	18		5040	-0.226	3.2547	-0.591

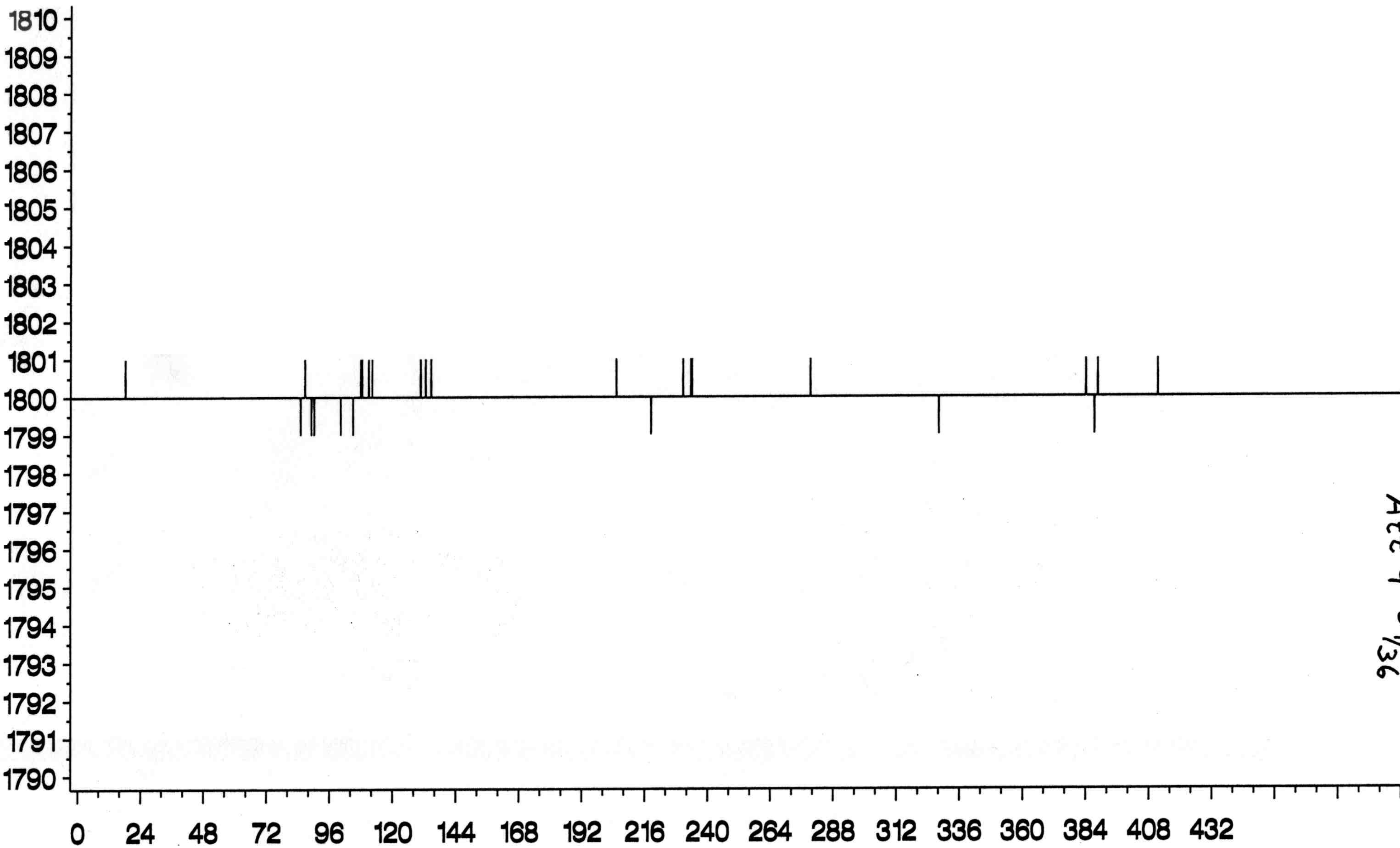
	Target	Round to	Spec Min	Spec Max	α	β	Δ (β-α)
1P-Derived Values	1800	1	1797	1803	1798.53	1801.47	2.94
Calculated 1R Values	1800	1	1797	1803	1798.71	1801.29	2.58

Att 4 33/36

Eng ne Speed P ot No 1

D Q 0 997

Numb of po nts plotted 5040

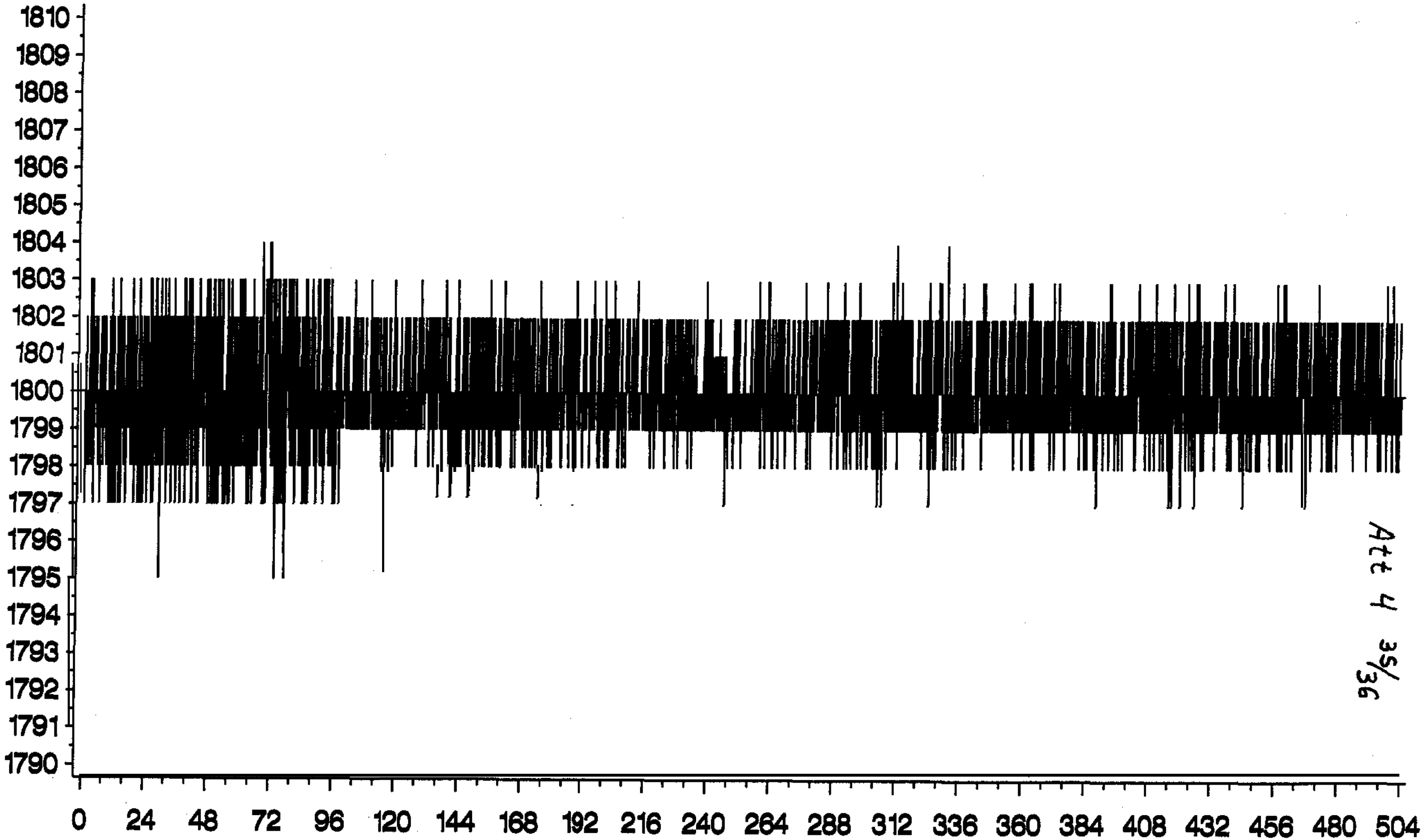


Att 4 34/36

Engine Speed Plot No. 17

ID = 17 QI = −0.000

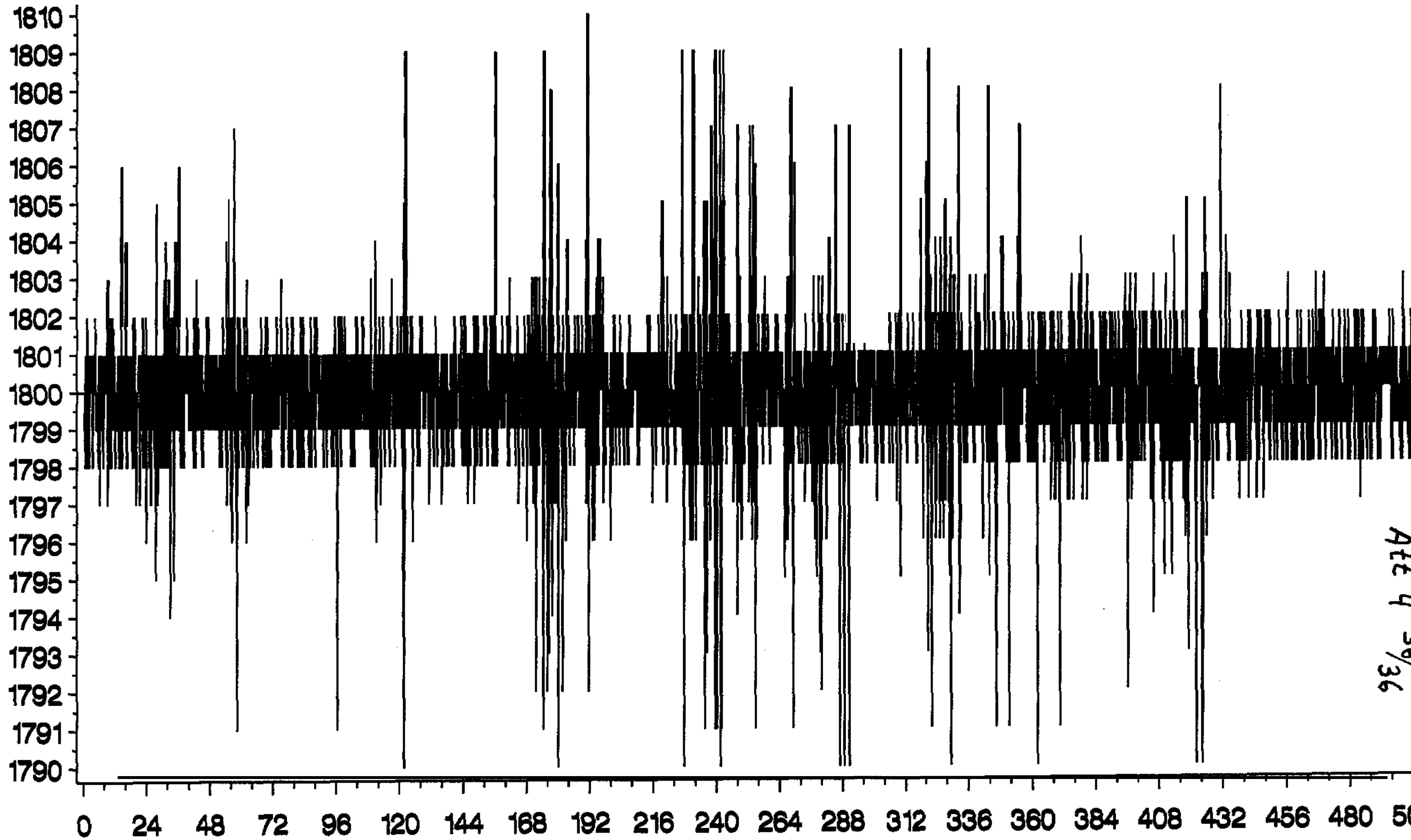
Number of points plotted = 5040



Engine Speed Plot No. 18

ID = 18 QI = −0.591

Number of points plotted = 5040



Att 4 36/36

Summary of 1R Quality Index Calculation Constants

Parameter	Target	to	Min	Max	α	ß	Δ	Floor	Ceiling
Coolant Flow	75	0.1	70	80	73.32	76.68	3.36	-44.33	194.33
Out Temp	105	0.1	102		04.77	105.24	0.47	88.06	121.94
Fuel Flow	240	0.	239	241	239.32	240.69	1.37	191.52	288.48
Fuel Temp	42	0.1	39	45	40.98	43.02	2.04	-30.56	114.56
Pressure	275	1	255	295	272.12	277.8	5.61	75.81	474.19
Humidity	17	0.1	16.1	19.5	17.12	18.48	1.36	-30.71	66.31
Pressure	292	0.1	29	293	291.44	292.57	1.13	251.89	332.11
Intake Air Temp	60	0.	57	63	59.46	60.55	1.09	21.36	98.64
Oil Man Pressure	415	1		435	407.94	422.06	14.12	-86.20	916.20
Temp	20	0.1	17	123	119.53	120.48	0.95	86.31	153.69
	1800	1	1797	803	798.7	1801.29	2.58	1708.40	1891.60

Att 5 ½

1M-PC Statistical Analysis Summary

Inquiry	Labs	Data	Conclusion
Does WTD depend on Era (2-1-98 cutoff)?	A, B, D, G	all	Yes
Does TGF depend on Era (2-1-98 cutoff)?	A, B, D, G	all	No
Does WTD depend on Liner?	A, B, D, G	all	Yes
Does TGF depend on Liner?	A, B, D, G	all	Yes
Does WTD depend on Lab?	A, B, D, G	all	Yes
Does TGF depend on Lab?	A, B, D, G	all	Yes
Does WTD depend on Liner?	A, B, D, G	>19980201	No
Does TGF depend on Liner?	A, B, D, G	>19980201	Yes
Does WTD depend on Lab?	A, B, D, G	>19980201	No
TGF depend on Lab?	A, B, D, G	>19980201	No
WTD depend on Lab?	A, B, D, G	1Y3995	No
Does TGF depend on Lab?	A, B, D, G	1Y3995	No
1Y3995 WTD depend on Spring/Fall?	A, B, D, G	1Y3995	No
Does 1Y3995 TGF depend on Spring/Fall?	A, B, D, G	1Y3995	No
Does TGF depend on Era (10-1-95 cutoff)?	A, B, D, G	all	Yes

Att 6 1/4

1M-PC Severity Worksheet

Att 6 2/4

Current Targets	n	x	Std
WTD	30	232.5	50.5
TGF	30	41.0	16.1

Inquiry	Labs	Data	n	Stats x	Std	Levene	
WTD vs Era	A. B, D, G	all		p=0.0001		p=0.8338	
			n	x	Std		
<19980201			165	235.2	45.2		-2.7
>19980201			119	274.9	44.5		-42.4
TGF vs Era	A, B, D, G	all		p=0.4281		p=0.5396	
			n	x	Std		
<19980201			165	49.6	17.3		-8.6
>19980201			119	51.3	18.1		-10.3
WTD vs Liner	A, B, D, G	all		p=0.0156		p=0.3208	
			n	x	Std		
New			27	273.4	42.5		-40.9
Old			257	249.6	49.1		-17.1
TGF vs Liner	A. B, D, G	all		p=0.0081		p=0.4349	
			n	x	Std		
New			27	58.9	16.0		-17.9
Old			257	49.4	17.6		-8.4
WTD vs Lab	A, B, D, G	all		p=0.0045		p=0.3557	
			n	x	Std		
A			73	253.8	43.5		-21.3
B			46	266.0	47.5		-33.5
D			28	224.2	55.6		8.3
G			137	251.7	48.9		-19.2
TGF vs Lab	A, B, D, G	all		p = 0.0005		p=0.1703	
			n	x	Std		
A			73	47.3	16.3		-6.3
B			46	55.6	15.8		-14.6
D			28	40.1	20.8		0.9
G			137	52.3	17.2		-11.3
WTD vs Liner	A, B, D, G	>19980201		p=0.8494		p=0.6323	
			n	x	Std		
New			27	273.4	42.5		-40.9
Old			92	275.3	45.2		-42.8
TGF vs Liner	A, B, D, G	>19980201		p=0.0133		p=0.3809	
			n	x	Std		
New			27	58.9	16.0		-17.9
Old			92	49.1	18.2		-8.1

1M-PC Severity Worksheet

Att 6 3/4

Inquiry	Labs	Data	n	Stats x	Std	Levene	
WTD vs Lab	A, B, D, G	>19980201		p=0.3400		p=0.6773	
			n	x	Std		
A			36	271.9	45.9		-39.4
B			17	286.9	46.8		-54.4
D			12	257.4	34.5		-24.9
G			54	277.0	44.5		-44.5
TGF vs Lab	A, B, D, G	>19980201		p=0.0514		p=0.0188	
			n	x	Std		
A			36	47.9	17.1		-6.9
B			17	61.0	13.0		-20.0
D			12	45.1	25.0		-4.1
G			54	52.0	17.6		-11.0
TGF vs Lab	A, B, G	>19980201		p=0.0327		p=0.2693	
			n	x	Std		
A			36	47.9	17.1		-6.9
B			17	61.0	13.0		-20.0
G			54	52.0	17.6		-11.0
WTD vs Lab	A, B, D, G	1Y3995		p=0.6196		p=0.4269	
			n	x	Std		
A			10	284.0	36.5		-51.5
B			5	275.8	38.2		-43.3
D			3	246.8	30.7		-14.3
G			9	269.2	54.7		-36.7
TGF vs Lab	A, B, D, G	1Y3995		p=0.0935		p=0.1429	
			n	x	Std		
A			10	57.9	13.3		-16.9
B			5	70.4	8.0		-29.4
D			3	68.3	6.0		-27.3
G			9	50.3	19.9		-9.3
WTD vs Lab	A, D, G	>19980201		p=0.3758		p=0.4557	
			n	x	Std		
A			36	271.9	45.9		-39.4
D			12	257.4	34.5		-24.9
G			54	277.0	44.5		-44.5
TGF vs Lab	A, D, G	>19980201		p=0.3838		p=0.0527	
			n	x	Std		
A			36	47.9	17.1		-6.9
D			12	45.1	25.0		-4.1
G			54	52.0	17.6		-11.0

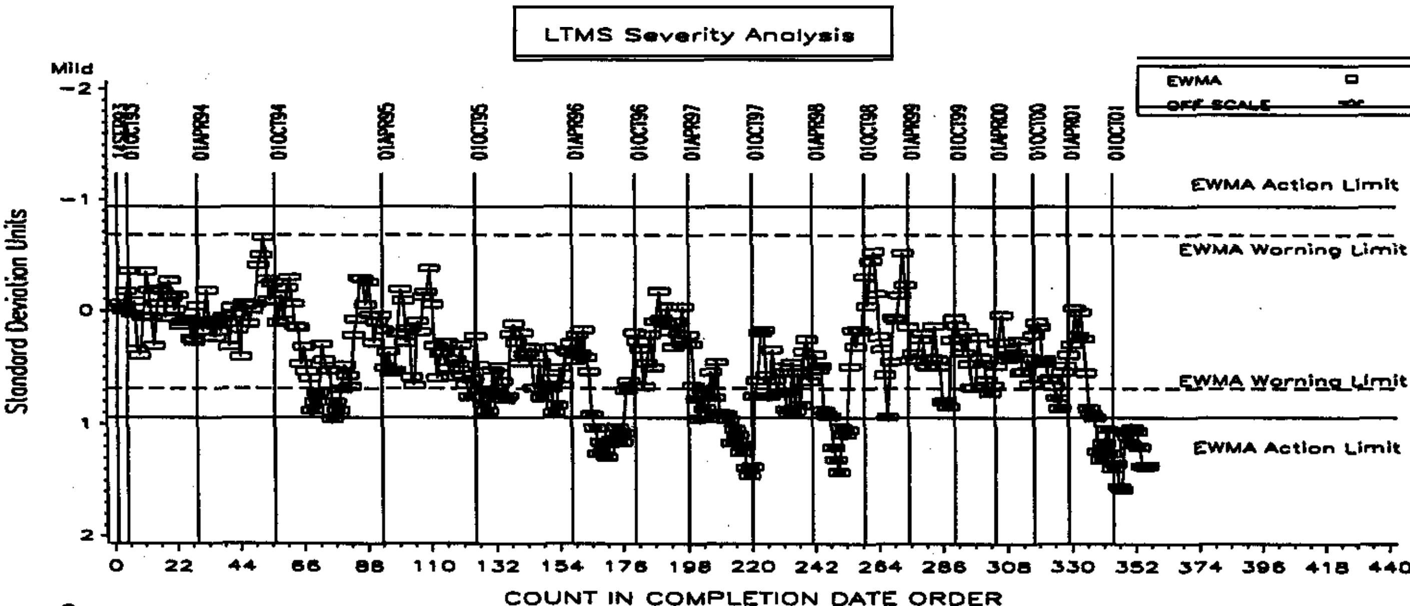
1M-PC Severity Worksheet Att 6 4/4

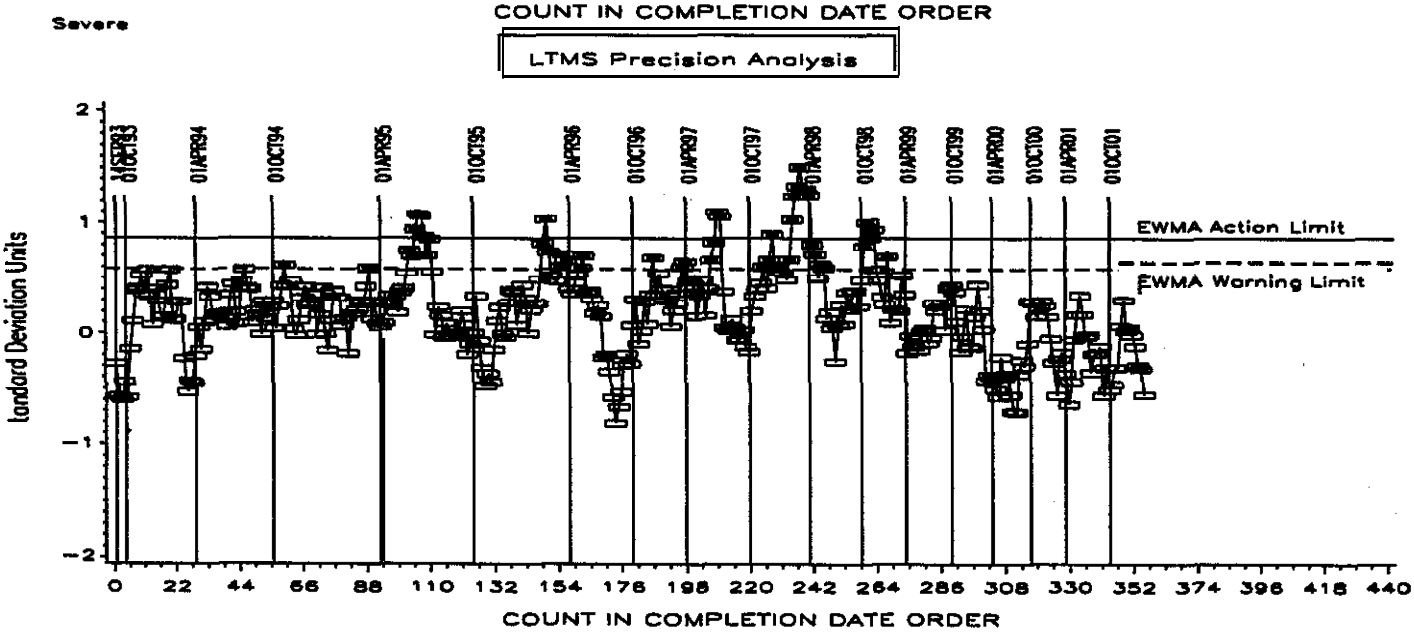
Inquiry	Labs	Data		Stats		Levene	
WTD vs Liner	A, D, G	>19980201		p=0.9985		p=0.9241	
			n	x	Std		
New			22	272.9	44.3		-40.4
Old			80	272.9	44.2		-40.4
TGF vs Liner	A, D, G	>19980201		p=0.0599		p=0.3688	
			n	x	Std		
New			22	56.2	16.4		-15.2
Old			80	47.9	18.6		-6.9
WTD vs Season	A, B, D, G	1Y3995		p=0.7928		p=0.7907	
			n	x	Std		
Fall			14	271.3	41.8		-38.8
Spring			13	275.7	44.9		-43.2
TGF vs Season	A, B, D, G	1Y3995		p=0.1677		p=0.3790	
			n	x	Std		
Fall			14	63.0	13.5		-22.0
Spring			13	54.4	17.9		-13.4
WTD vs TGF Era	A, B, D, G	all		p=0.0084		p=0.4538	
			n	x	Std		
<19951001			72	238.8	50.9		-6.3
>19951001			212	256.3	47.5		-23.8
TGF vs TGF Era	A, B, D, G	all		p=0.0381		p=0.4531	
			n	x	Std		
<19951001			72	46.6	16.7		-5.6
>19951001			212	51.6	17.8		-10.6

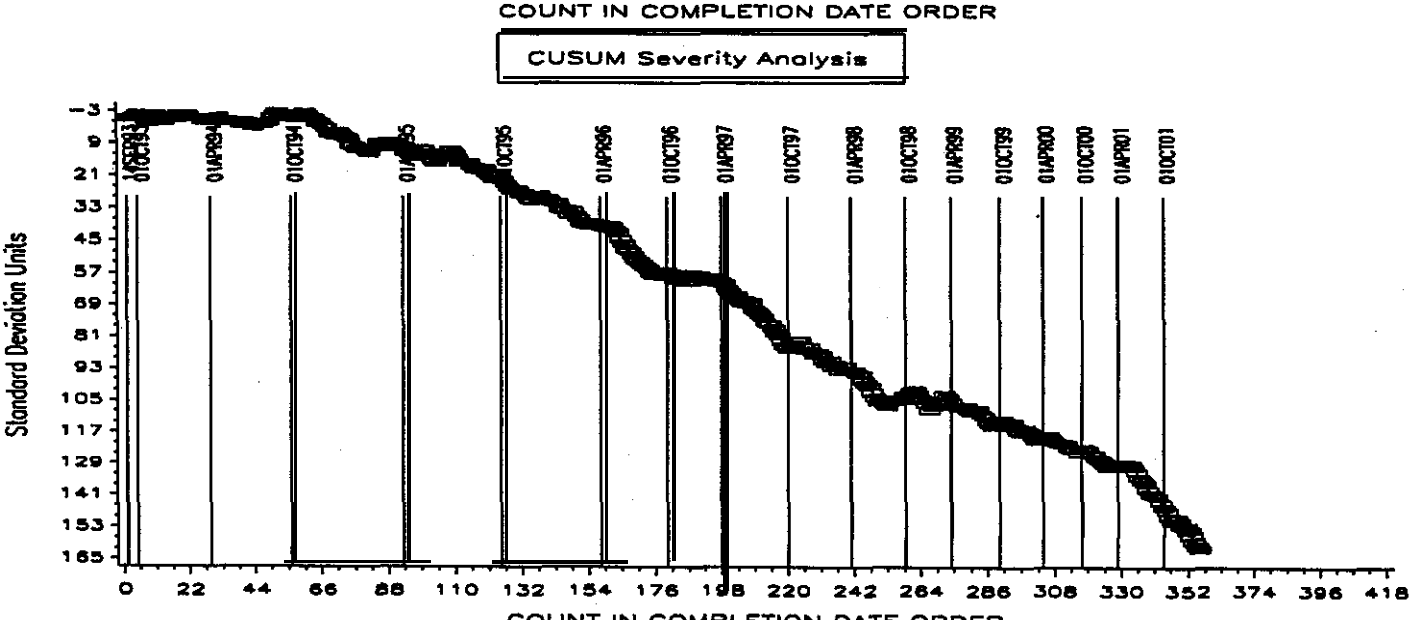
CATERPILLAR 1 M-PC INDUSTRY OPERATIONALLY VALID DATA

Top Groove Fill

Att 7 1/6







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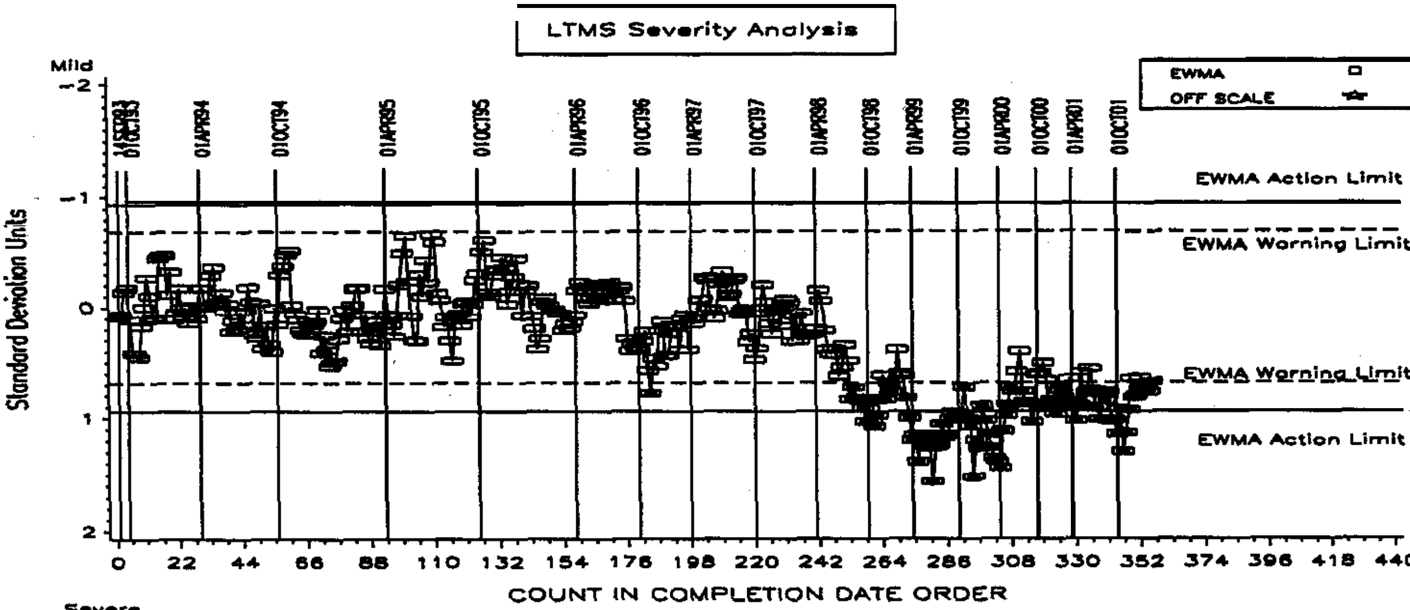
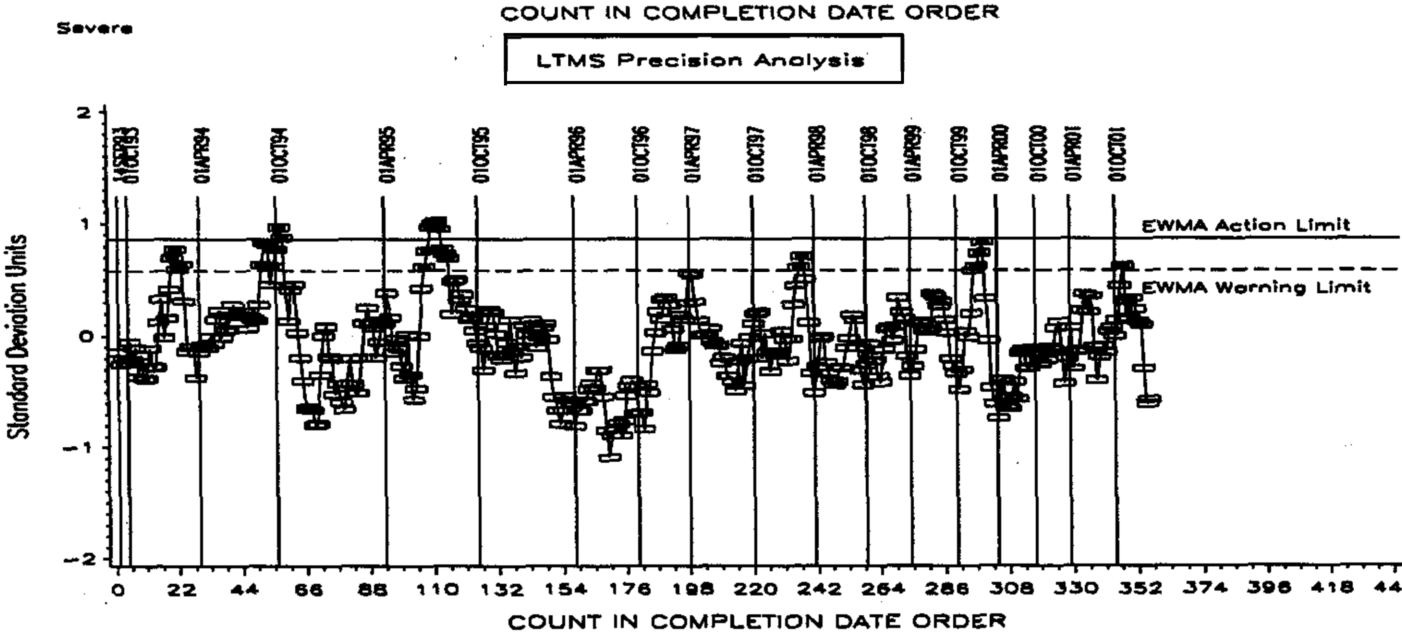
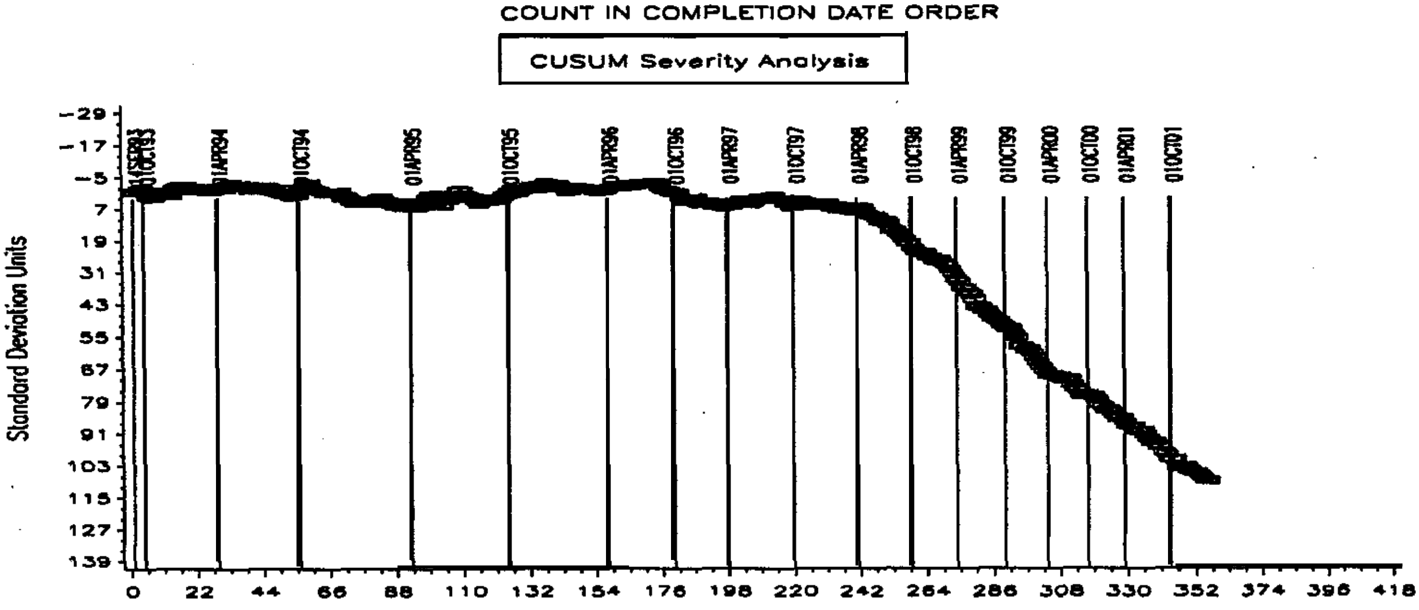
CATERPILLAR 1 M-PC INDUSTRY OPERATIONALLY VALID DATA

Weighted Total Demerits

Att 7 2/6







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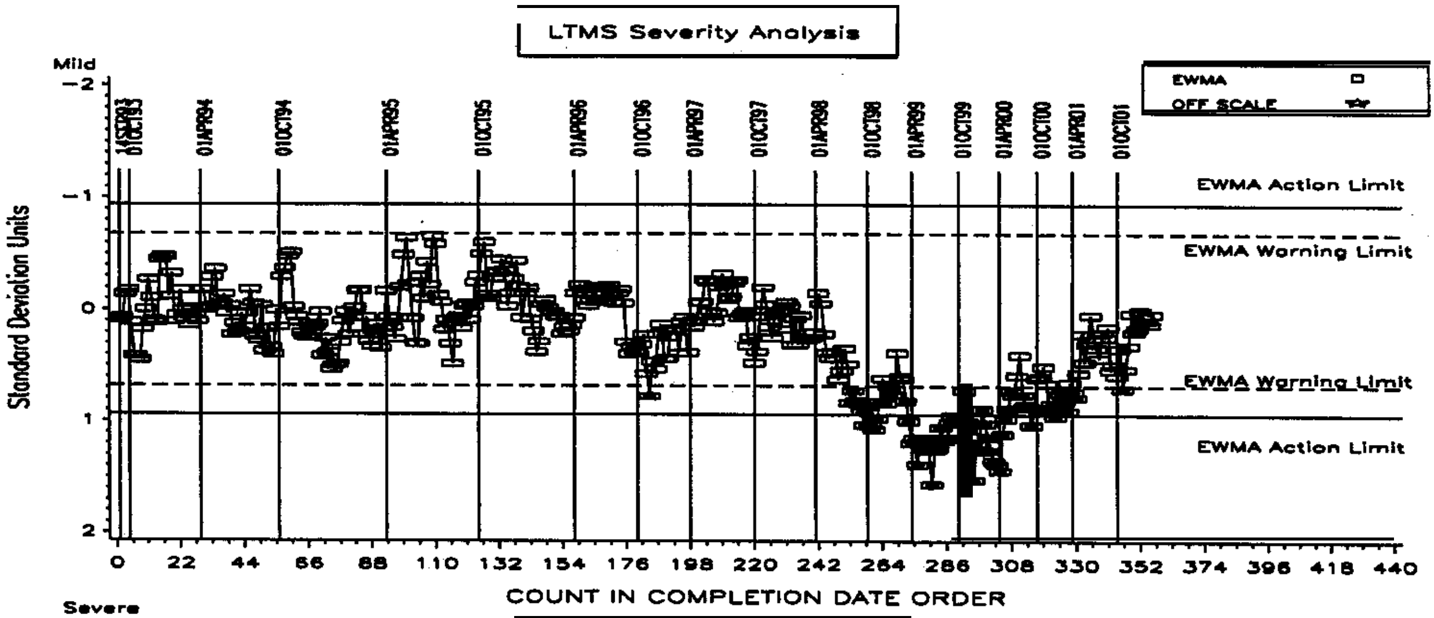
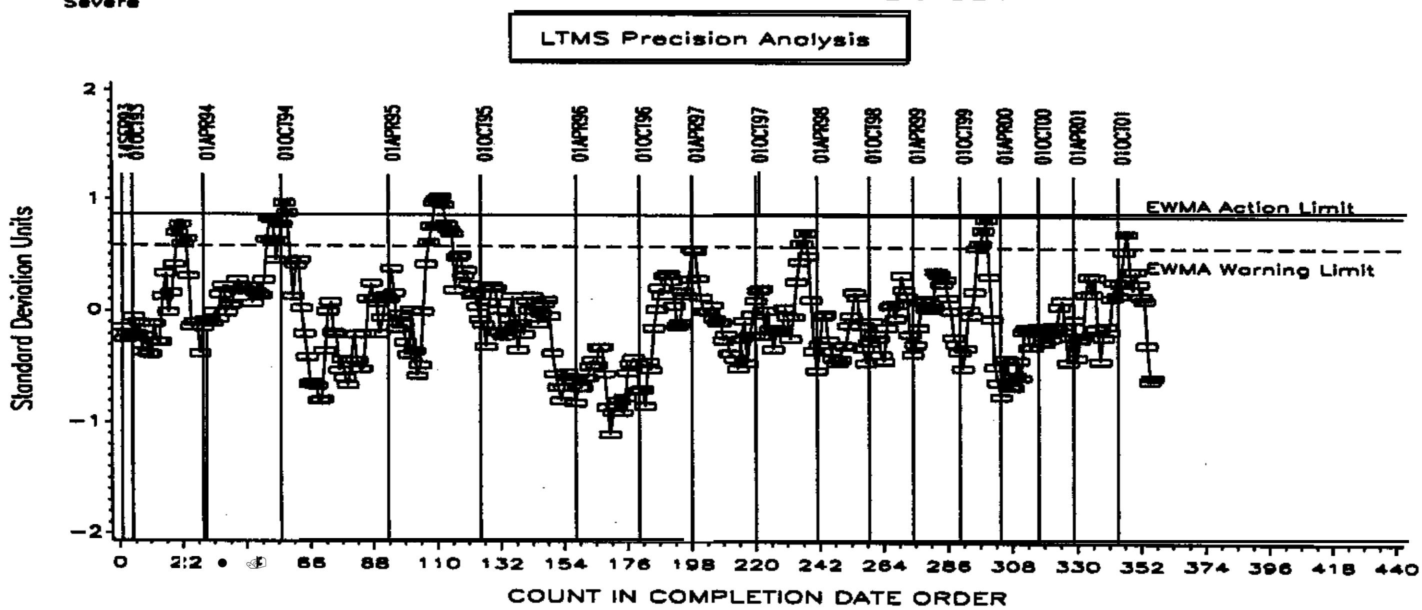
CATERPILLAR 1 M-PC INDUSTRY OPERATIONALLY VALID DATA

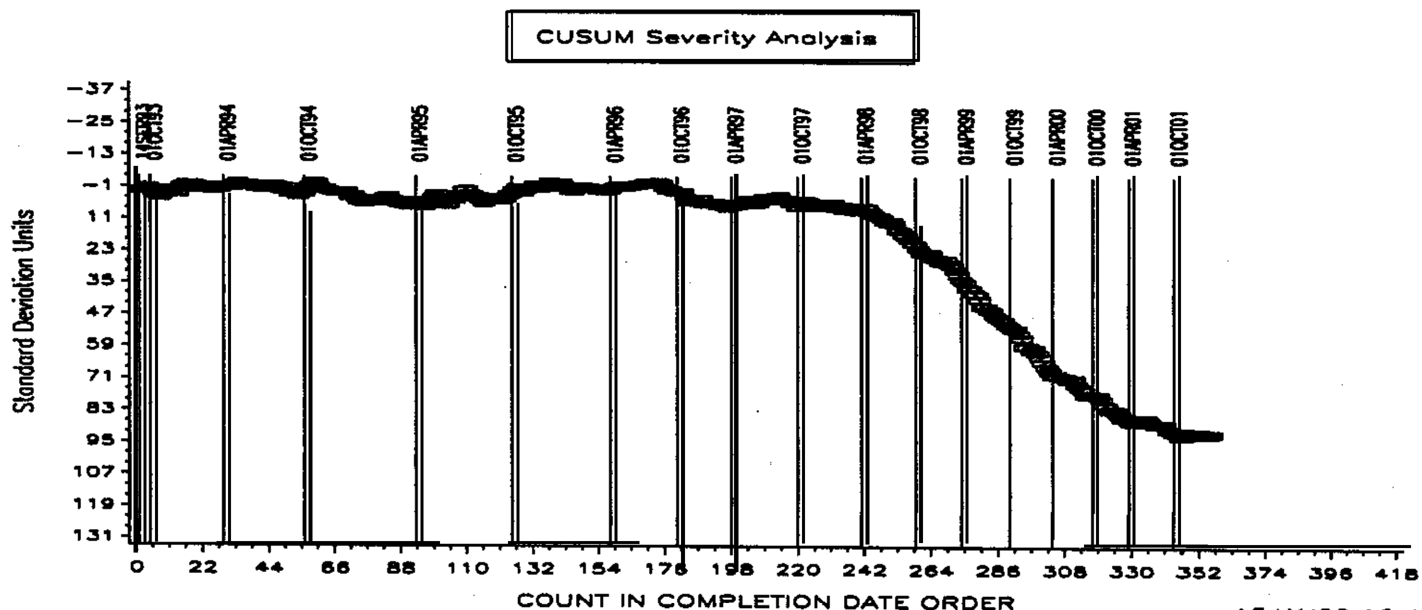
Minimum Possible SA Applied (-32.99)

Weighted Total Demerits

Att 7 3/6







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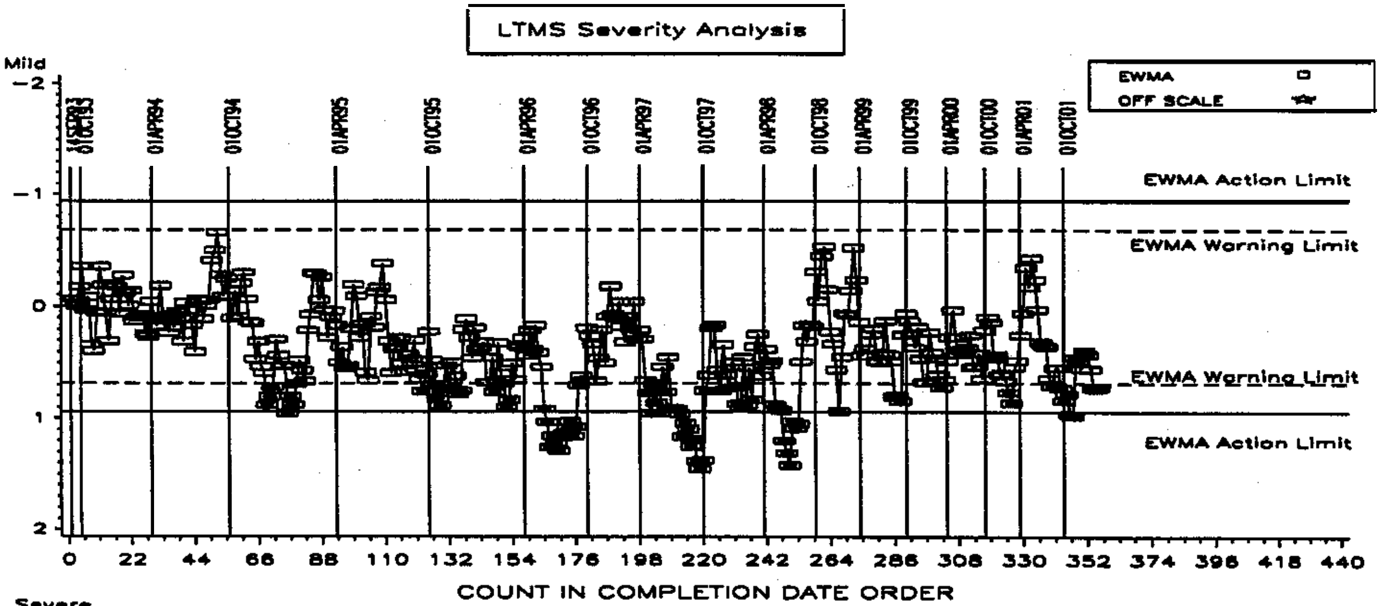
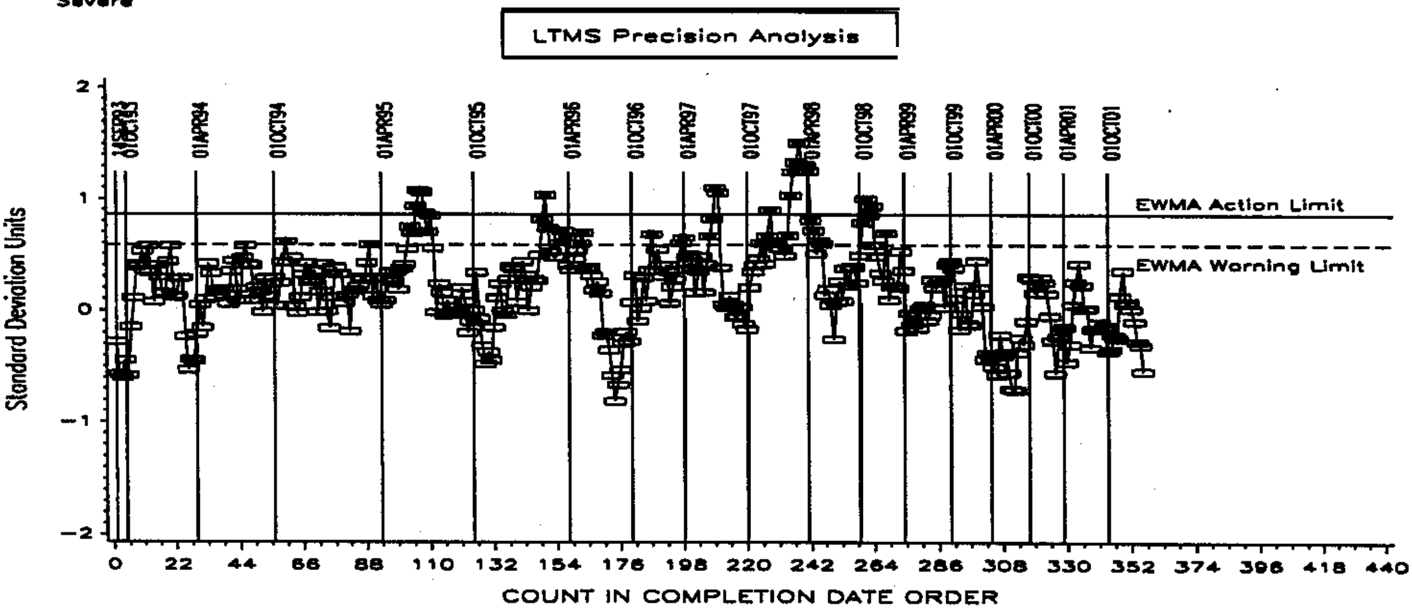
CATERPILLAR 1 M-PC INDUSTRY OPERATIONALLY VALID DATA

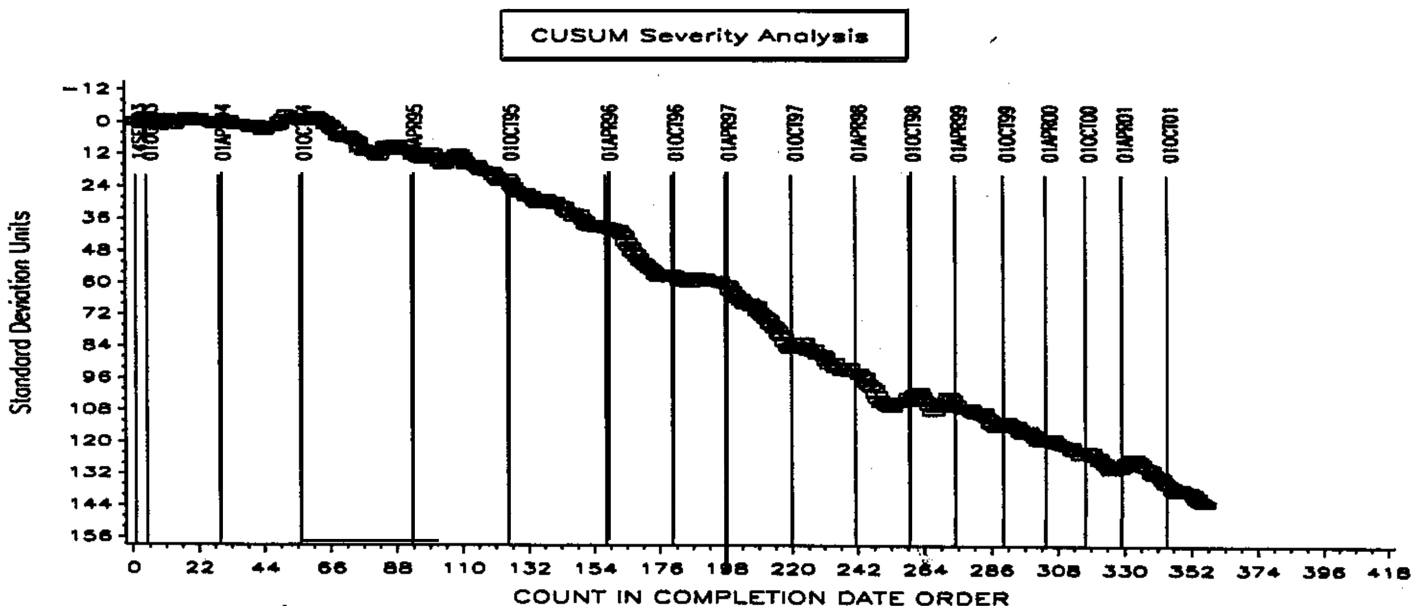
Minimum Possible SA Applied (- 10.51)

Top Groove Fill

Att 7 4/6







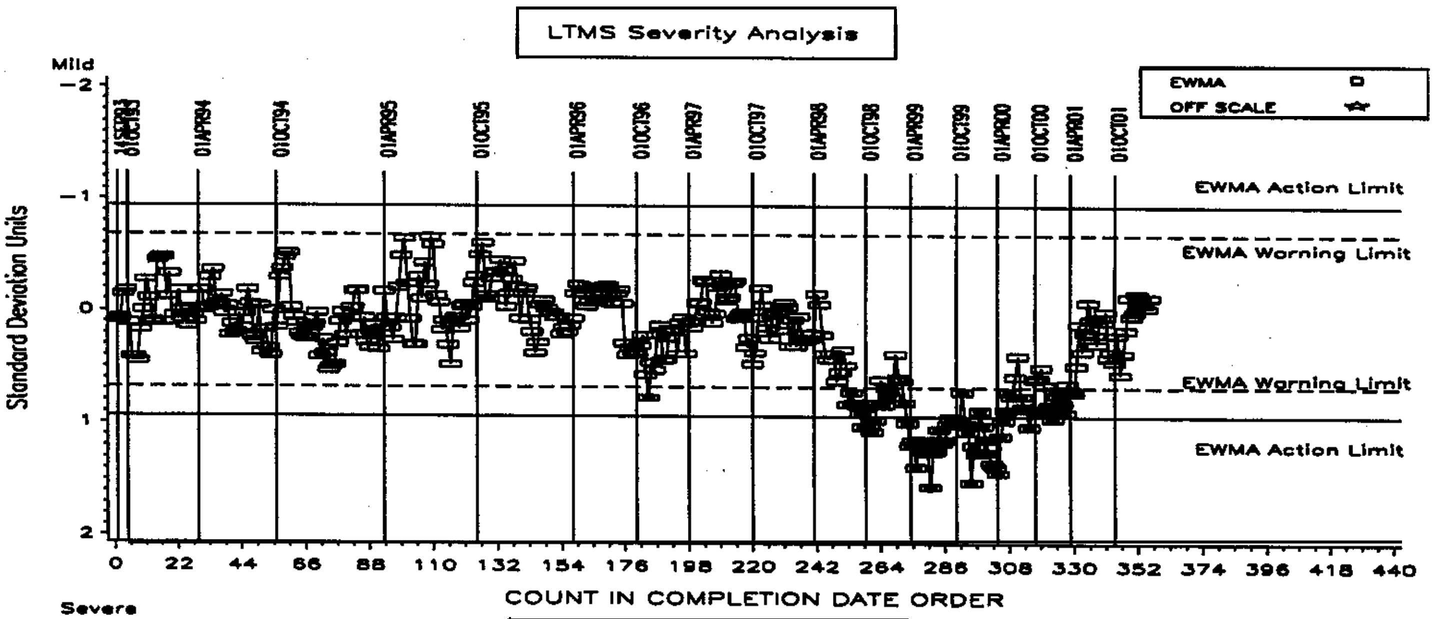
TMC 15JAN02:16:43

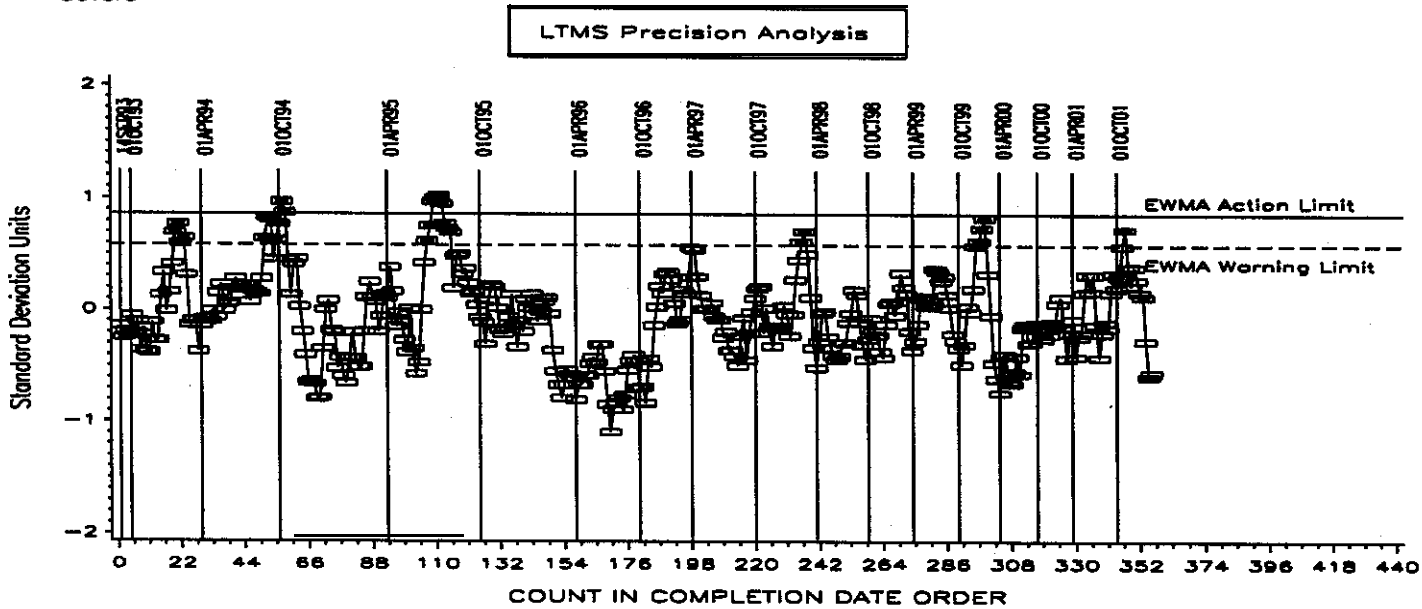
CATERPILLAR 1 M-PC INDUSTRY OPERATIONALLY VALID DATA

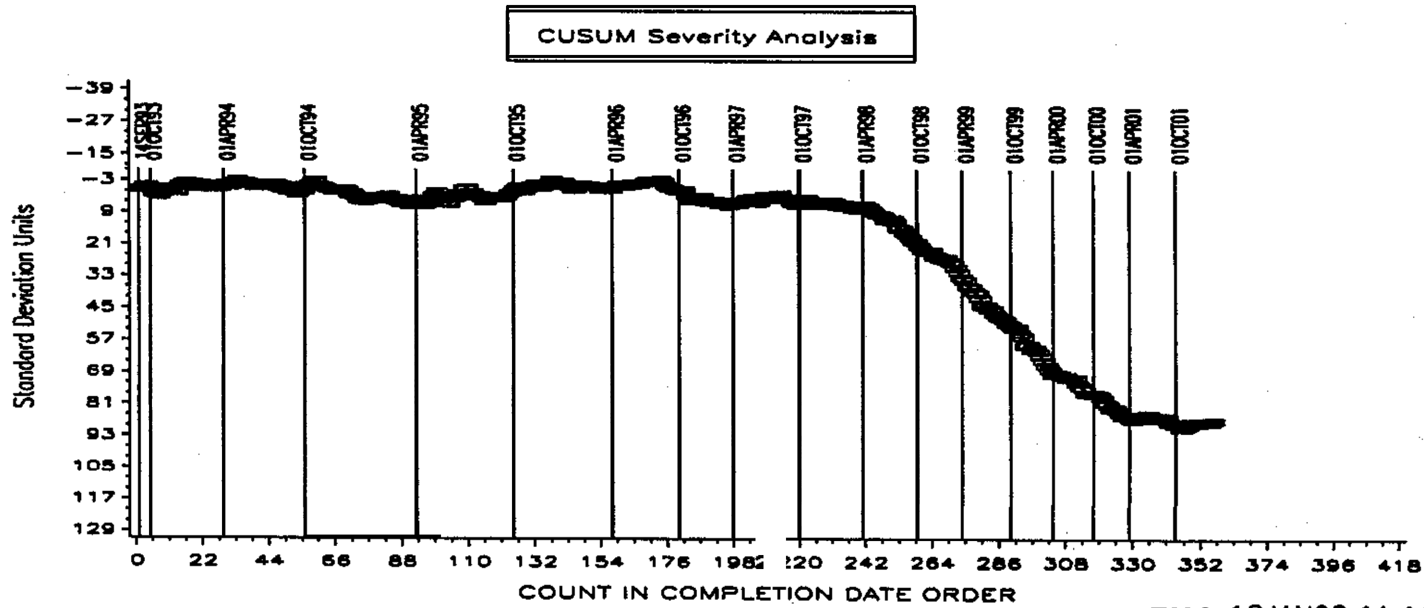
1Y3995 Mean Offset from Torget (-40.9)

Weighted Totol Demerits

Att 7 5/6







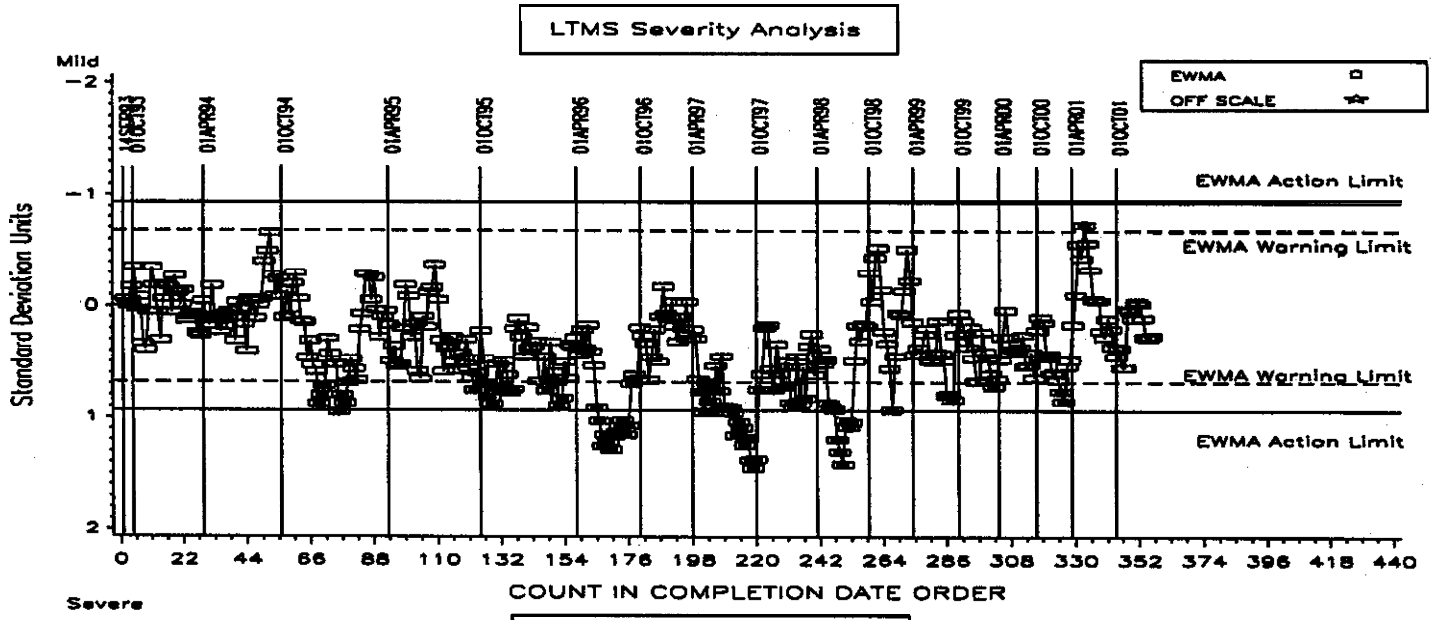
TMC 18JAN02:11:11

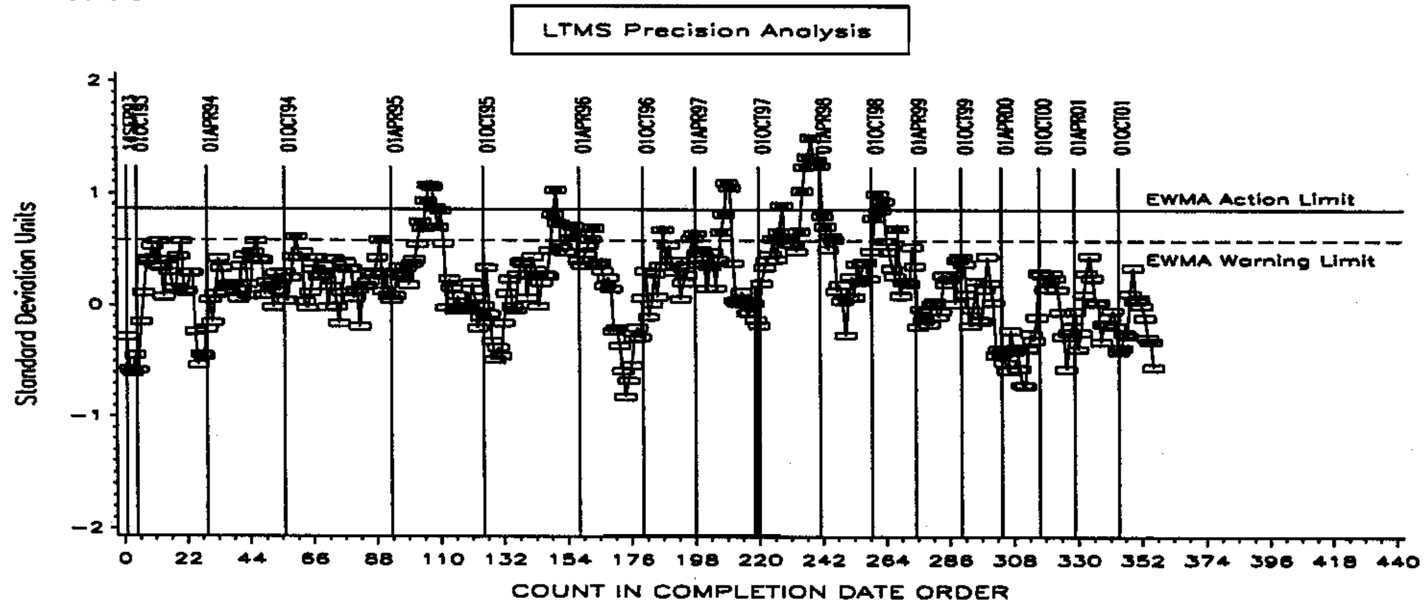
CATERPILLAR 1 M-PC INDUSTRY OPERATIONALLY VALID DATA

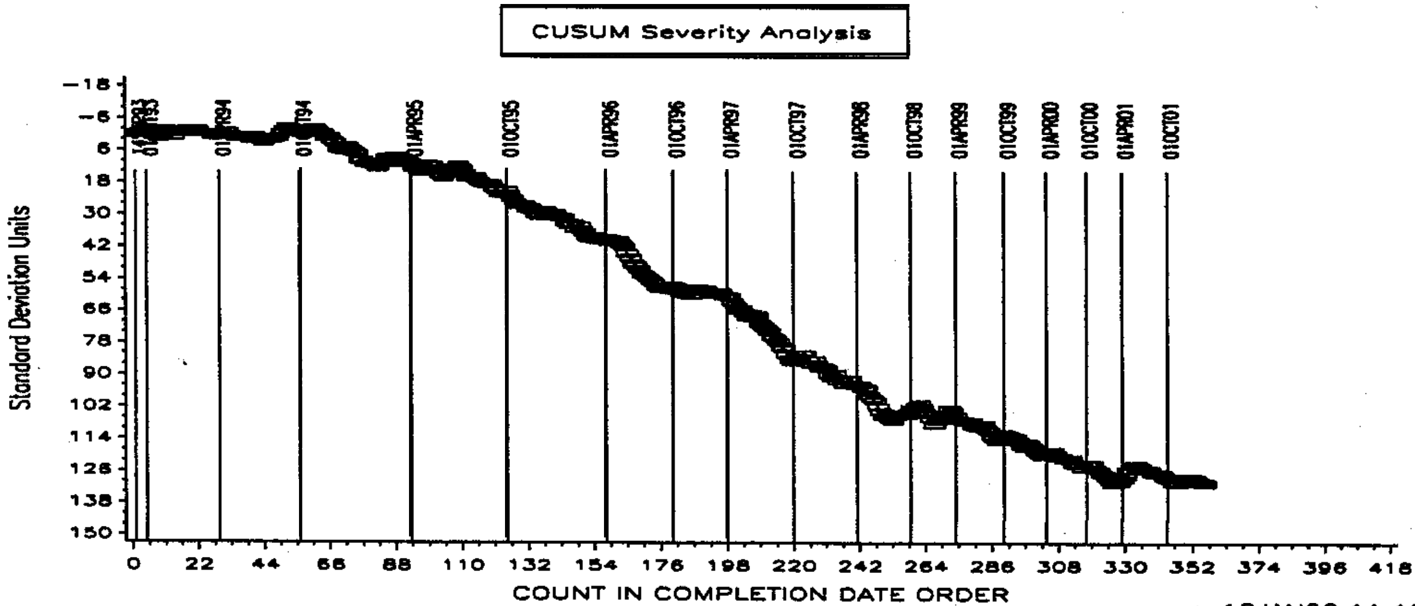
1Y3995 Mean Offset from Torget (-17.9)

Top Groove Fill

Att 7 6/6





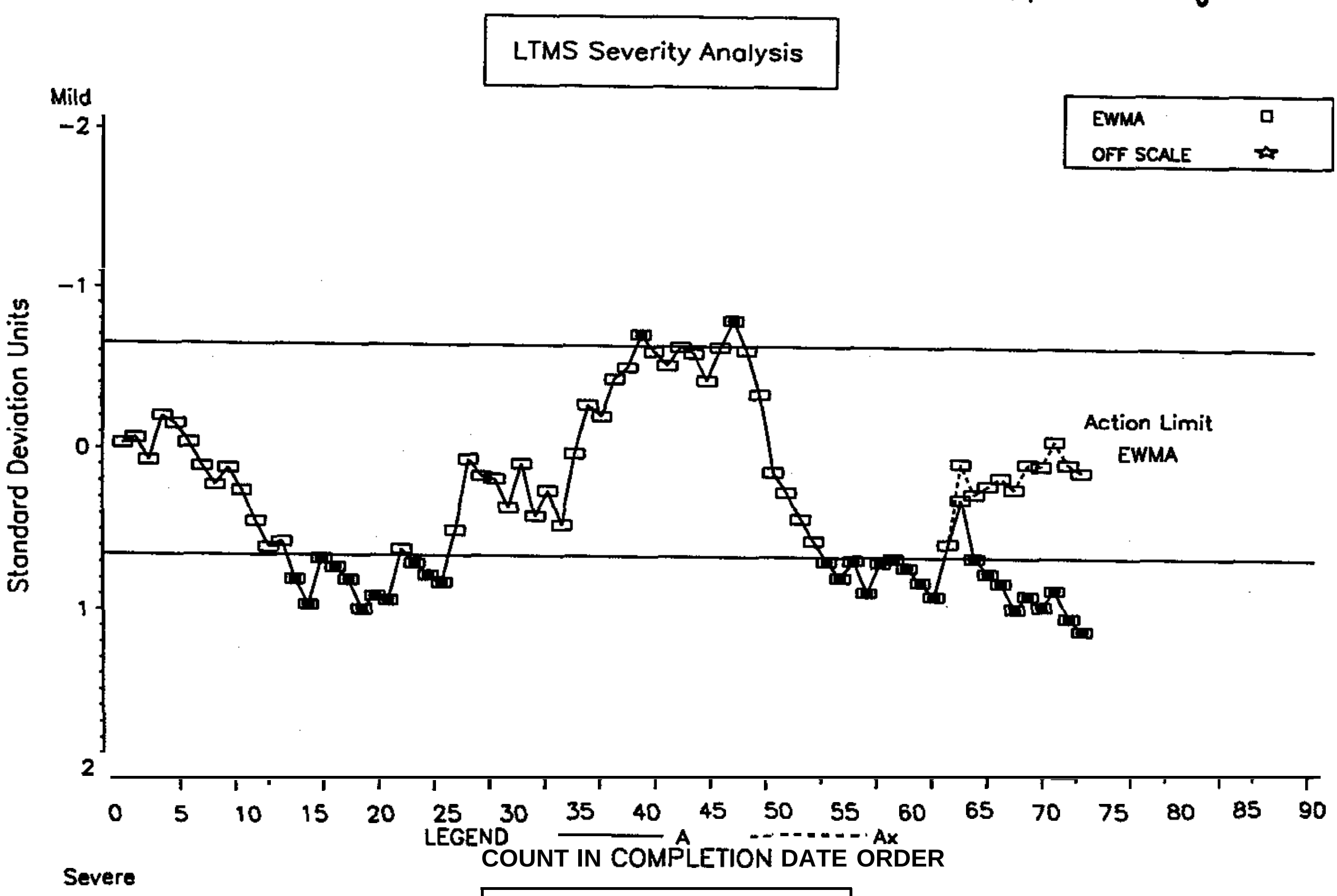


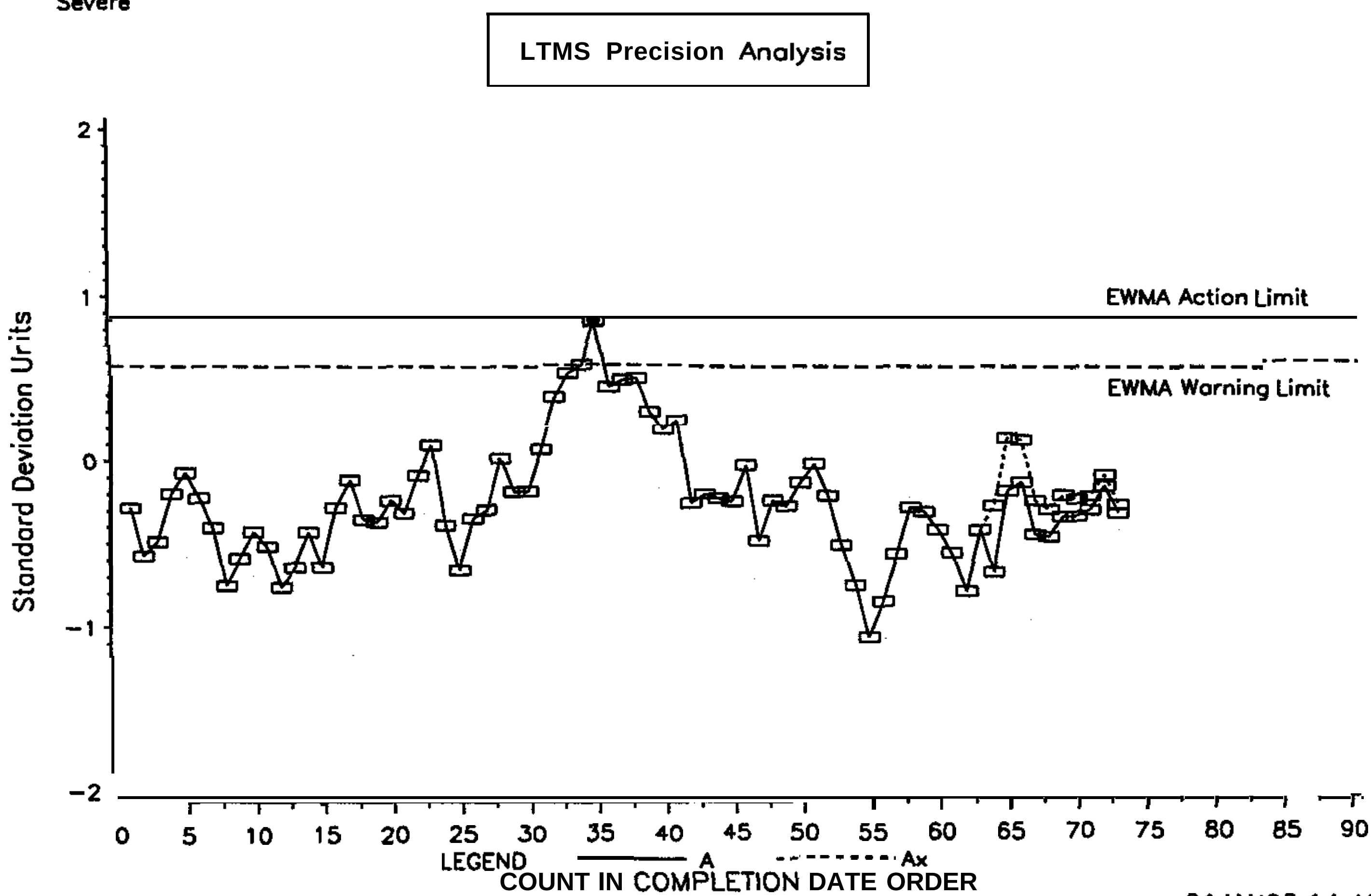
TMC 18JAN02:11:10

CATERPILLAR 1M-PC LAB OPERATIONALLY VALID DATA

Top Groove Fill

Att 8 1/8





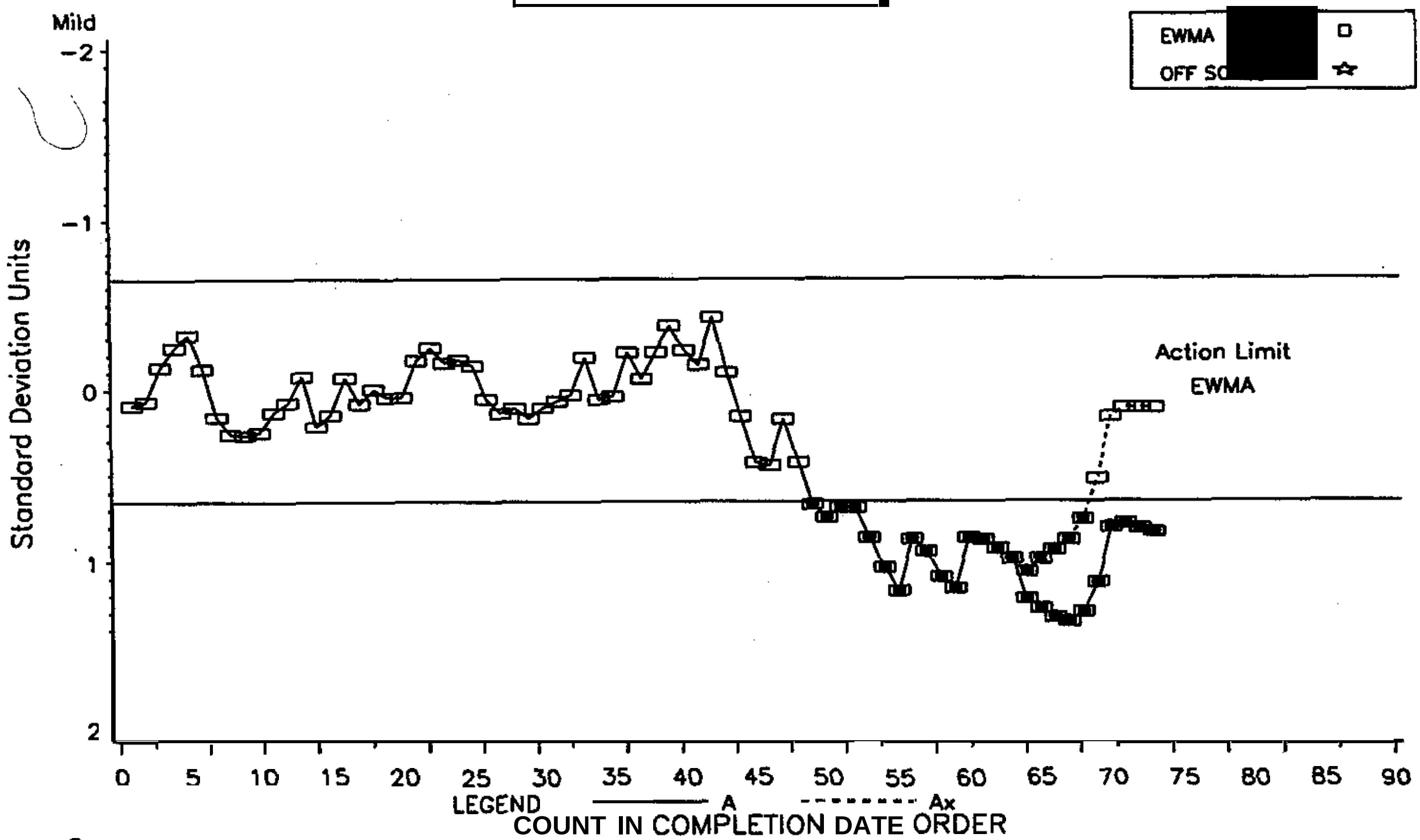
TMC 21JAN02:14:40

CATERPILLAR 1 M-PC LAB OPERATIONALLY VALID DATA

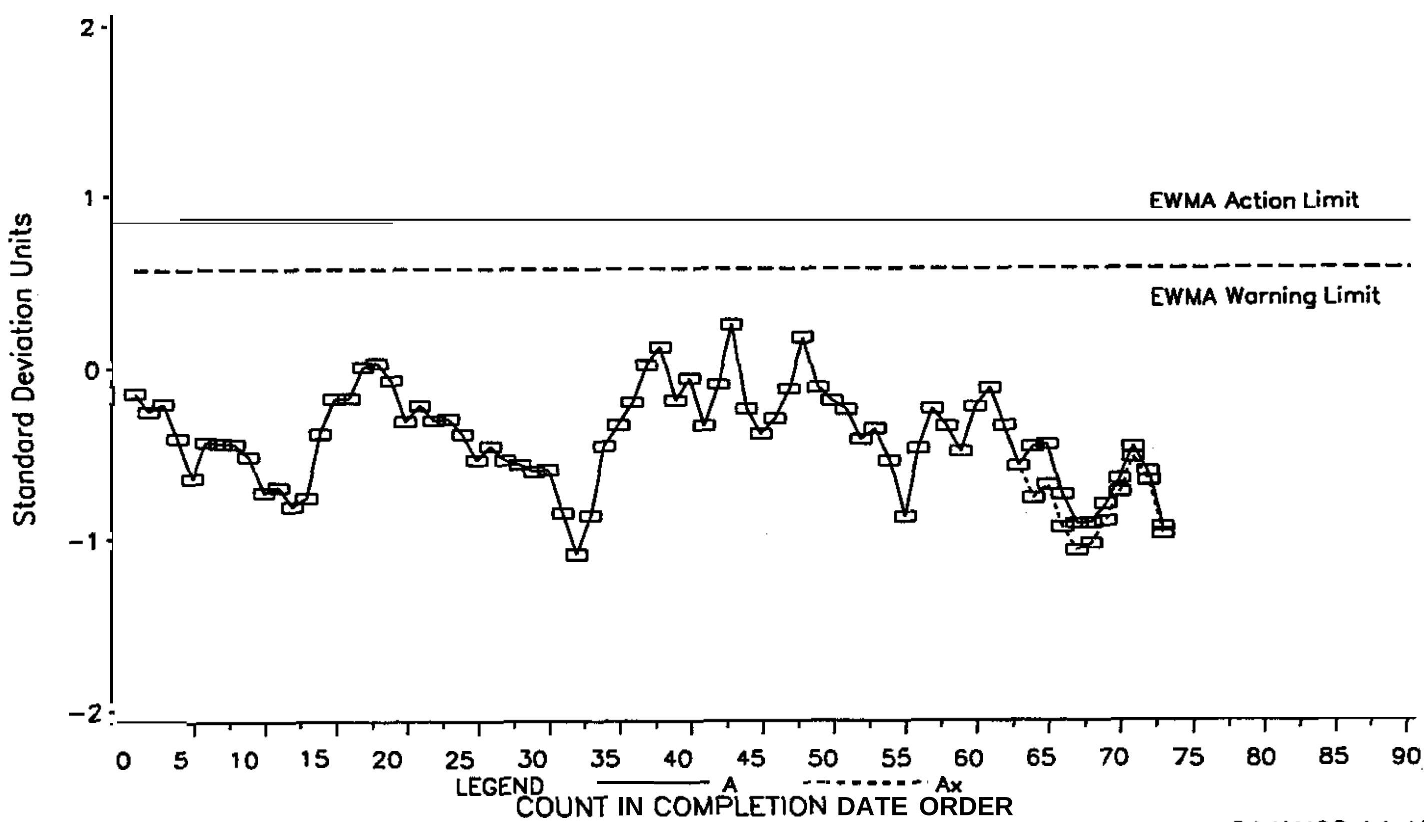
Weighted Total Demerits

Att 8 2/8

LTMS Severity Analysis



LTMS Precision Analysis



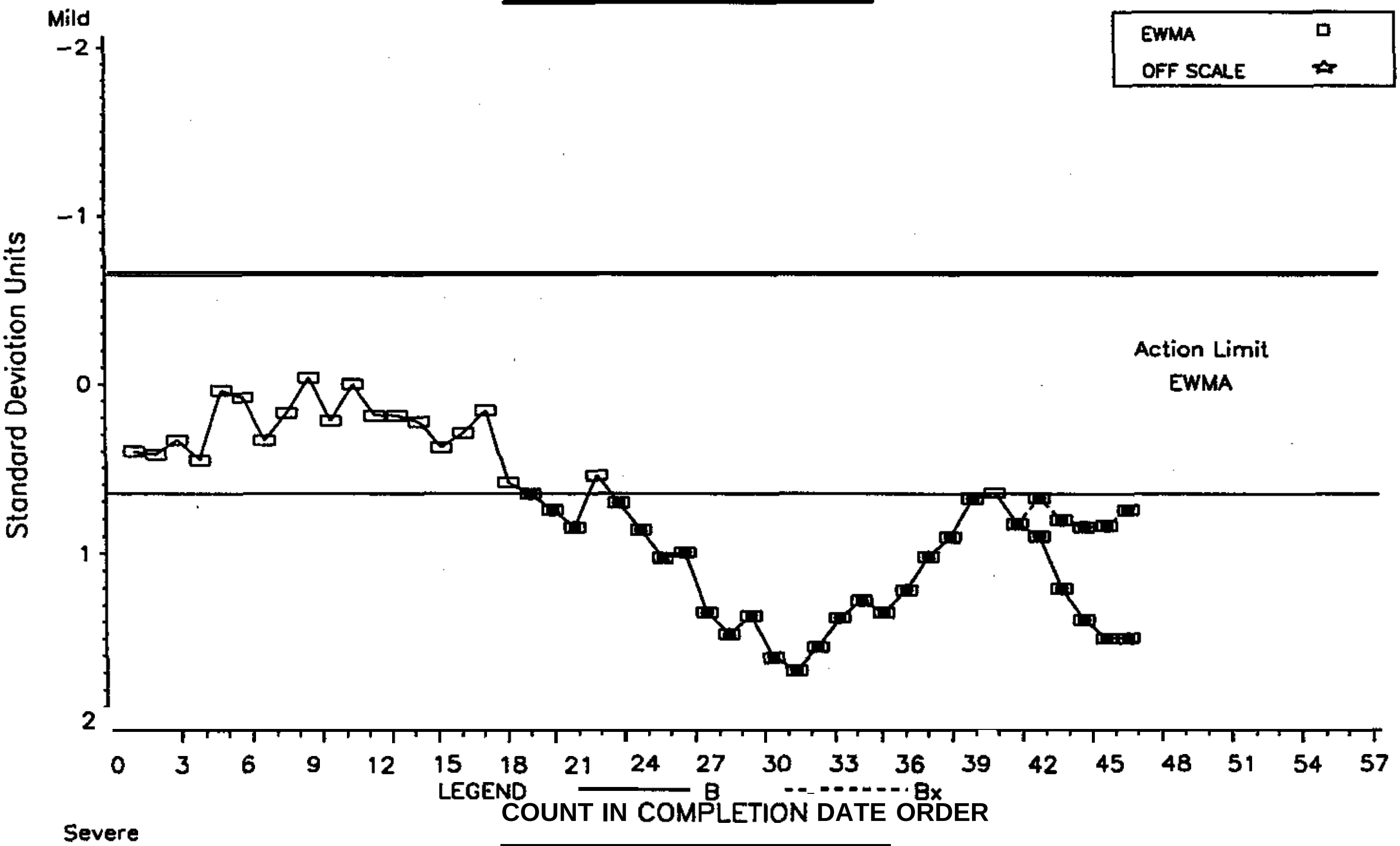
TMC 21JAN02:14:40

CATERPILLAR 1 M-PC LAB OPERATIONALLY VALID DATA

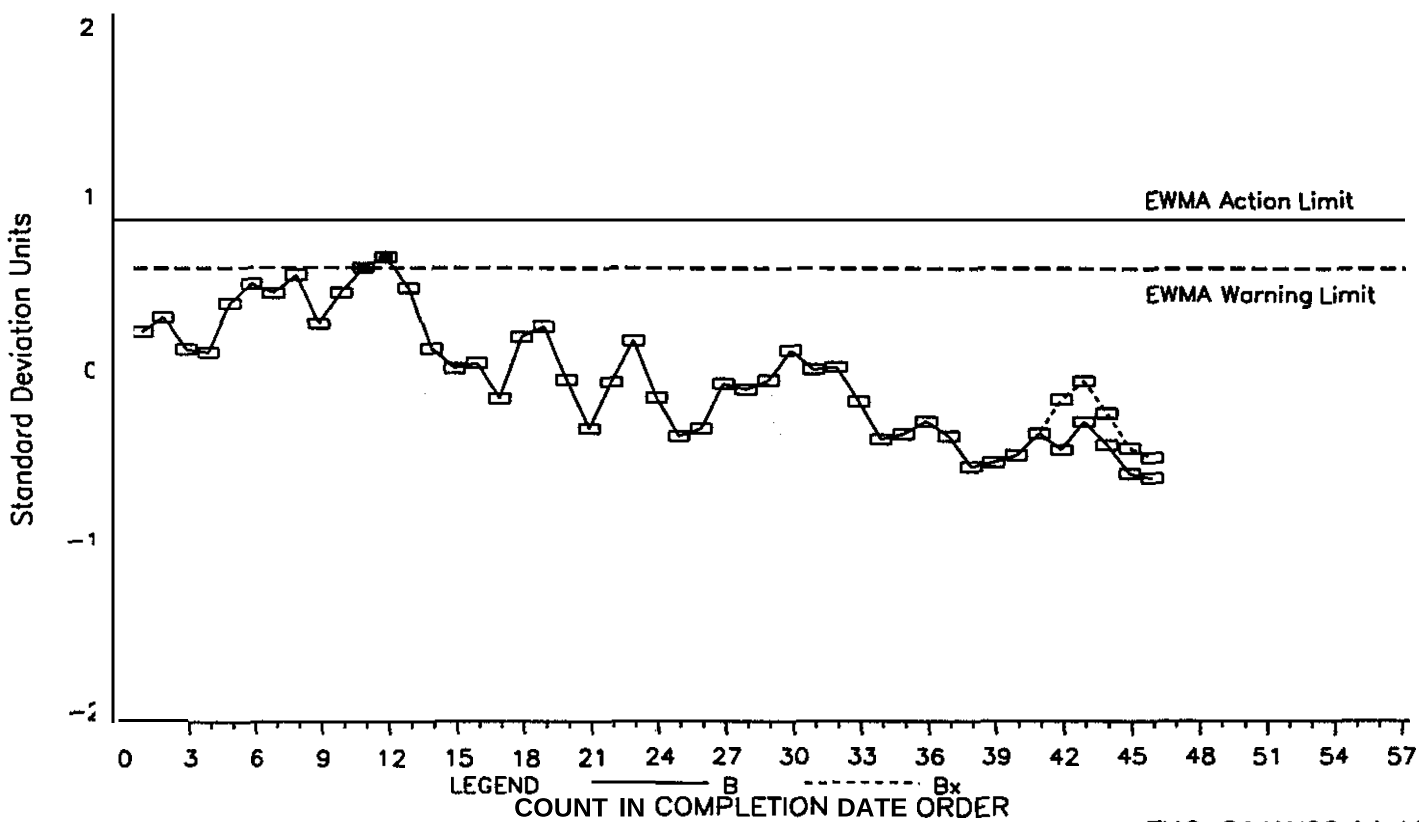
Top Groove Fill

Att 8 3/8

LTMS Severity Analysis



LTMS Precision Analysis



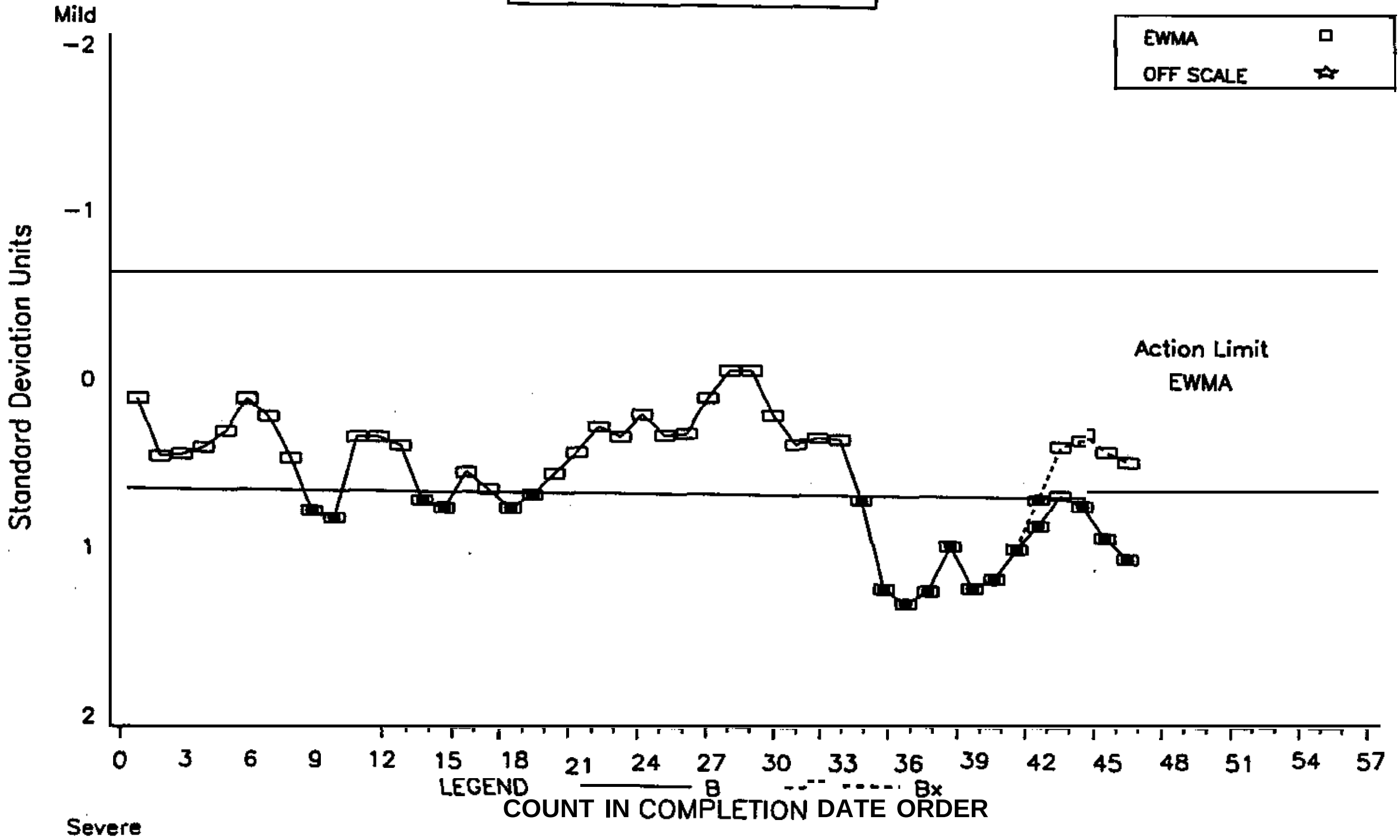
TMC 21JAN02:14:41

CATERPILLAR 1 M-PC LAB OPERATIONALLY VALID DATA

Weighted Total Demerits

Att 8 4/8

LTMS Severity Analysis



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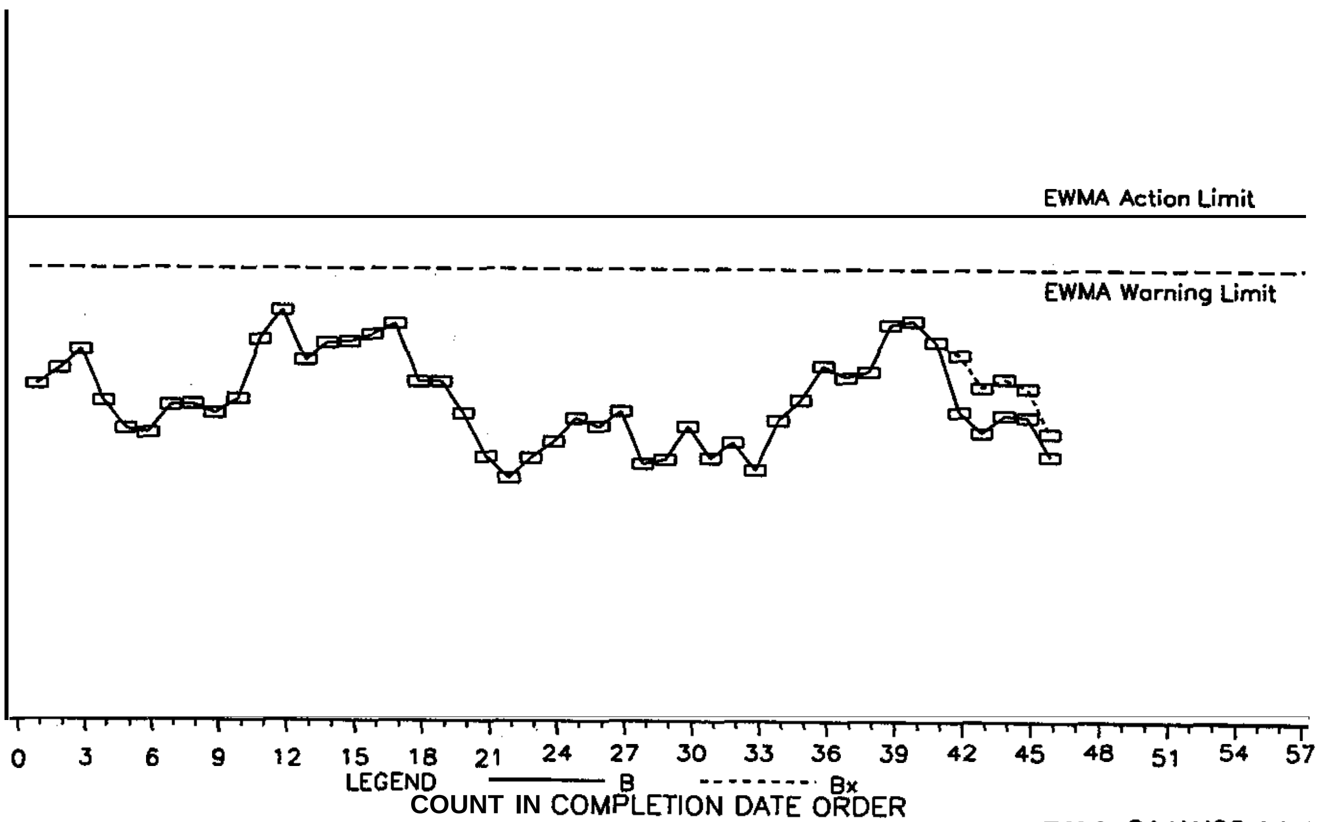


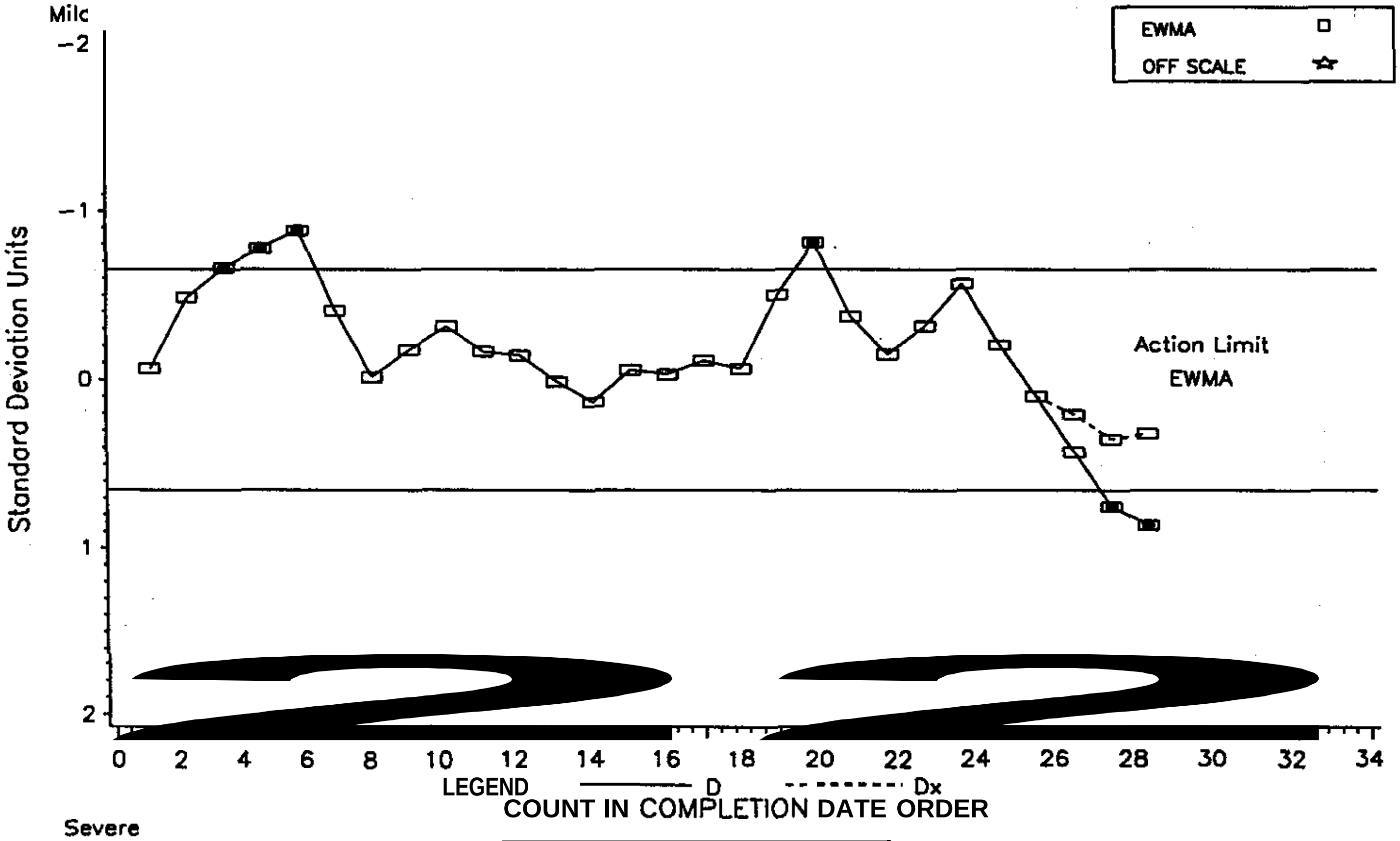
TMC 21JAN02:14:41

CATERPILLAR 1 M-PC LAB OPERATIONALLY VALID DATA

Top Groove Fill

Att 8 5/8

LTMS Severity Analysis



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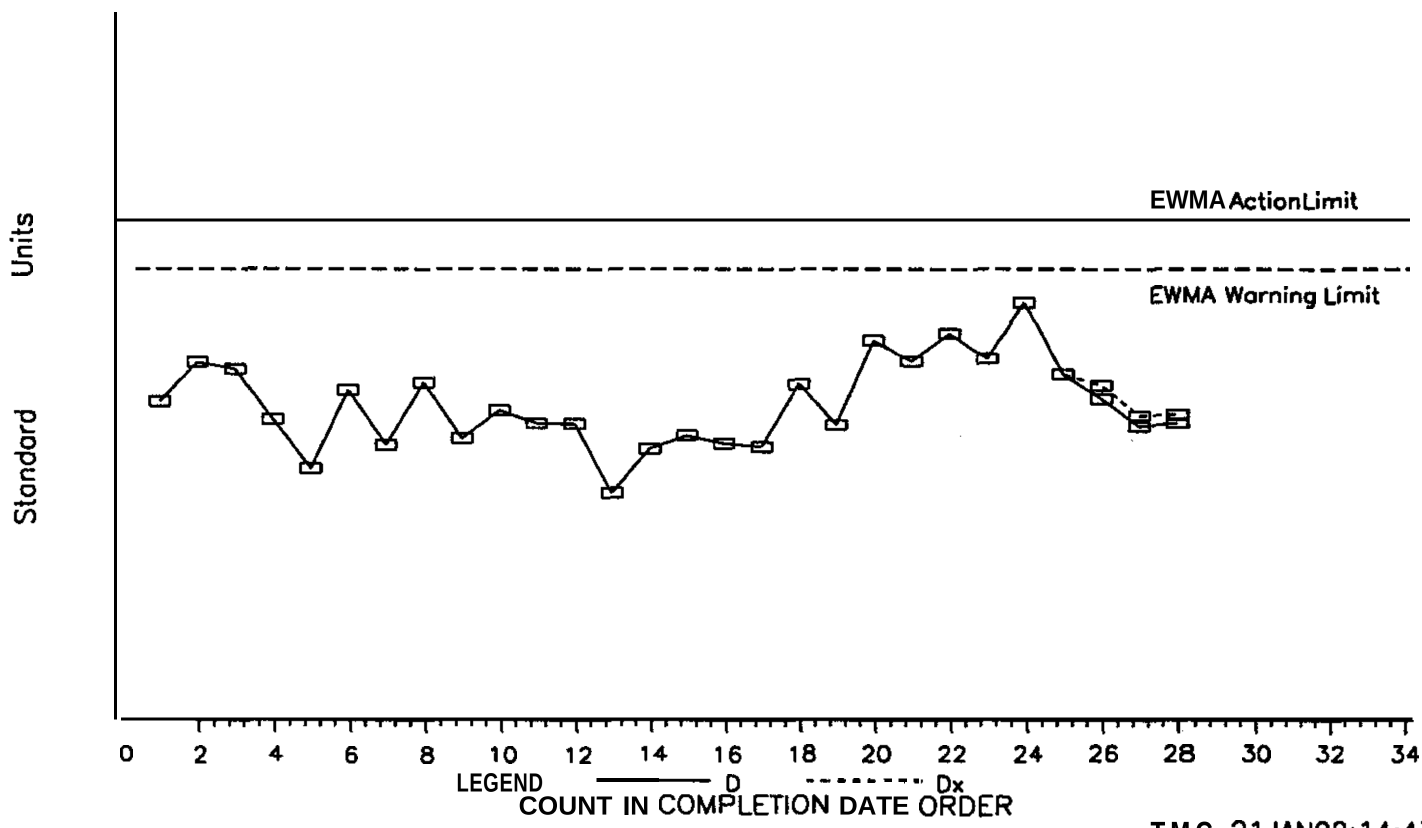
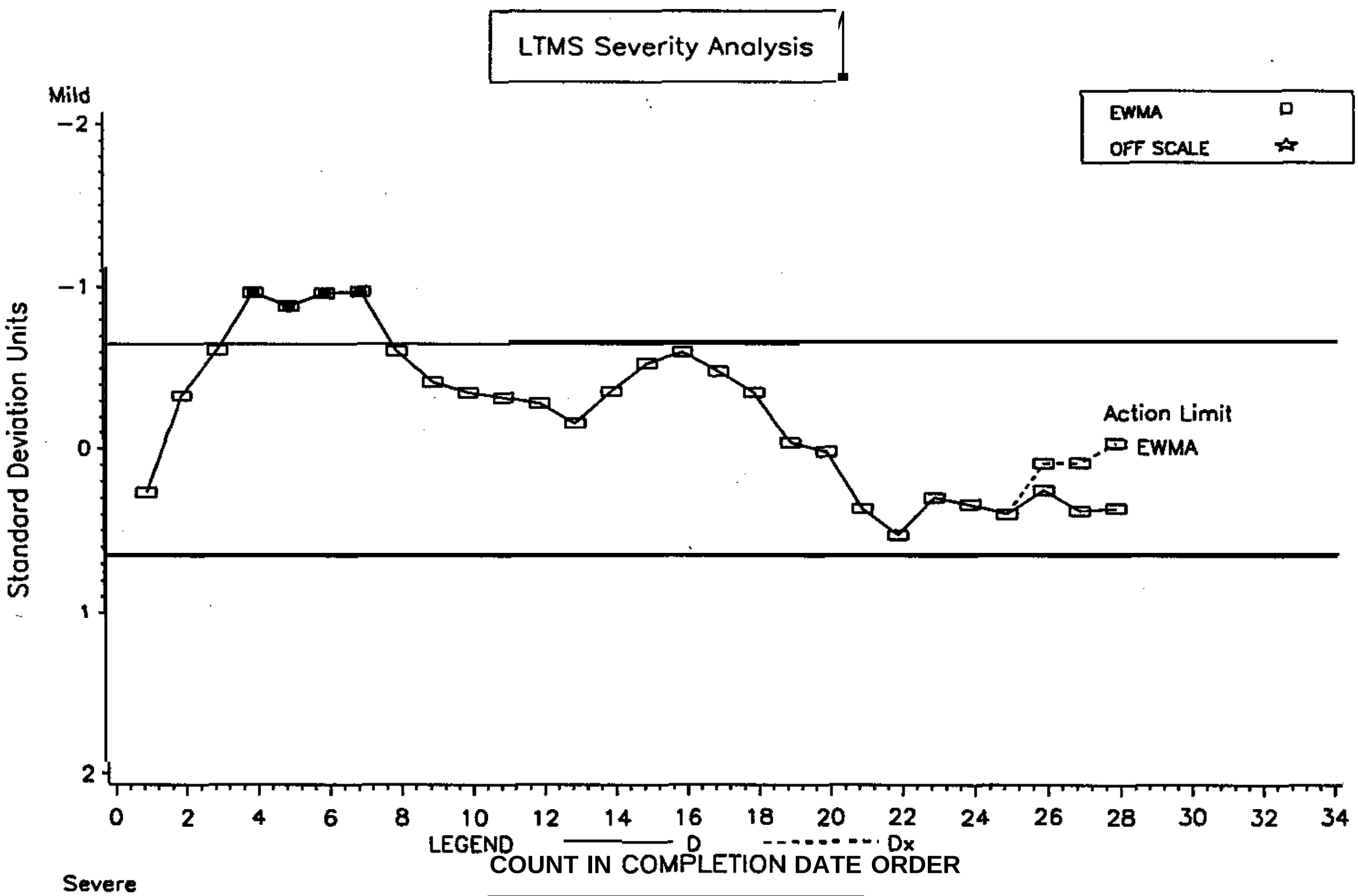


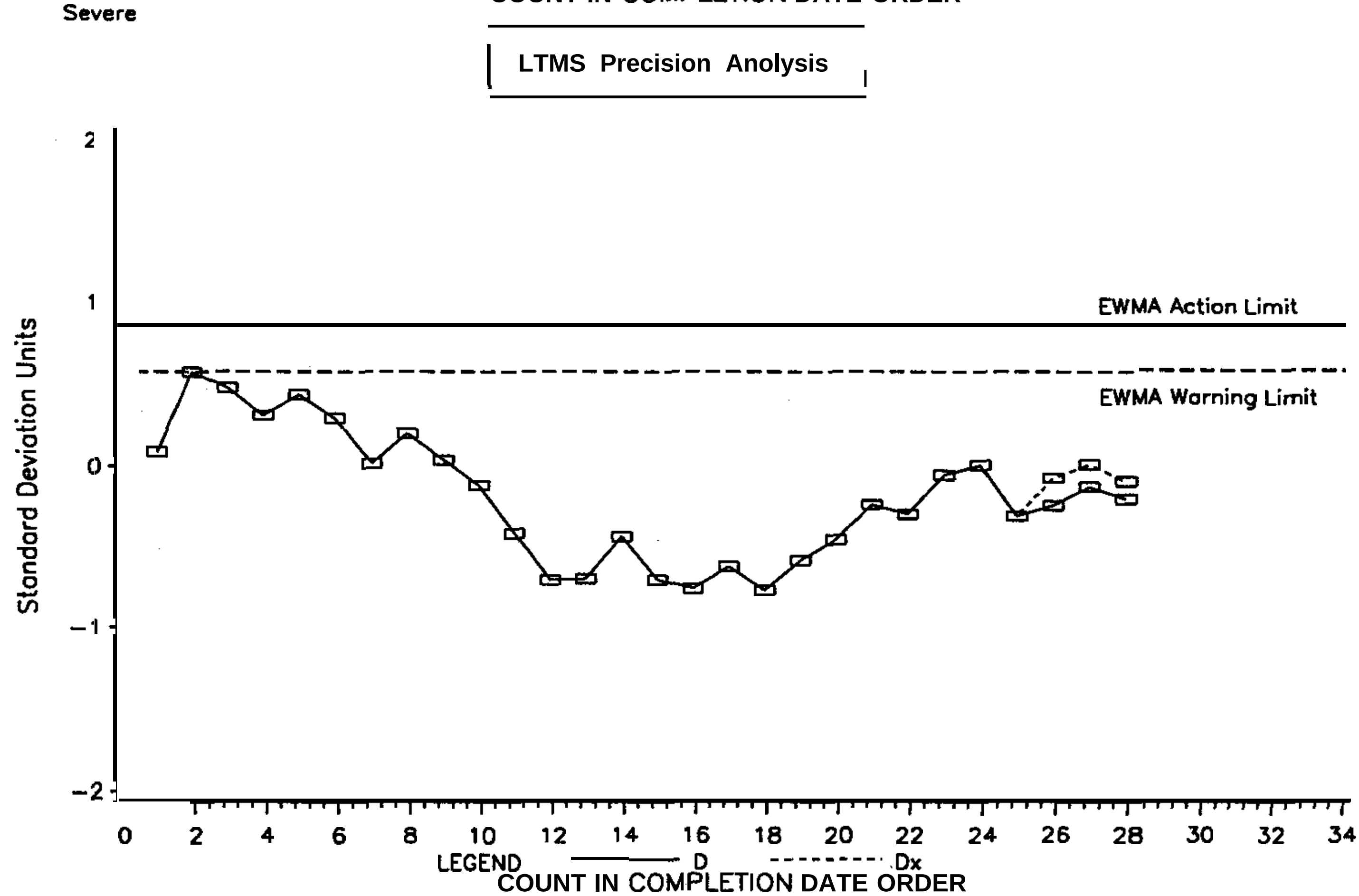
TMC 21JAN02:14:43

CATERPILLAR 1 M-PC LAB OPERATIONALLY VALID DATA

Weighted Total Demerits

Att 8 6/8





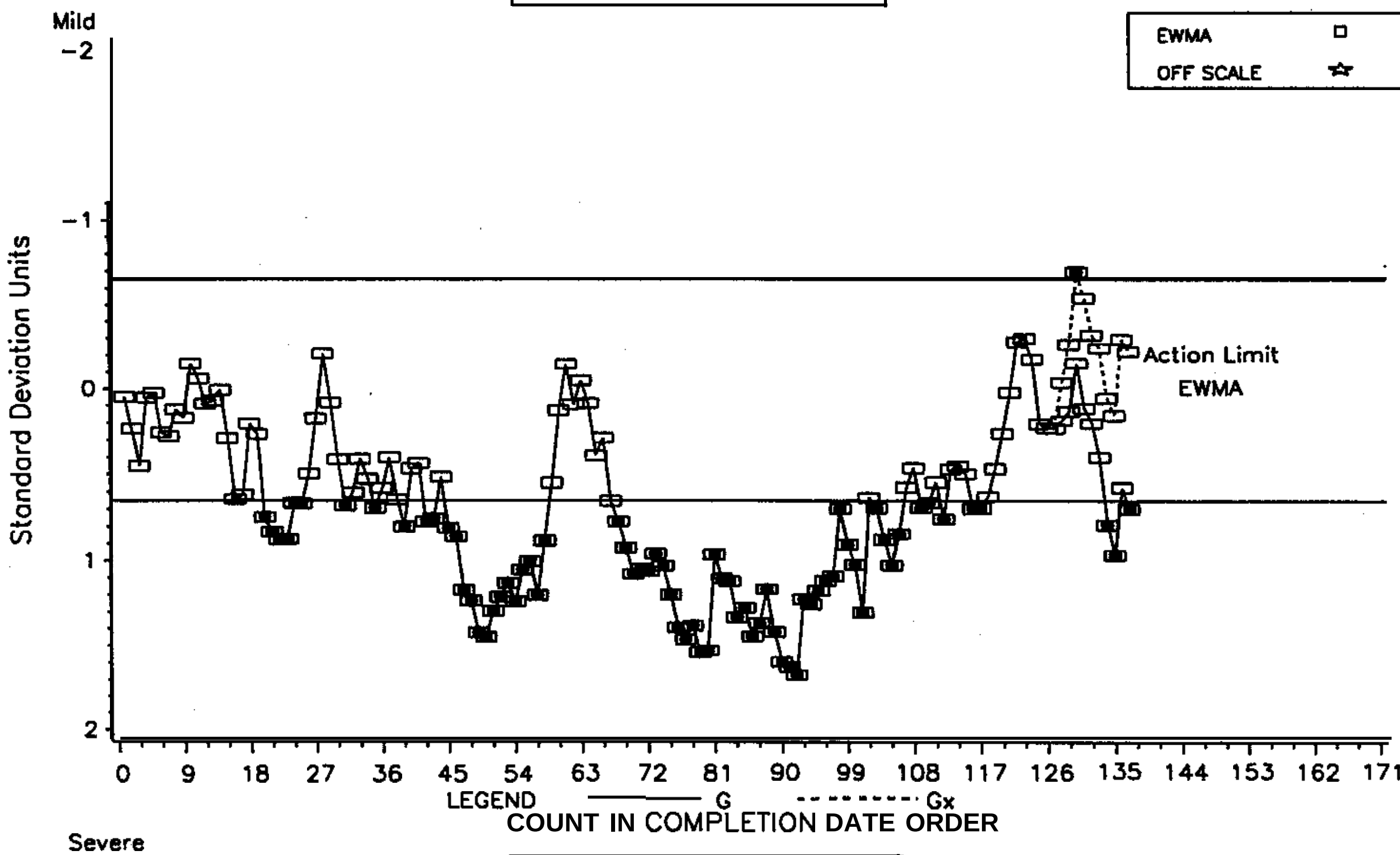
TMC 21JAN02:14:43

CATERPILLAR 1 M-PC LAB OPERATIONALLY VALID DATA

Top Groove Fill

Att 8 7/8

LTMS Severity Analysis



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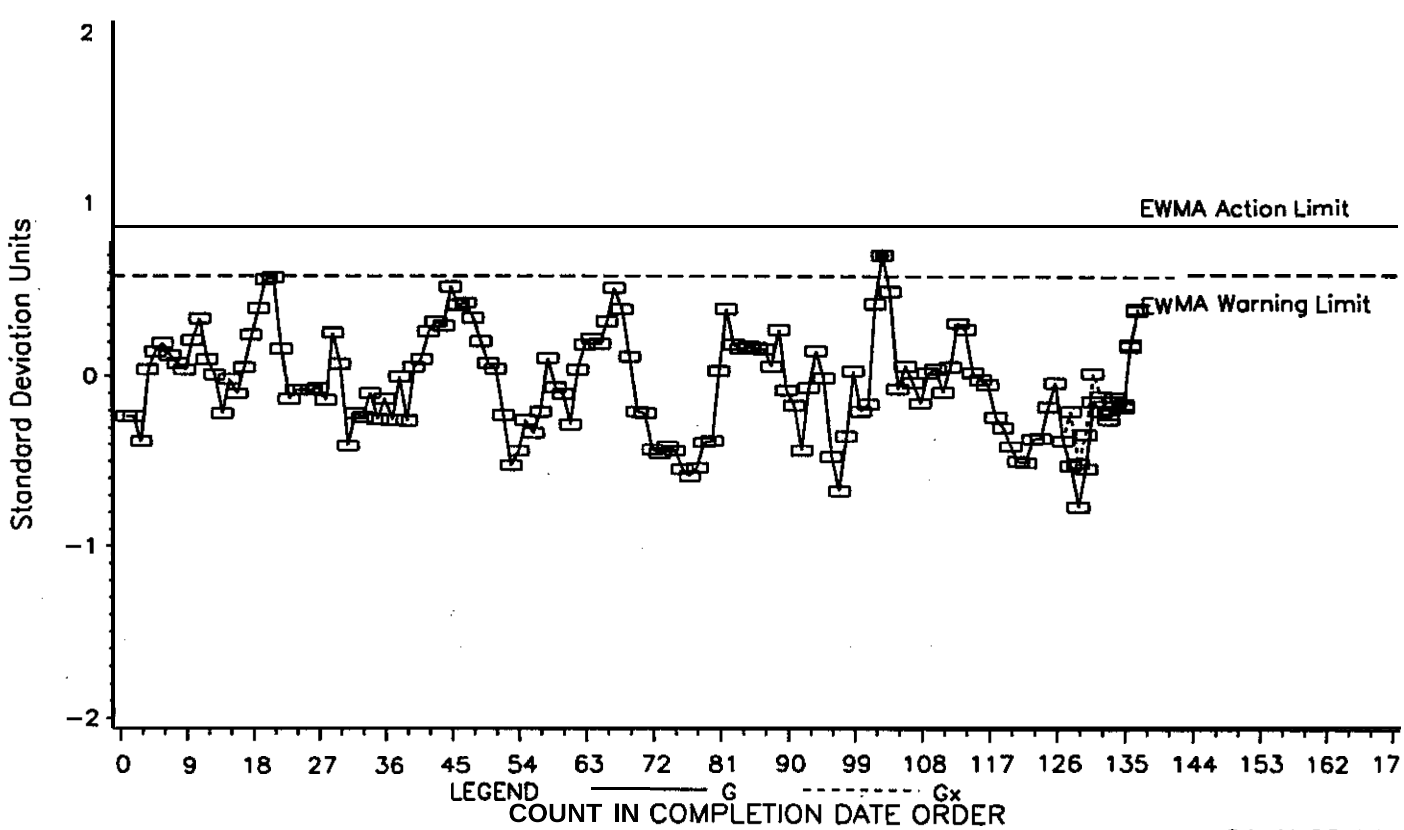
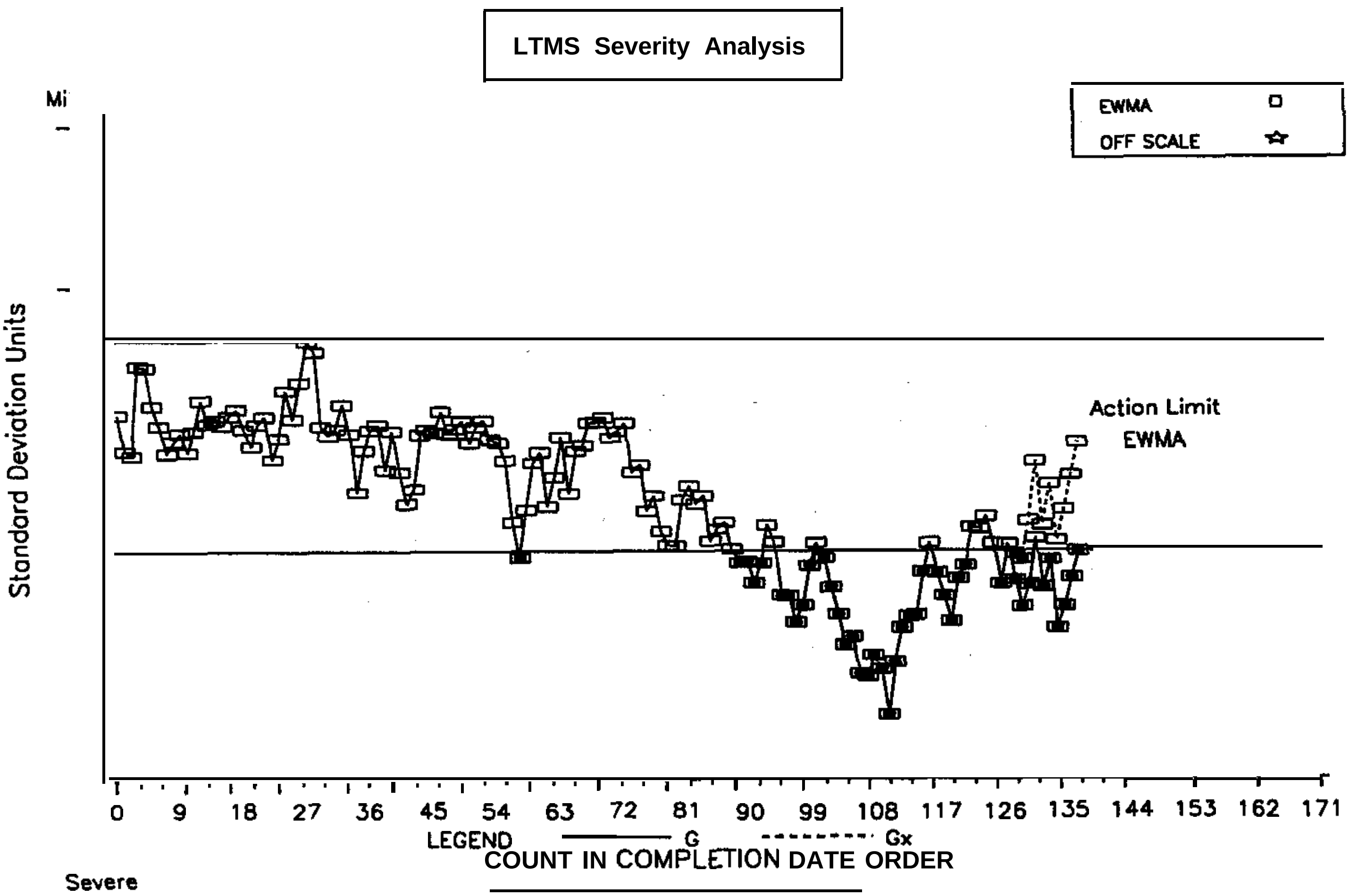


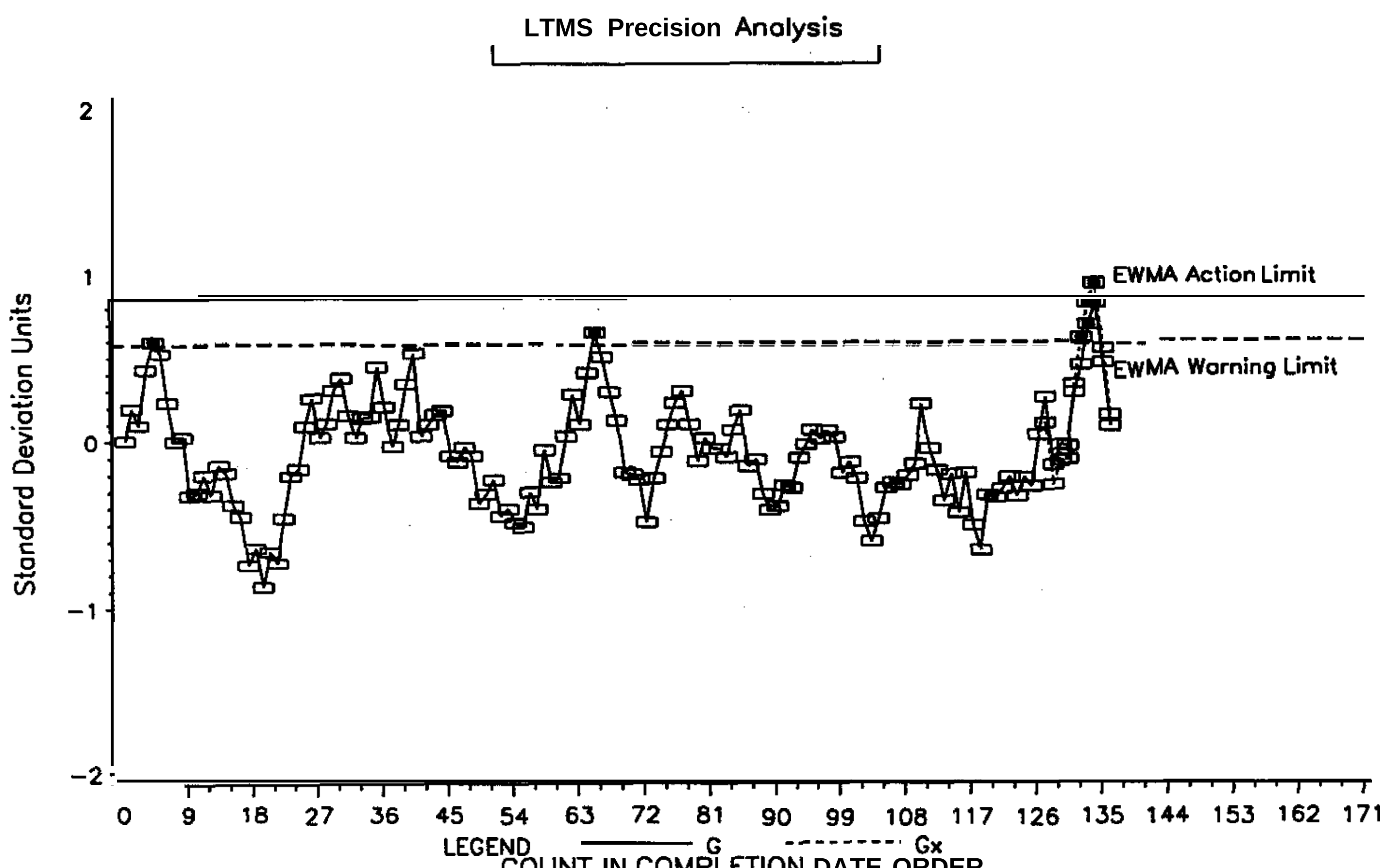
TMC 21JAN02:14:44

CATERPILLAR 1 M-PC LAB OPERATIONALLY VALID DATA

Weighted Totol Demerits

Att 8 8/8





TMC 21JAN02:14:44

CAT 1MPC Test Analysis

Preliminary Analysis

To Be Presented at the SCOTE Surveillance Panel Meeting

Elisa Santos

Elisa.Santos@Infineum.com

January 2002

Att 9 1/24

Data

- Data Source: Data collected from the Test Monitoring Center web site on 01/15/2002 (Path: refdata/diesel/1m/data)
- The following filters were applied to the original file
  - LTMSLAB equal to “A”, “B”, “D”, “G”
  - IND equal “873-1”
  - CHART equal to “Y”
  - VAL equal to “AC”, “OC”, “C”

Att 9 2/24

Graphical Analysis of the reference data

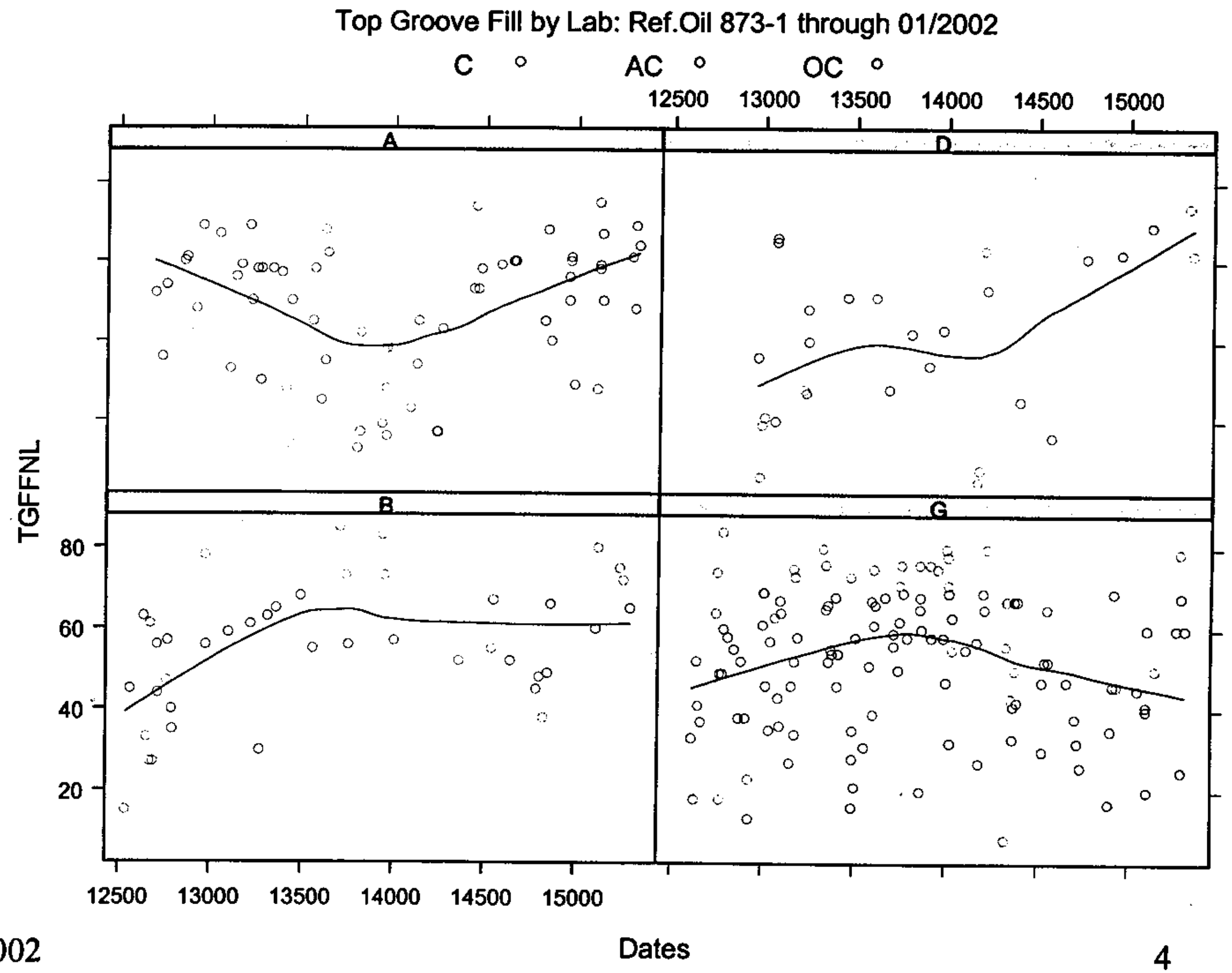
Att 9 3/24

This TGF plot shows how this test has evolved with time and where the AC and OC points fall. It shows a lot of variability and an increase of TGF values for Labs A, D, and B. Lab G seems to show some decrease in the TGF values.

Date Key

Dates	Julian
10/14/1998	14166
12/27/1998	14240
12/02/1999	14582
12/21/2000	14965
12/25/2001	15334

Validity Designation
C Calibration test
AC Acceptable
OC Operationally valid, does not meet statistical criteria

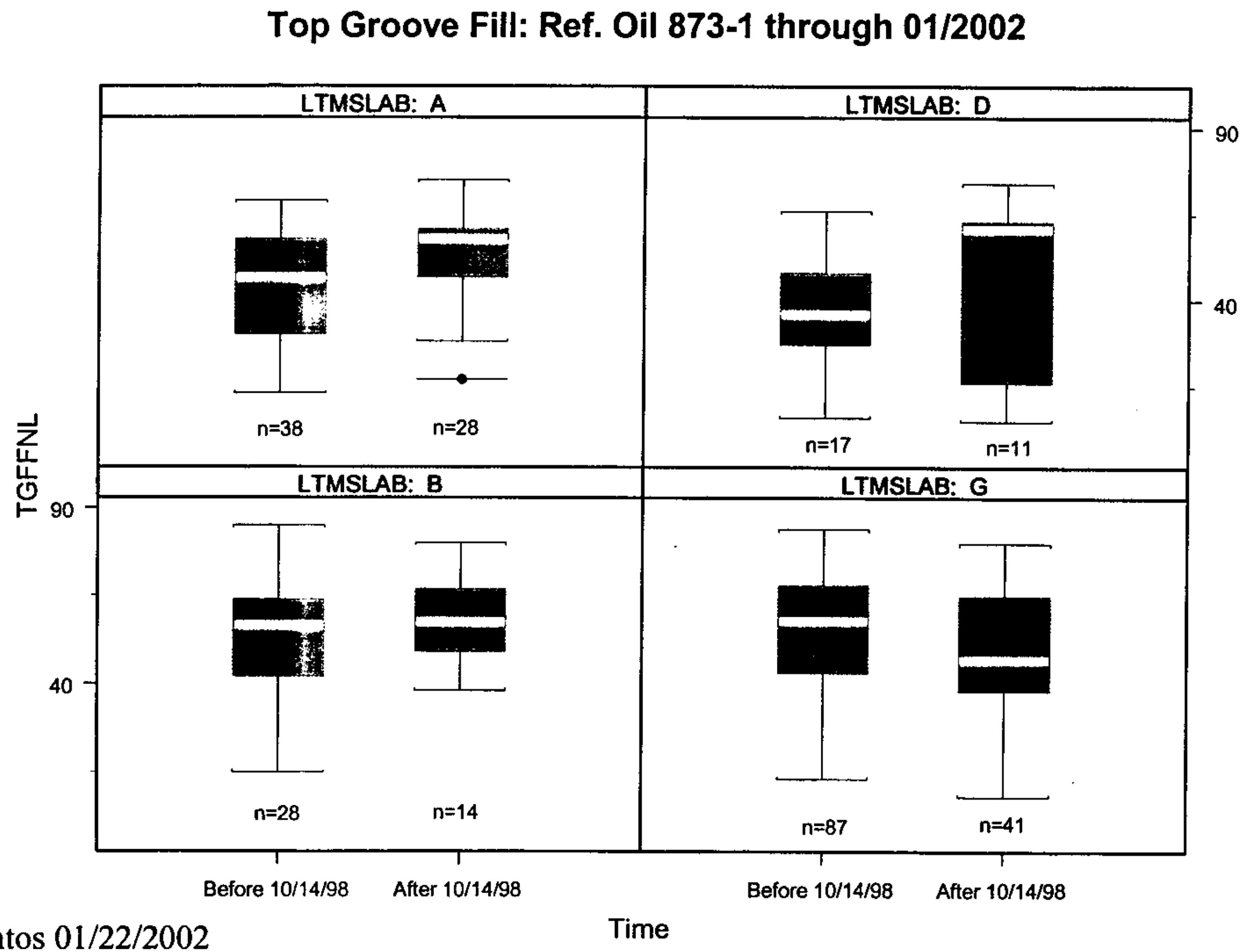


Elisa Santos 01/22/2002

Att 9 4/24

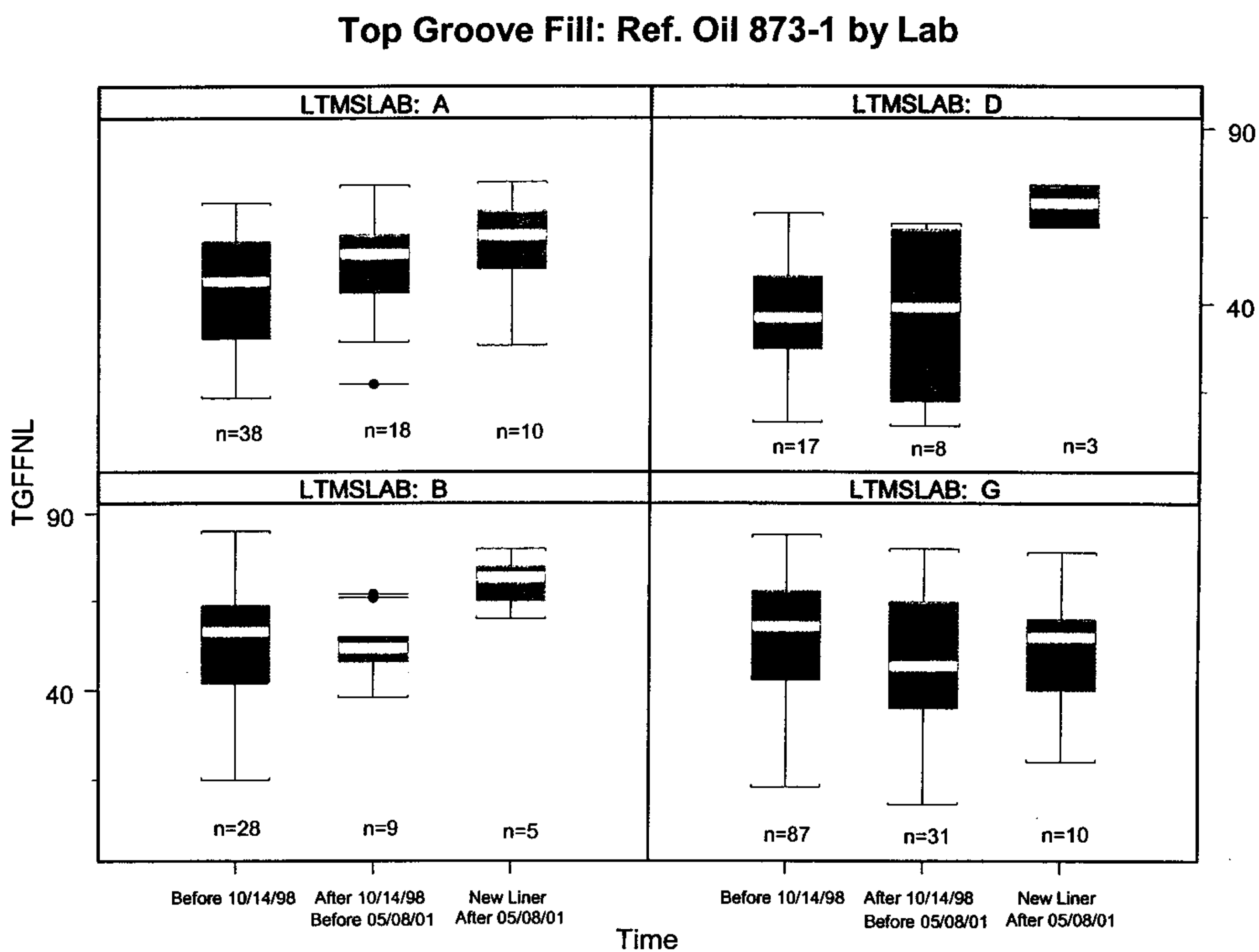
Cut off for Time: 10/14/1998

Objective: show how test has evolved with time and by Lab. Note that Lab G shows a mild downward tendency while the others don't.



Att 9 5/24

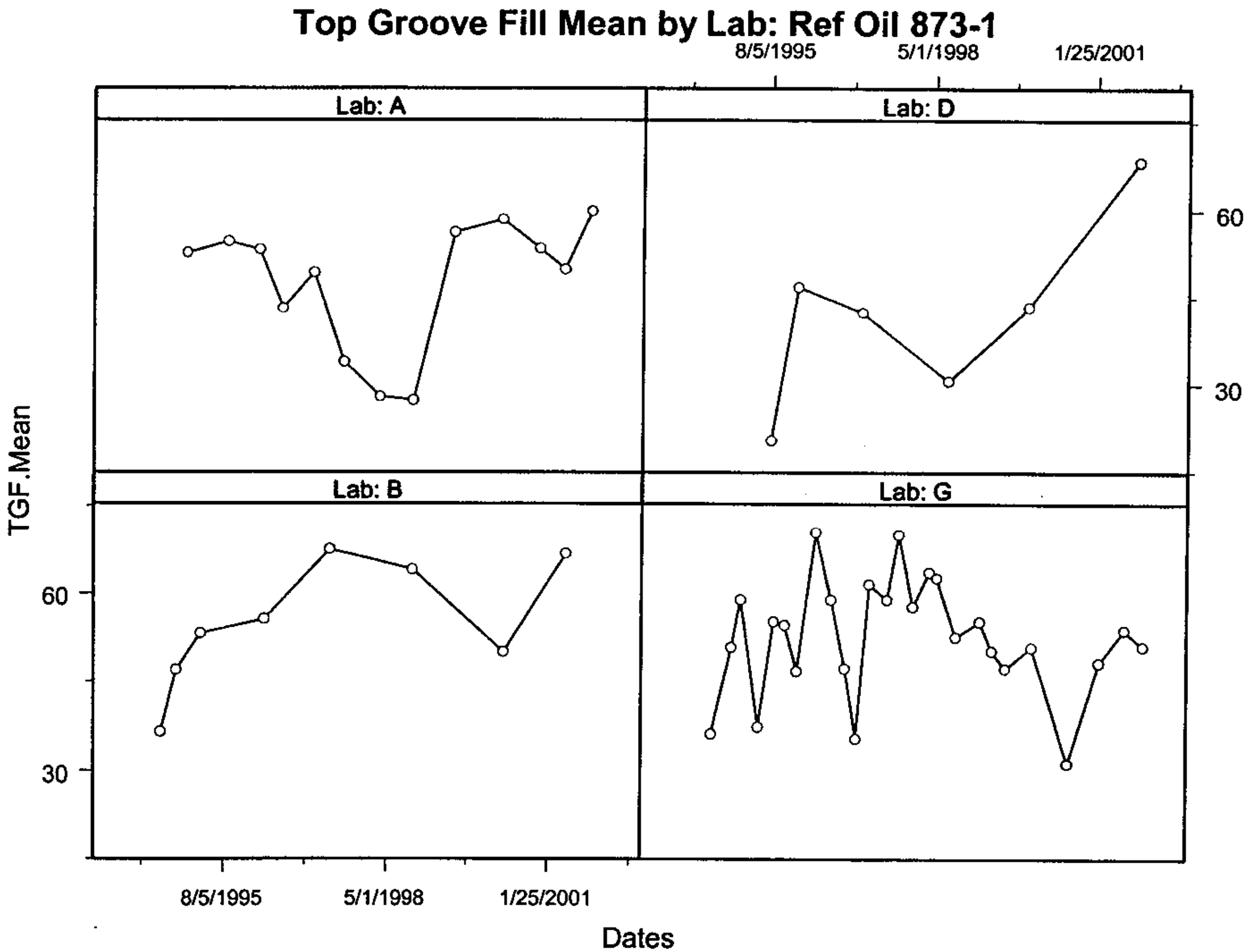
Introducing one more level for Time through "New Liner" New Liner seems to have an impact on TGF



Elisa Santos 01/22/2002

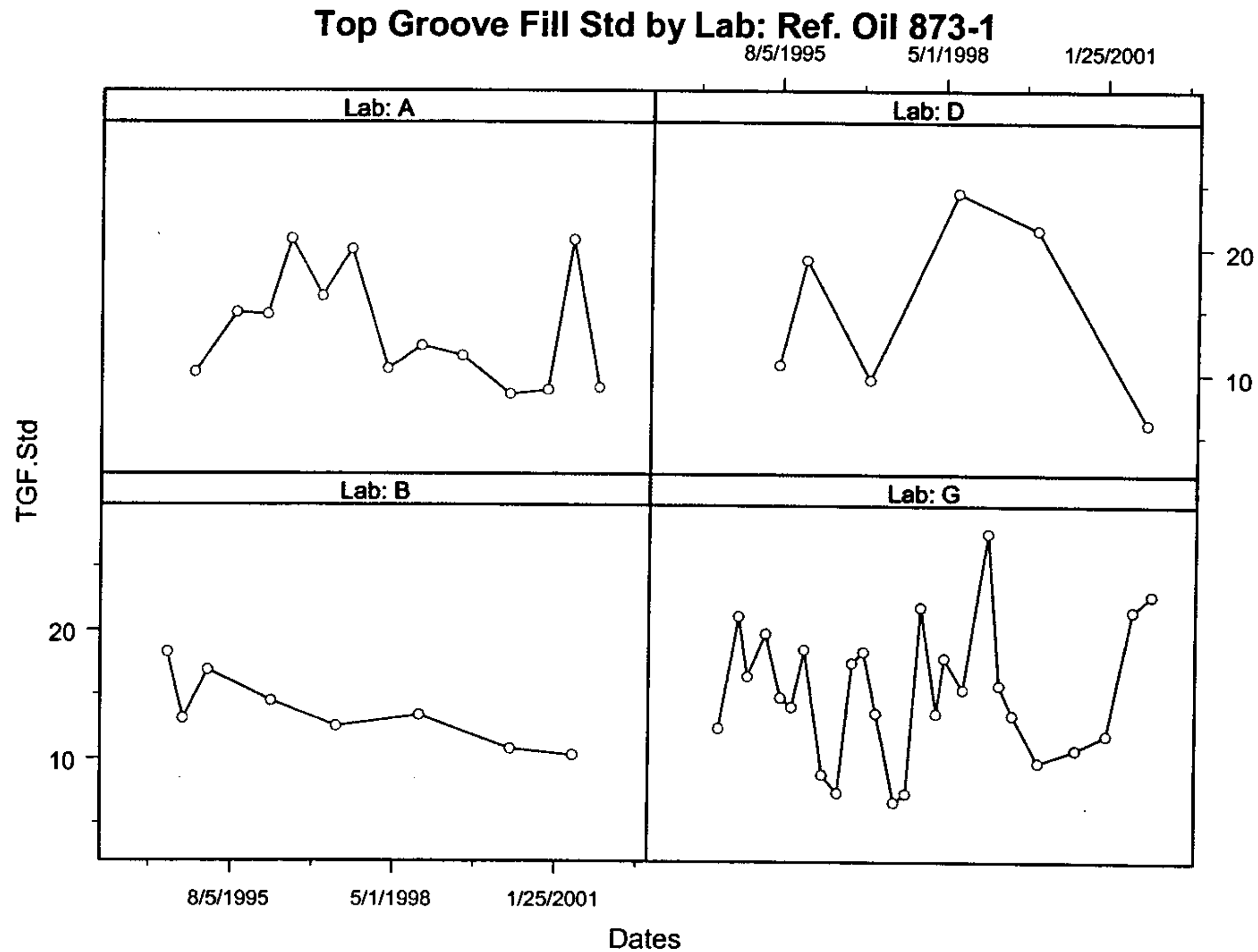
Att 9 6/24

This plot shows the average of every five data points for TGF across time for Ref. Oil 873-1 by Lab. It is just another way of describing the test behaviour along time.



Att 9 7/24

This plot shows the standard deviation for every five data points for TGF across time Ref. Oil 873-1 by Lab. It is a way of describing the variability of the test along time.



Att 9 8/24

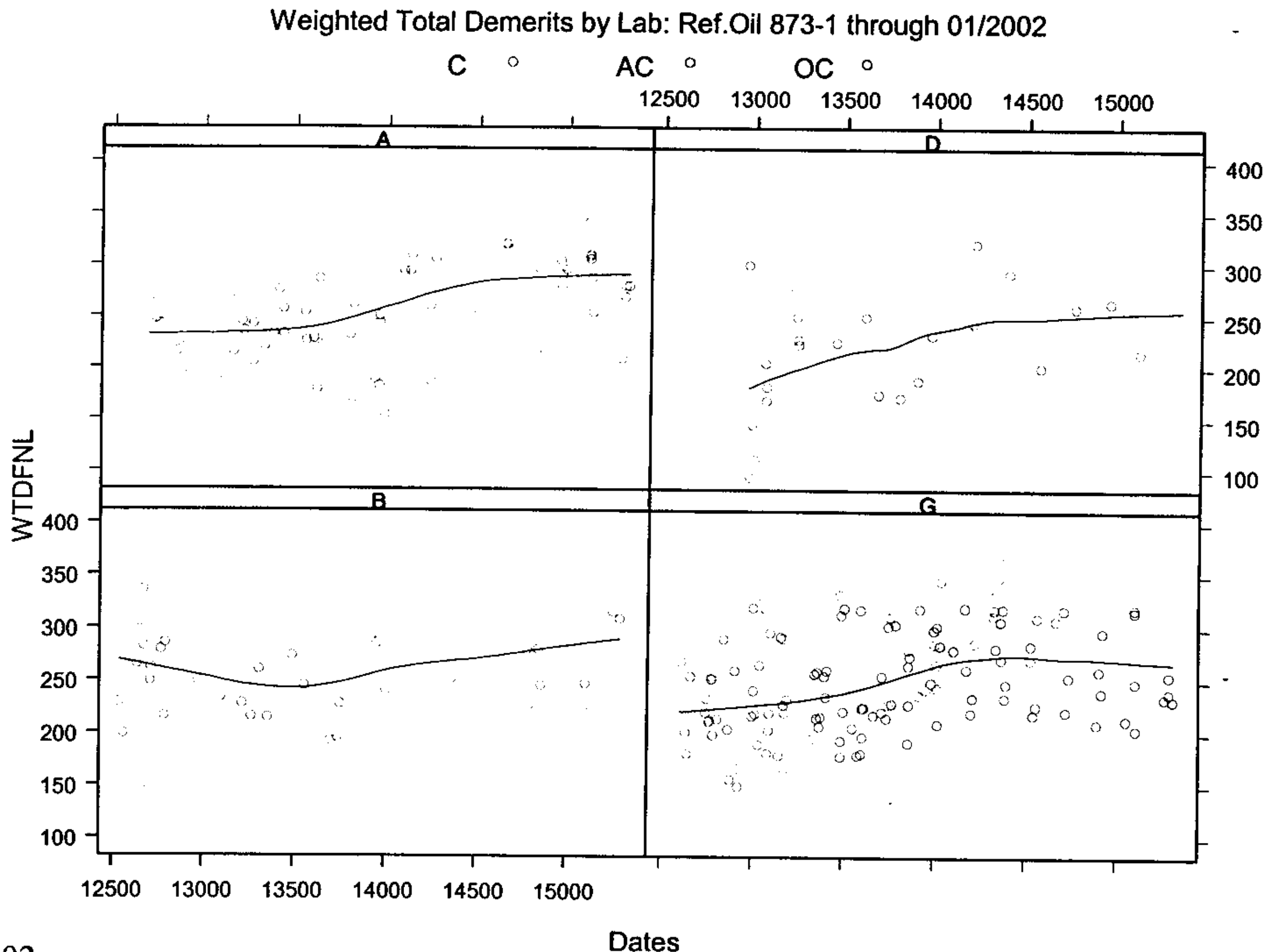
Elisa Santos 01/22/2002

This plot of WDT shows how this test has evolved with time and where the AC and OC points fall. It shows that WTD is less variable than TGF and also an increase of WDT for all Labs.

Date Key

Dates	Julian
10/14/1998	14166
12/27/1998	14240
12/02/1999	14582
12/21/2000	14965
12/25/2001	15334

Validity Designation
C Calibration test
AC Acceptable
OC Operationally valid. does not meet statistical criteria

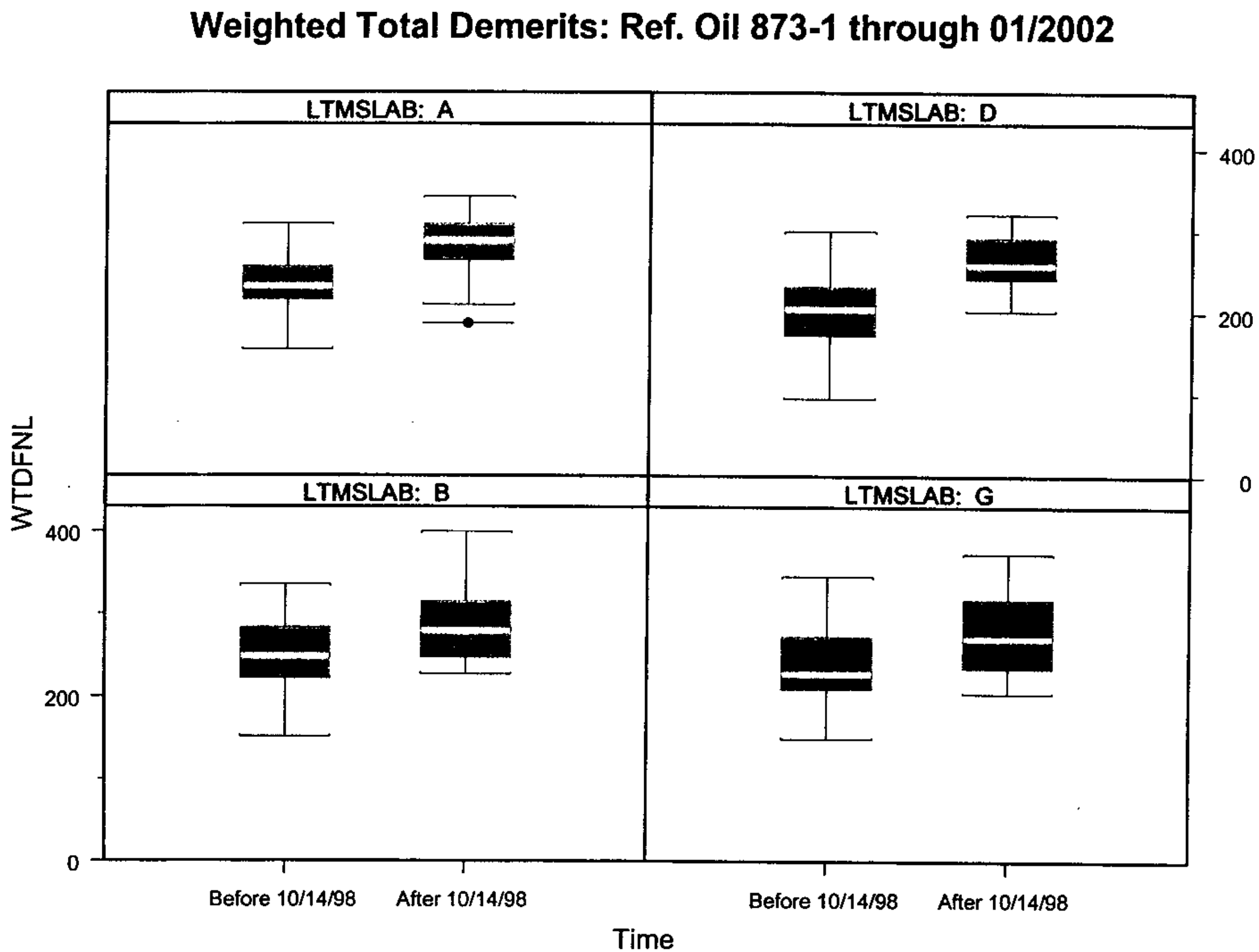


Elisa Santos 01/22/2002

ATZ 9 9/24

Cut off for Time: 10/14/1998

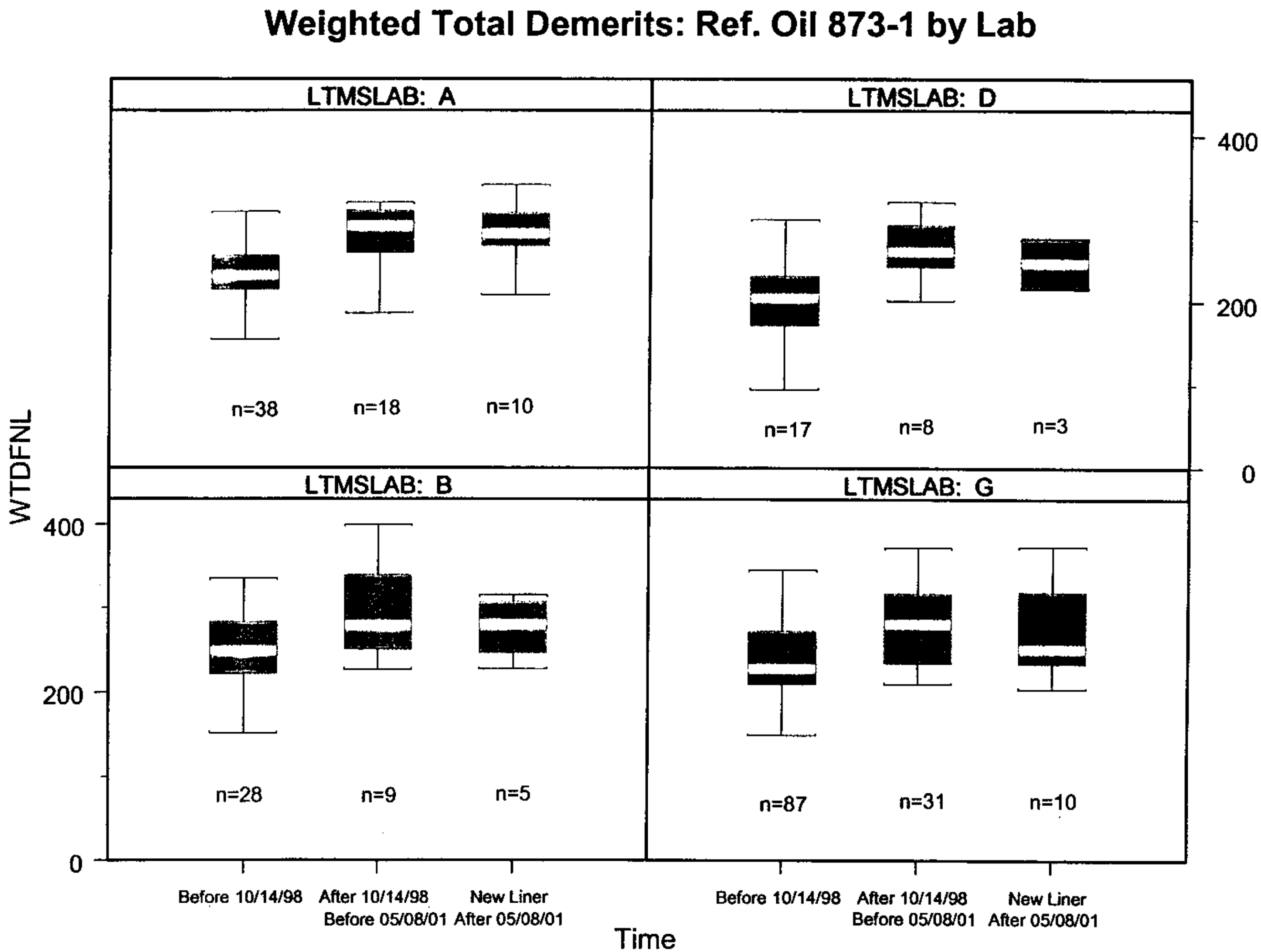
Objective: Show how the test evolved with time and by Lab. Note that all labs show an increase for WDT values with time.



Att 9 10/24

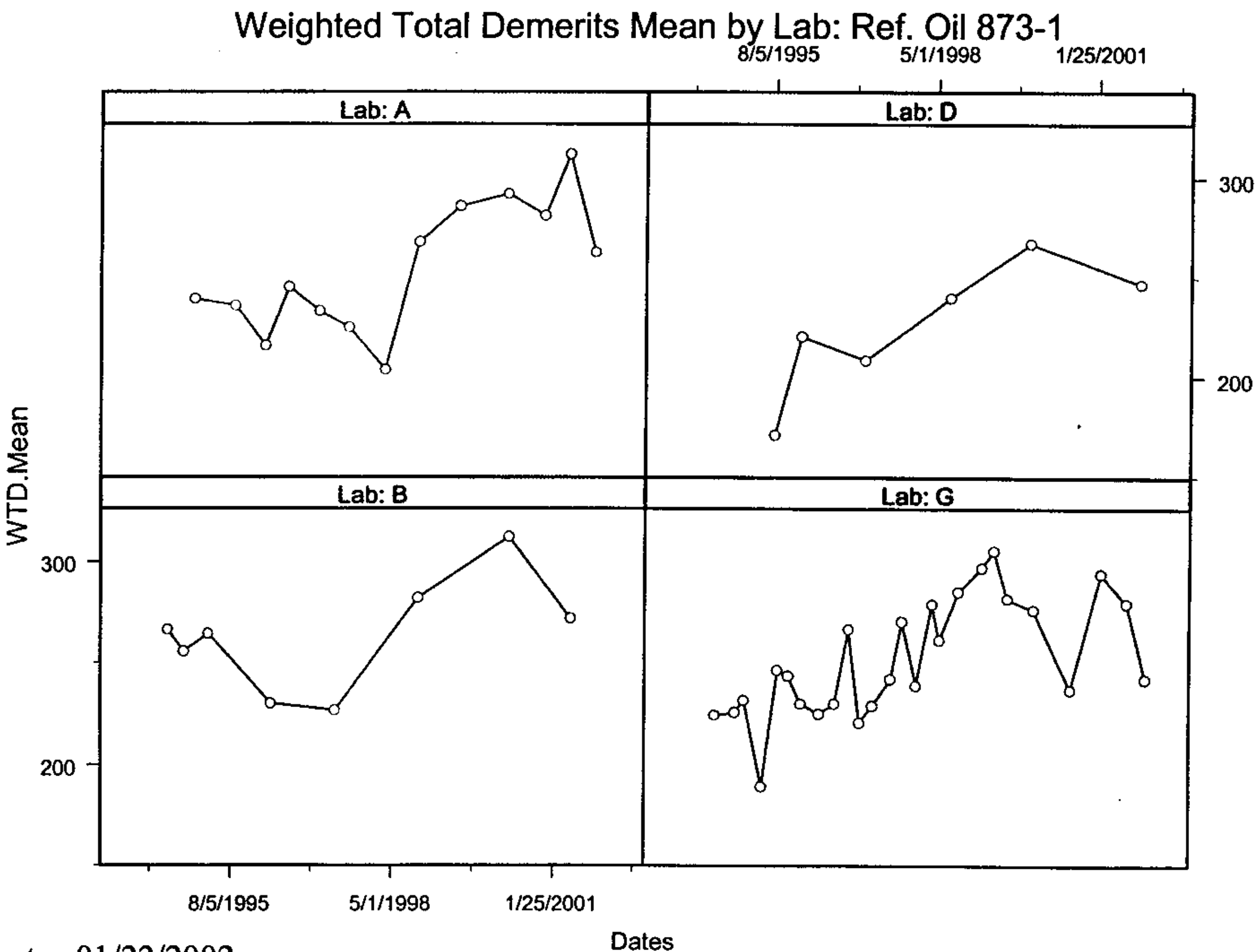
Elisa Santos 01/22/2002

Introducing one more level for Time through "New Liner"
New Liner does not seem to change WDT after 10/14/98



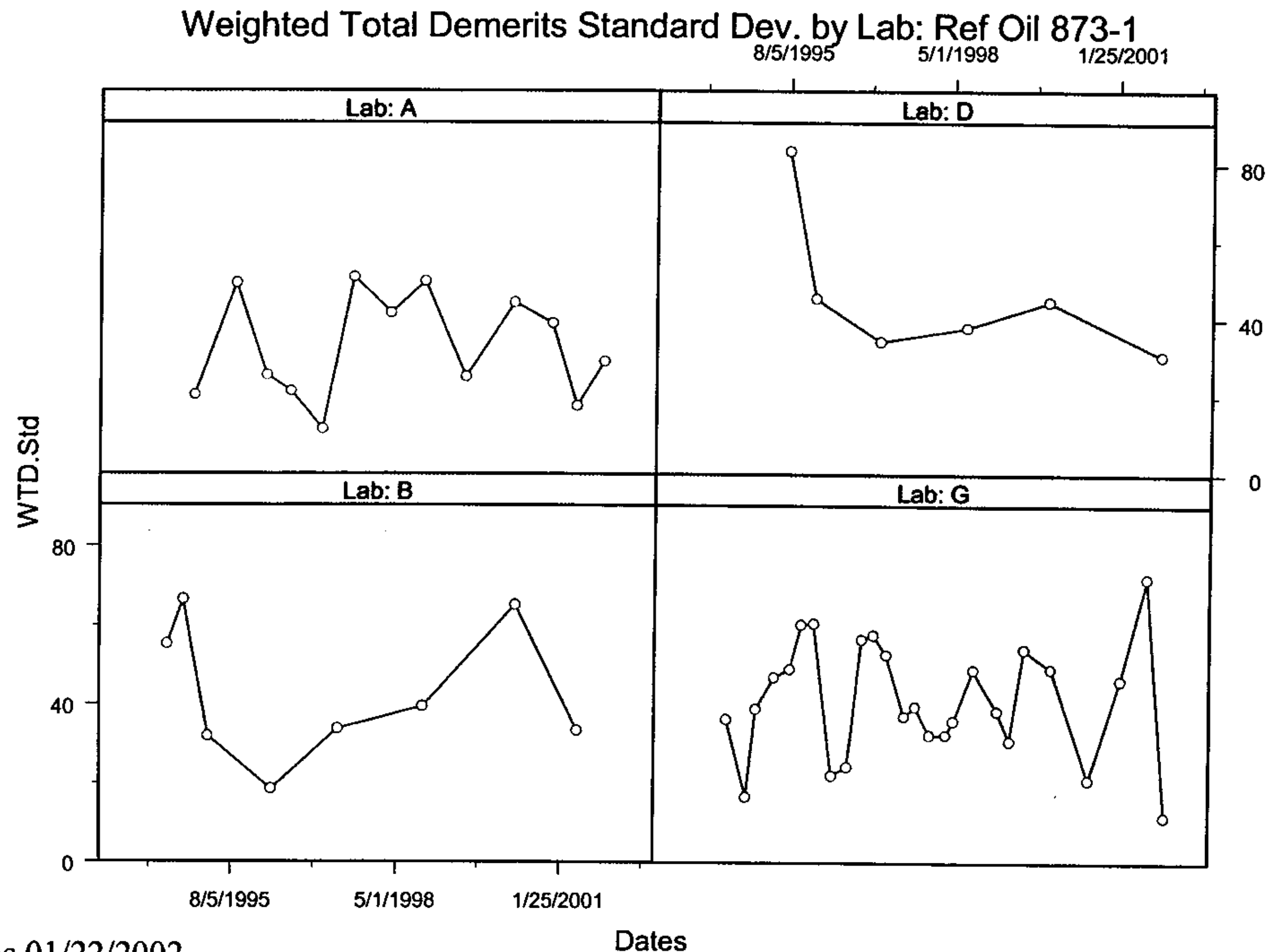
Ate 9 11/24

This plot shows the average for every five data points for WDT across time Ref. Oil 873-1 by Lab. It is just another way of showing the growth of WDT values with time.



Att 9 12/24

This plot shows the standard deviation for every five data points for WDT across time for Ref. Oil 873-1 by Lab. It is a way to describe the variability of the test along time.



Elisa Santos 01/22/2002

Att 9 13/24

Candidate data

Att 9 14/24

Source: RSI web site

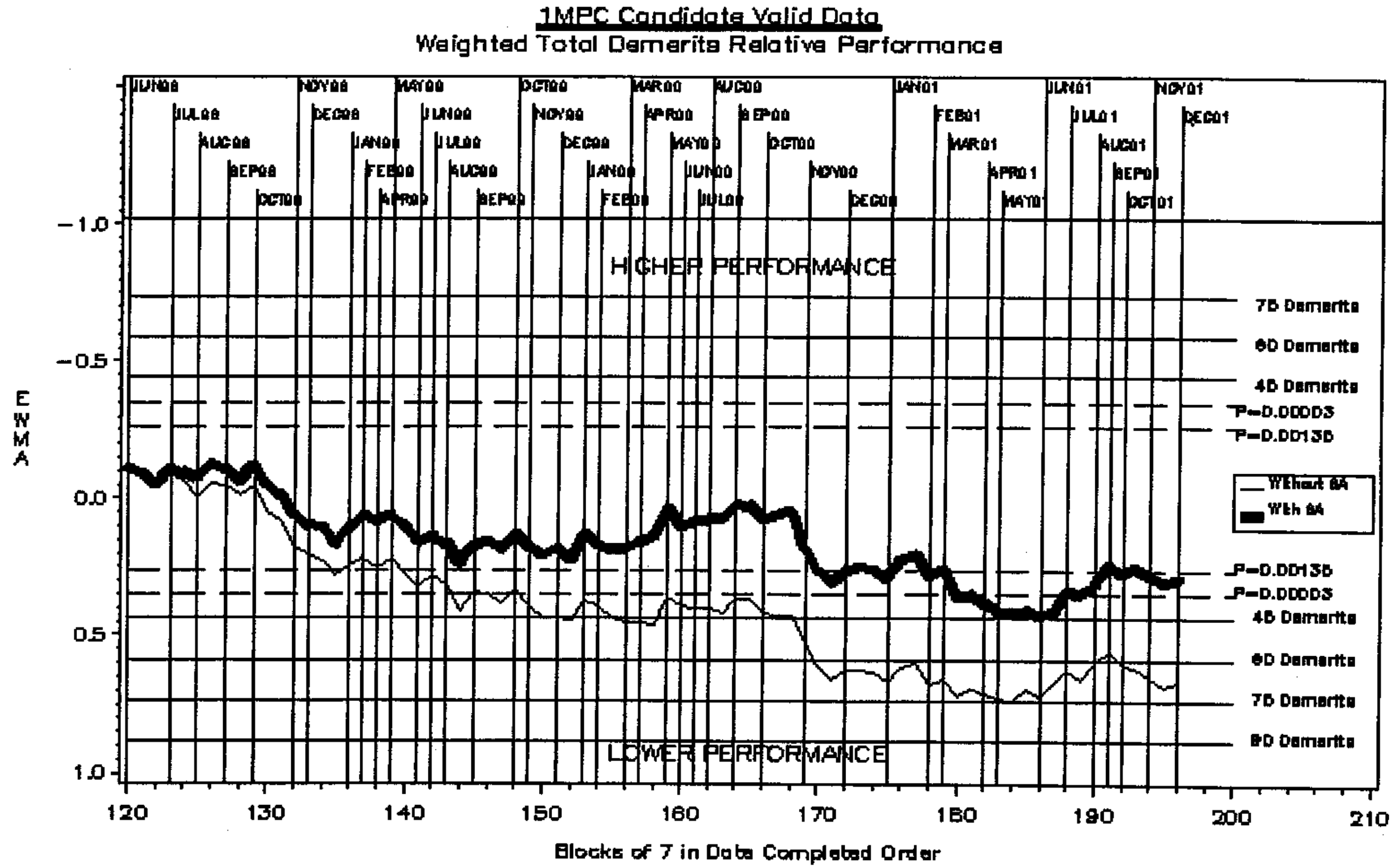
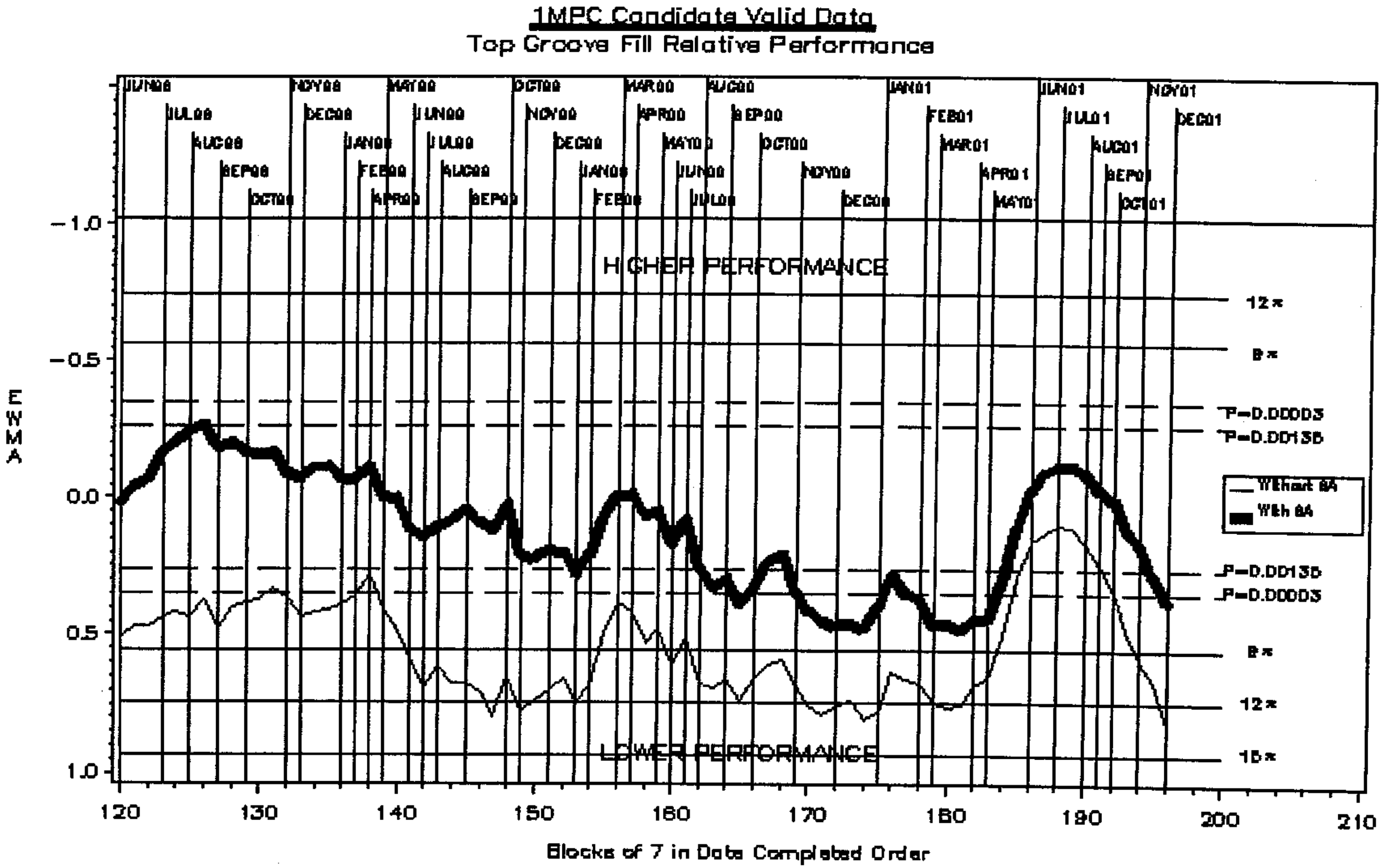


Figure 1MPC—1

Att 9 15/24

Source: RSI web site



Thursday, 03JAN02

Figure 1MPC–2

Registration Systems, Inc.
ACC Monitoring Agency

Elisa Santos 01/22/2002

A22 9

16/24

Source: RSI web site

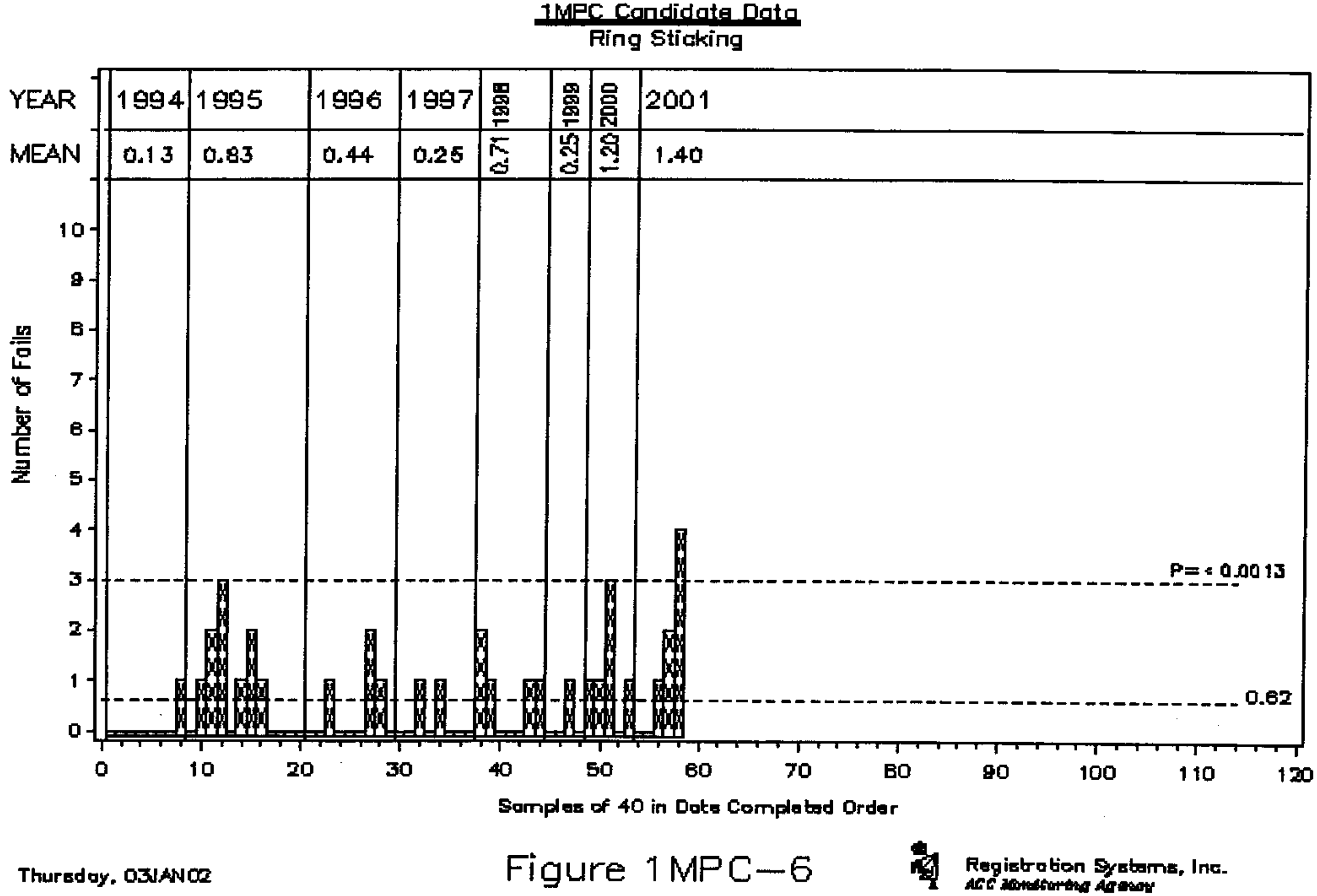


Figure 1MPC—6

Att 9 17/24

Modelling Reference Data

Att 9 18/24

Modelling reference data: WTD

Fit #1 WTDFNL explained as a function of Lab and Time

- Labs: A, B, D, and G.
- Time is analysed as having three levels:
  - One to explain the period Before 10/14/98, one to explain the period between 10/14/98 and 05/08/2001 and the third level corresponding to the time after the New Liner is available.
- Point corresponding to CMIR 40539 from Lab G was eliminated from the modelling phase. This point corresponds to a special run involving a request for the use of the old liner after the new liners had been adopted by all labs. This was done to allow for "New Liner" to be considered as a level of Time
- The ANOVA table is presented below:

summary for Fit #1

	Df	Sum of Sq	Mean Sq	F Value	Pr(F)
LAB	3	27976.2	9325.41	4.71947	0.003
Special Time scale	2	105968.5	52984.23	26.81462	0.000
Interaction of Lab and Time	6	5394.1	899.01	0.45498	0.841
Residuals	251	495962.3	1975.95		

- The table shows that the Labs differ among each other and that Time is also a relevant factor. For WTD the interaction of the two factors is not relevant.

Att 9 19/24

Modelling reference data: WTD

- The coefficients of the fit considering Lab B as a reference Lab and the time between 10/14/98 and 05/08/2001 as the reference time (the goal is to detect the impact of Liner and for this the chosen reference time is appropriate) are presented next.

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	294.3194	8.4190	34.9589	0.0000
LAB G	-11.9997	7.8745	-1.5239	0.1288
LAB A	-14.0379	8.7339	-1.6073	0.1092
LAB D	-42.6634	10.7852	-3.9557	0.0001
Before 10/14/98	-43.9971	6.4189	-6.8543	0.0000
New Liner	-6.9392	10.1244	-0.6854	0.4937

Residual standard error: 44.17 on 257 degrees of freedom

F-statistic: 13.73 on 5 and 257 degrees of freedom

- Observe the box plot on page 11 showing the behavior of Labs A, B, D and G over time to see that Labs D and A are the most different from B. The main finding here is that the significant growth of WDT is detected by going from Before 10/14/98 to After 10/14/98 but before the New Liner is available. The introduction of the new liner does not seem to impact WTD.

Att 9 20/24

Modelling reference data: TGF

Fit # 2: TGFFNL explained as a function of Lab and Time

- This fit uses the same methodology for Total Groove Fill.

Summary for Fit #2:

	Df	Sum of Sq	Mean Sq	F Value	Pr(F)
LAB	3	5171.83	1723.944	5.944392	0.0006
Special Time scale	2	2560.36	1280.181	4.414235	0.0130
Interaction of Lab and Time	6	4075.76	679.294	2.342297	0.0322
Residuals	251	72792.99	290.012		

- The ANOVA table shows that the Labs differ among each other and that Time is also a relevant factor. For TGF the Time*Lab interaction seems to be relevant and the behaviour of Lab G could be causing the interaction to be detected (all labs seem to have TGF growing with Time and/or New Liner, but for G this trend is less noticeable). By definition, Time and New Liner are confounded with each other.

Att 9 21/24

Modelling reference data: TGF

- The coefficients of the fit considering Lab B as a reference Lab and the time between 10/14/98 and 05/08/2001 as the reference time (the goal is to detect the impact of Liner and for this the chosen reference time is appropriate) are presented next.

Coefficients	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	52.4444	5.6766	9.2387	0.000
LAB G	-4.5090	6.4482	-0.6993	0.485
LAB A	-2.2778	6.9524	-0.3276	0.744
LAB D	-15.8194	8.2750	-1.9117	0.057
Before 10/14/98	1.5556	6.5254	0.2384	0.812
New Liner	17.9556	9.4987	1.8903	0.060
Interaction of LAB G with Before 10/14/98	5.0262	7.4344	0.6761	0.500
Interaction of LAB A with Before 10/14/98	-7.6959	8.1440	-0.9450	0.346
Interaction of LAB D with Before 10/14/98	-1.4158	9.7925	-0.1446	0.885
Interaction of LAB G with New Liner	-15.5577	11.4806	-1.3551	0.177
Interaction of LAB A with New Liner	-10.2222	11.6335	-0.8787	0.380
Interaction of LAB D with New Liner	13.7528	14.9381	0.9206	0.358

Residual standard error: 17.03 on 251 degrees of freedom

F-statistic: 3.701 on 11 and 251 degrees of freedom, the p-value is 0.00006704

Att 9 22/24

Conclusions

- Problems with all p/f parameters on CAT 1MPC
  - Change in reference TGF severity correlated with new liners
  - Three labs have similar behaviour for TGF {A,B,D} while G is mildly different
  - TGF has been sever nearly all the time period RSI has been monitoring
  - Change in severity with WTD observed with both reference and candidates {RSI}.
  - Unadjusted candidate severity is nearly 4 stdev away from zero line. Lab severity adjustments do not seem to be correcting the problem.
  - No correlation between liner and WTD severity change.
  - RSI data indicates failure rate in ring sticking is at the highest level since they have been monitoring.
- Is it possible to correct these problems in a timely manner or should this test be declared out of control ?

Att 9 23/24

Appendix 1

Table 1: Average of every five data points for TGF and WTD across time 873-1 ref. Oil by Lab

Dates	WTD.Mean	WTD.Std	TGF.Mean	TGF.Std	Lab
7/14/1994	286.4	55.30	36.6	18.30	B
10/19/1994	255.6	66.56	47	13.10	B
3/18/1995	264.5	31.96	53.2	16.90	B
4/11/1996	230.2	18.66	55.6	14.48	B
6/18/1997	226.8	33.87	67.4	12.50	B
10/11/1998	262.1	39.55	64	13.36	B
4/24/2000	312.8	65.22	60	10.79	B
6/11/2001	271.9	33.44	66.7	10.29	B
8/7/1994	224.5	36.43	36.2	12.40	G
12/8/1994	225.8	16.82	50.8	21.18	G
2/2/1995	231.9	39.01	59	16.46	G
5/24/1995	189.7	47.07	37.4	19.83	G
8/28/1995	246.6	49.27	56.2	14.81	G
11/1/1995	243.8	60.47	54.6	14.08	G
1/17/1996	230.2	60.74	46.6	18.67	G
5/10/1996	225.2	22.28	70.4	8.85	G
8/13/1996	230.2	24.51	59	7.42	G
11/6/1996	266.6	56.78	47.2	17.94	G
1/15/1997	220.9	57.92	35.4	18.42	G
4/4/1997	229.1	52.90	61.6	13.59	G
7/25/1997	242.2	37.24	59	6.71	G
10/2/1997	270.6	39.77	70	7.38	G
12/28/1997	239.1	32.53	67.8	21.91	G
4/6/1998	279.2	32.64	63.6	13.56	G
5/22/1998	261.5	36.09	62.6	17.92	G
9/17/1998	265.4	40.14	62.6	15.46	G
2/11/1999	297.3	38.64	55.2	27.74	G
4/27/1999	305.9	31.08	50.2	15.79	G
7/19/1999	281.9	54.32	47.2	13.44	G
12/29/1999	276.3	49.36	50.8	9.78	G
6/14/2000	237.0	21.24	31.2	10.76	G
2/19/2001	294.4	46.49	48.2	11.90	G
7/27/2001	279.7	72.23	53.8	21.61	G
11/19/2001	242.2	11.91	51	22.87	G
12/21/1994	239.1	20.18	62.6	10.04	A
6/29/1995	235.8	48.92	54.6	14.77	A
3/6/1996	215.9	25.24	53.2	14.62	A
7/29/1996	245.1	21.16	43	20.69	A
2/4/1997	233.0	11.41	49.2	16.06	A
8/6/1997	225.0	60.45	33.6	19.67	A
3/19/1998	203.6	41.33	27.8	10.31	A
10/11/1998	257.8	49.48	27.2	12.13	A
6/19/1999	265.8	24.97	56.2	11.34	A
4/9/2000	282.2	44.08	56.4	8.32	A
11/24/2000	261.2	38.75	53.4	8.65	A
4/26/2001	311.9	17.51	49.8	20.58	A
10/6/2001	262.5	28.99	59.8	8.84	A
8/2/1995	171.2	63.29	20.4	10.64	D
1/14/1996	220.4	46.24	40.8	19.02	D
2/11/1997	208.6	34.25	42.4	9.50	D
7/22/1998	239.9	37.91	30.6	24.40	D
11/28/1999	287.3	44.62	43.4	21.43	D
10/11/2001	246.8	30.71	68.3	6.03	D

Table 2: Number of tests according to Year and Lab

Number of tests

Year	B	G	A	D
1994	11	11	3	0
1995	5	19	7	7
1996	5	23	11	5
1997	4	21	9	3
1998	3	18	10	6
1999	3	16	6	2
Jan-Jun 2000	2	4	2	1
Jul-Dec 2000	4	5	7	1
Jan-Jun 2001	2	6	7	1
Jul-Dec 2001	3	5	4	1
2002	0	0	0	1

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1MPC Industry Correction Factor Proposal

~ data below generated using operationally valid oil 873-1 data
~ pass/fail data for WTD and TGF generated using TMC validity codes

Pass Ratio	All Labs	Current Labs
Total Passing Tests on 873-1 (4/94 to 1/02/02)	77.7%	77.3%
Total Passing on old liners (4/94 - 5/01)	78.4%	78.0%
Total Passing since new liners (5/01 - 1/02/02)	71.4%	71.4%
Delta	**7% fewer passing references**	

Percentage of "OC" tests failing by each parameter	All Labs	Current Labs
WTD on old liners (4/94 - 5/01)	25%	25%
WTD since new liners (5/01 - 1/02/02)	38%	38%
Delta	**13% more fail on WTD**	
TGF on old liners (4/94 - 5/01)	49%	51.9%
TGF since new liners (5/01 - 1/02/02)	75%	75.0%
Delta	**26%**	**23%**

Operationally Invalid Percentage (LC & RC TMC codes)	All Labs	Current Labs
Op. Invalid as a percent of Op. Valid on 873-1 (4/94 to 1/02/02)	10.7%	9.5%
Op. Invalid as percent of Op. Valid on old liners (4/94 - 5/01)	10.3%	8.9%
Op. Invalid as percent of Op. Valid on new liners (5/01 - 1/02/02)	14.3%	14.3%
Delta	**4%**	**5.4%**

	WTD	Std
Current Targets	232.5	50.5
Current Stats on new liners (n=28)	275.7	43.5
Delta new liners to old	**43.2**	severe

	TGF	Std
Current Targets	41	16.1
Current Stats on new liners (n=28)	59	16.4
Delta new liners to old	**18**	severe

Proposal:
Institute effective immediately an industry correction factor on WPD and TGF for all tests run on 1Y3995 liners.
WTD correction factor - 43.2 demerits
TGF correction factor - 18%

1M-PC Lab Severity Adjustments

	Lab	Current	Corrected
		TGF = TGF	TGF = TGF –17.9
TGF	A	-18	0
	B	-24	-12
	D	-14	0
	G	-11	0
		WTD = WTD	WTD = WTD – 40.9
WTD	A	-42.0	0
	B	-51.3	0
	D	0.0	0
	G	-33.0	0

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