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Committee D02 on Petroleum Products and Lubricants
Subcommittee D02-B0 on Automotive Lubricants

Research Report D02-1210

Data Acquisition Task Force Report (Subcommittee D02.BO)

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ITEM FOR MAIN COMMITTEE BALLOT

TO: E. R. Sullivan, Staff Manager, 1916 Race St., Phila., PA 19103

Type of Action Requested:

	Complete Sections
[x] Main Committee Ballot	1, 2, 3, 4, 5, & 6
[ ] Concurrent Main/Sub Ballot	1, 2, 3, 5, & 6
[ ] Special Ballot (i.e. Bylaws, Officers, Confirmatory)	1, 2, & 3

1. Designation (with year) and Title of Document:
Data Acquisition Task Force Report

Check here if this is a revised title [ ]

2. Purpose of Ballot: [ ] New Standard [ ] Withdrawal without replacement
[ ] Revision [ ] Withdrawal, replaced by _____
[ ] Reapproval
[ ] Special Ballot [x] Assignment of Research Report Number

3. Materials Attached: [x] Latest Draft of Document
[ ] Original Figures (New and Revised)
[ ] Research Report (See Reverse Side)
[ ] Adjunct Material (See Reverse Side)

4. Subcommittee Ballot Information: (Use voting members only for the official tally)

Issue Date 10-1-86 Closing Date 11-15-86

Number of Ballots: Issued 85 Returned 75

Percent Returned 88

Affirmative 56 Negative* 0 Abstain 19

*(Do not report withdrawn negatives)

[ ] Copies of negative votes attached

[ ] Consideration of negative votes by subcommittee: all documentation, including vote counts and date of meeting, attached.

5. Name of person(s) to receive edited manuscript for review:
?

6. Key Words: list appropriate key words for indexing, selected from the title and test of document
Data Acquisition Task Force

D02.B0
Subcommittee Designation

Subcommittee Chairman/Authorized Signature Secretary D02.B0

1/26/87
Date

Rev. 4/85

REPORT OF THE DATA ACQUISITION TASK FORCE TO THE TECHNICAL GUIDANCE COMMITTEE OF THE TEST MONITORING BOARD DECEMBER 9, 1985

INTRODUCTION

There is growing use of automated data acquisition systems to support the operations of ASTM engine-dynamometer type lubricant tests. Such systems, while offering potential benefits to both the test operator and the data user, often conflict with the letter of the test procedure which they support. This task force was formed to recommend a format for establishing concert between existing procedures and new data acquisition techniques.

The task force was formed in the Fall of 1984. The first of five one and two day task force meetings was held in November of 1984. Presentations of preliminary recommendations were made to the test surveillance panels in December 1984 and June of 1985. Having now established a consensus on how computerized data acquisition systems might best serve the industry, the task force is issuing its final report.

The scope and objectives of the task force may be found in Appendix A and a list of task force participants in Appendix B.

DEFINITIONS

In order to establish common ground upon which to discuss various aspects of the data acquisition process and aid in the understanding of the recommendations, several terms are defined.

DATA POINT:

Single unscreened value used by a computer for further processing, limited by system validation requirements.

READING:

The reduction of data points that represents the operating conditions observed in the time period as defined in the test procedure.

BAD QUALITY DATA:

A single data point that does not accurately measure the operating parameter.

OUT-OF-LIMITS DATA: (Also "procedural excursion")

OUT-OF-LIMITS DATA (CONT'D)

Sampled value of a monitored test parameter that has deviated beyond the procedural limits.

ALARM:

Notification or alert that a monitored test parameter has deviated from a preset range.

RECOMMENDATIONS

In all cases the task force has attempted to stay within the guidelines of the written procedures except where unable due to constraints of automatic data acquisition. It would be appropriate for the surveillance panels to review the information generated in future tests and suggest deletion of certain procedural items.

The task force did not provide any recommendations which were directed to assist the TMC in the development of procedures for direct electronic data transfer (task force objective No.6), that process has advanced to the point that the TMC did not consider that task force effort would be productive.

(1.) The Task Force recognizes that with rapidly changing computer technology and costs, there exist a variety of sound approaches to the data acquisition task. It is unlikely that the existance of such a variety will change in the near future. Therefore, our first recommendation involves a simple categorization of systems to improve communications and allow us to deal with what we consider to be the real charge of the task force. The following is a list and explanation of the three simple categories:

A. MANUAL: Such systems would include those which use techniques assumed by the test procedures, namely periodic hand logging of operating data based upon visual observation of an undefined array of instrument readings or displays. Such systems would include those in which one or more of the measured parameters may be recorded automatically but only at the procedurally prescribed intervals. Reports from manual systems should be formatted as prescribed by the procedure.

B. ENHANCED: With these systems some or all data are recorded, usually automatically, at a frequency higher than that prescribed by the procedure. To reduce the number of reported data and enhance the value of the reported data, some number crunching technique, e.g. averaging, is used. Report format is that as prescribed in the test procedure; however, a statement is added to the report defining those data subject to and the method used for enhancement.

C. AUTOMATED: An electronic processing system used to provide:

a) Alarms for parameter excursions at a frequency compatible with process control requirements.

b) Data point recording at a frequency compatible with sound engineering/statistical practice for operation review and trend analysis.

c) Reporting capability consistent with data user requirements and including the reporting of all out-of-limits data.

d) Optional manual entry of data not available from full time sensors in order that all data be available in a common data base.

Minimum performance criteria for category "C" Automated Systems will be established by the other task force recommendations.

(2.) Automated data acquisition systems should be allowed a maximum time period over which to accumulate, average or in any other way sort or filter data to be included in one data point. This maximum time period should be established at one second.

This one second maximum "data window" was chosen to allow systems adequate collection and sorting time to generate an accurate representation of the measured condition. In the judgement of the task force time intervals or "data windows" in excess of one second allow sufficient time for the filtering of data such that erroneous conclusions might be drawn.

(3.) Time intervals between recorded data points should not exceed six minutes (except during transition periods). Each data point which is out-of-limits is included in the recorded data bank unless it is shown to be bad quality data. Reporting strategy and tests for bad quality data are in other recommendations.

Although data point recording at intervals shorter than six minutes is encouraged, this interval was judged adequate to provide sufficient data representation within a reading. Within the context of the test procedures considered by this task force, this data point frequency would result in the use of ten data points to arrive at one reading. This condition was considered to provide a major improvement to those procedures.

(4.) Readings are to be obtained and recorded at intervals which are exactly as prescribed by the test procedures. Processing of data points to obtain a reading will result in a numerical average (mean value), a maximum data point value, a minimum data point value, and the standard deviation of the data points which were averaged. All data points recorded during the reading interval except those determined to be bad quality data or data collected during transition periods are to be processed to obtain the reading.

Transition periods will require no collection of data points provided that the transition period is not included in test time by procedure. If the transition period is included in the test time, point collection for readings is suspended for the maximum length of the transition as defined by the procedure. If the procedure does not define the length of the transition, data point collection is suspended for readings until that data point due for collection during the 18th minute following the start of the transition. It must be noted that collection of certain data during the transition period may be required by procedure. In such cases, these are used for special purpose readings. Additional transition considerations:

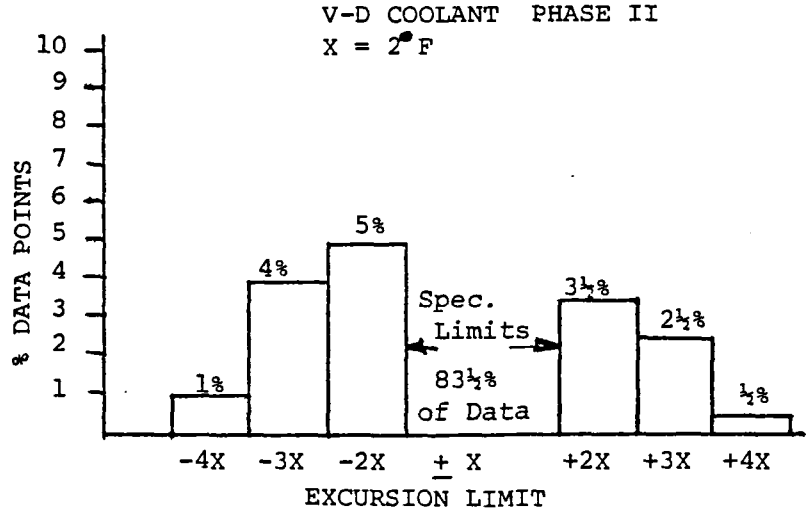
- o When the act of taking one data point affects others, the others are forzen until the affect is eliminated.
- o Oil additions to an operating engine initiates a transition period.

(5.) Out-of-limits data should be handled in two ways:

a) Each O.L.D. which is six minutes or longer is to be tabulated individually showing, test hour of occurrence, total length of excursion, and maximum magnitude of excursion.

b) All O.L.D. regardless of length, are to be reported in a histogram representing the data for each parameter for the complete test; by test phase, if appropriate. The horizontal axis of the histogram is to be divided into multiples of the band width for acceptable data both high and low. The vertical axis is scaled to show the percent of total readings for each category. Differences of 1% should be clearly discernable. No data which fall within the allowable limits are to be included. There is no background information to indicate the real value of this histogram; therefore, the individual surveillance panels should review the need for continued inclusion after an information base is developed.

SAMPLE O.L.D. CHART
V-D COOLANT PHASE II
X = 2° F



(6.) Certain data collected by automated systems are likely to fall in the category of system noise and would clearly be Bad Quality Data. The task force recommends that B.Q.D. be automatically rejected by the lab if certain pre set static or dynamic process limitations are exceeded. If these limits are properly set, the observed condition would be physically impossible and the observation should, therefore, be eliminated without discussion. Appendix C provides a tabulation of certain such static and dynamic limitations. While each laboratory should be allowed to choose these limits to best fit their particular system and should present them explicitly to the TMC, the lists in Appendix C are intended to provide guidelines both for lab selection and TMC monitoring. These data are based upon measurements provided by several task force members and should be quite reliable. A careful review of these tables by the surveillance panels is encouraged.

(7.) Bad quality data (noise) should not be specifically reported. It is, however, recommended that data points discarded as B.Q.D. be counted and reported as a percentage of the total data points which should be available to make up the readings.

(8.) Test operating data, while presented in tabular format including averages, min., max. and standard deviations, should also be supported with graphical presentations. The tabular formats should include two tables (one currently in use). The first table should show the average, max., min.(1) average and standard deviation for each parameter and each stage or phase as appropriate. The second table should list the rejection criteria used by the lab in rejecting bad quality data for each parameter and each phase or stage. This latter table should also provide a tabulation of the data rejected as a percentage of overall data points.

For the graphical presentations, all reported parameters(2) should be included except for 1H2/1G2 tests where only those parameters currently plotted are to be included. The frequency to be used in sampling data for plotting is as follows:

TEST TYPE	NUMBER OF READINGS TO BE PLOTTED
IID/IIID	1 / HR
V-D	1 / STAGE
L-38	1 / HR
1H2/1G2	1 AVG./5 HRS

It should be noted that this represents a change rather than addition to the 1H2/1G2 procedure which currently graphs 1 snapshot reading per 5 HOURS.

(1) Max and Min represent the maximum and minimum data points.

(2) For each parameter plot the following: reading, +2 standard deviations for the reading and the limits on the reading.

(9.) The Test Monitoring Center should be charged with the responsibility for acceptance of an automated data acquisition system proposed for use in a monitored laboratory. The TMC should be advised to consult with the test sponsor(s) and/or surveillance panel(s) only as required for resolution of technical disparities. The task force suggests a step-by-step procedure such as shown below to accomplish the acceptance of a new system.

I. Lab notifies the TMC of system plans

II. Lab and TMC agree upon the appropriate system category, i.e. Manual, Enhanced or Automated.

III. Lab provides the following technical detail to the TMC for study and review:

a) All aspects of the proposed data acquisition system which differ from the procedure. NOTE: Surveillance panel(s) should be consulted if specified instrumentation is not used or if system deletes specified operational data.

b) All system aspects which differ from previous practice in that lab.

c) Block diagram(s) showing the complete data handling system and specifing:

(i) Transducers

(ii) Amplification

(iii) Filtering

(iv) Processor

(v) Software Structure

d) A chart showing component calibration techniques and frequency.

e) Detail regarding the software handling of

(i) Data compression

- Number of data points per reading
- Criteria for rejecting bad quality data
- Transition phase handling
- Criteria for reporting out-of-limits data

(ii) Reporting

- o List all data to be reported which is in addition to the procedure requirements
- o List all data which will be deleted from procedure requirements. (Surveillance panel(s)' opinion should be sought).
- o List data which are acquired automatically.
- o List data which are acquired manually.
- o Describe the planned format which will be used to report out-of-limits data.

IV. Conduct an on-site demonstration of the system as required by the TMC. Areas for particular attention during such a demonstration would include:

a) Manual overide and/or operator interaction flexibility.

b) Traceability of post test data editing.

c) Handling of data loss as might result from failure of various system components.

d) System calibration methods.

V. Verify with reference oil test(s)

(10.) The task force purposely did not address the question of instrumentation. It should be noted that there are several instances within the procedure where the specified instrumentation is not compatible or at least not optimized for use with high speed data acquisition systems. Therefore, the task force recommends that the Instrumentation Task Force be reactivated to recommend replacement specifications based upon accuracy and time response rather than name brand or generic type.

(11.) The Task Force believes that the assigned work is completed and recommends that it be disbanded.

Recommend acceptance of report.

SUMMARY

The Data Acquisition Task Force formed by the Technical Guidance Committee, has developed a series of recommendations for the incorporation of automated data acquisition techniques into certain test procedures. These test procedures, found in STP 315 amd STP 509 are currently written to accept only hand logging of data. The recommendations of the task force provide information on data sampling, data analysis, data reporting and a method for obtaining "approval" for use of an automated data acquisition system with the STP 315 and STP 509 test procedures.

APPENDIX A

DATA ACQUISITION TASK FORCE

SCOPE:

This task force will recommend to the Technical Guidance Committee enhancements to test procedures which exist in STP 315 and STP 509 as needed to allow users of these procedures and/or the resulting data the full advantage of automated data acquisition, and a common information base from which to determine procedure compliance.

OBJECTIVES:

1. Define "automated data acquisition"
2. Define "Alarm"
3. Establish minimum sampling frequency for recording purposes.
4. Establish character of each required reading, i.e. average, single point.
5. Establish criterion for reporting conditions which do not fall within procedural specifications (i.e. is it real?)
6. Assist in the development of procedures and formats for direct electronic data transfer to the TMC.
7. Recommend revisions to standard report formats.
8. Recommend an acceptance mechanism for new automated data acquisition systems.

APPENDIX B

DATA ACQUISITION TASK FORCE MEMBERS

NAME	COMPANY
Larry Bendele	Southwest Research Institute
Tom Boschert	Ethyl Petroleum Additives Div.
Trevor Brettell	Exxon Chemical Company
Bernard Cuzzillo	Chevron Research Company
Mark Dalen (Secretary)	EG&G Automotive Research, Inc.
Dan Domonkos	Lubrizol Corporation
Tom Franklin (Chairman)	EG&G Lubricant Technology Center
Al Hahn	Caterpillar Tractor Co.
Herb Harpster	Lubrizol Corporation
Dave Herczeg	Ford Motor Company
Herbert Kube	Shell Canada Ltd.
Mary Noon	Texaco, Inc.
Don Smolenski	General Motors Research
Carl Stevens	Ashland Oil, Inc.
Randy Williams	Southwest Research Institute
Iain Winton	Esso Petroleum Co.
Frank Wood	ASTM-TMC
Ed Werderits	Auto Research Labs, Inc.

SEQUENCE IID TEST

APPENDIX C

PARAMETER			STATIC LIMITS MINIMUM	STATIC LIMITS MAXIMUM	RATE OF CHANGE LIMITS	
Average speed	RPM		0	4000	Up:	88 RPM/sec
					Down:	165 RPM/sec
Brake Load	Lb-ft	Hot	0	200		
		Cold	0	100		
B.H.P.			0	150		
Oil at filter block	Deg F	Hot	32	400	Up:	20 Deg F/min
		Cold		150	Down:	60 Deg F/min
Oil pan temperature	Deg F	Hot	32	400	Up:	20 Deg F/min
		Cold		150	Down:	60 Deg F/min
Oil pump outlet press	psi	Hot	0	120		30 psi/sec
Oil, engine pressure	psi	Hot	0	120		30 psi/sec
Coolant, jacket out	Deg F	Hot	32	300	Up:	12 Deg F/min
		Cold	32	150	Down:	28 Deg F/min
Coolant, jacket in	Deg F	Hot	32	300	Up:	12 Deg F/min
		Cold	32	150	Down:	28 Deg F/min
Coolant, jacket flow	GPM		0	100		5 GPM/min
Coolant, Breather out	Deg F	Hot	32	300	Up:	12 Deg F/min
		Cold	32	150	Down:	28 Deg F/min
Coolant, left cover out	Deg F	Hot	32	300	Up:	12 Deg F/min
		Cold	32	150	Down:	28 Deg F/min
Coolant, rt cover out	Deg F	Hot	32	300	Up:	12 Deg F/min
		Cold	32	150	Down:	28 Deg F/min
Coolant, crossover out	Deg F	Hot	32	300	Up:	12 Deg F/min
		Cold		150	Down:	28 Deg F/min
Coolant, cover-breather flow	GPM		0	10		
Coolant, Xover flow	GPM		0	10		
Coolant, jacket out	Deg F		32	300	Up:	12 Deg F/min
					Down:	28 Deg F/min
Coolant, jacket in	Deg F		32	300	Up:	12 Deg F/min
					Down:	28 Deg F/min
Coolant, Xover out	Deg F		32	300	Up:	12 Deg F/min
					Down:	28 Deg F/min

"Suggested Static and Dynamic Limits for Rejecting Bad Quality Data"

SEQUENCE IID TEST (continued)

PARAMETER		STATIC LIMITS MINIMUM	STATIC LIMITS MAXIMUM	RATE OF CHANGE LIMIT
Air Fuel ratio		0	20	
Fuel inlet temp	Deg F	0	150	
Carb air temp	Deg F	32	100	10 Deg F/min
Humidity	Gr/lb	0	100	
Carb Air pressure	InH2O	-200	1	
Ambient Air Temp	Deg F	0	150	
Blowby gas outlet temp	Deg F	32	350	
Blowby	CFM	0	3	
Right exhaust pressure	InH2O	0	50	
Left exhaust pressure	InH2O	0	50	
Diff. exhaust pressure	InH2O	0	2	
Intake Vacuum	InHG	0	35	
Intake mixture temp	Deg F	32	150	
Crankcase pressure	InH2O	0	5	Up: 1.6 In H_2O/sec Down: 5 In Hg/sec

"Suggested Static and Dynamic Limits for Rejecting Bad Quality Data"

SEQUENCE IIID TEST

PARAMETER		STATIC LIMITS MINIMUM	STATIC LIMITS MAXIMUM	RATE OF CHANGE LIMIT
Average speed	RPM	0	4000	Up: 88 RPM/sec Down: 165 RPM/sec
Brake Load	Lb-ft	0	200	
B.H.P.		0	150	
Oil at filter block	Deg F	32	400	Up: 20 Deg F/min Down: 60 Deg F/min
Oil pan temperature	Deg F	32	400	Up: 20 Deg F/min Down: 60 Deg F/min
Oil pump outlet press	psi	0	100	30 psi/sec
Oil, engine pressure	psi	0	100	30 psi/sec
Coolant, jacket out	Deg F	32	300	Up: 12 Deg F/min Down: 28 Deg F/min
Coolant, jacket in	Deg F	32	300	Up: 12 Deg F/min Down: 28 Deg F/min
Coolant, jacket flow	GPM	0	100	
Coolant, Breather out	Deg F	32	300	Up: 12 Deg F/min Down: 28 Deg F/min
Coolant, left cover out	Deg F	32	300	Up: 12 Deg F/min Down: 28 Deg F/min
Coolant, rt cover out	Deg F	32	300	Up: 12 Deg F/min Down: 28 Deg F/min
Coolant, cover flow	GPM	0	10	
Coolant, breather tube flow	GPM	0	10	
Air Fuel ratio		0	20	
Fuel inlet temp	Deg F	0	150	
Carb air temp	Deg F	32	100	10 Deg F/min
Humidity	Gr/lb	0	100	
Carb Air pressure	InH2O	-200	1	
Ambient Air Temp	Deg F	0	150	
Blowby gas outlet temp	Deg F	32	350	
Blowby	CFM	0	3	
Right exhaust pressure	InH2O	0	50	
Left exhaust pressure	InH2O	0	50	
Diff. exhaust pressure	InH2O	0	2	
Intake Vacuum	InHG	0	35	
Intake mixture temp	Deg F	32	150	
Crankcase pressure	InH2O	0	5	Up: 1.6 InH2O/sec Down: 5 InHg/sec
Spark timing	BTDC	0	60	

"Suggested Static and Dynamic Limits for Rejecting Bad Quality Data"

CATERPILLAR 1H AND 1G TESTS

PARAMETER		STATIC LIMITS MINIMUM	MAXIMUM	RATE OF CHANGE LIMIT
Average Speed	R.P.M.	0	2600	100 RPM/sec
B.H.P.		0	55	
Humidity	Grains/LB	0	300	10 Gr/LB/min
Intake Air to Engine	Deg F	40	350	4 Deg F/min
Water In	Deg F	40	220	14 Deg F/min
Water Out	Deg F	40	220	14 Deg F/min
Coolant Delta	Deg F	0	20	
Oil Gallery	Deg F	40	220	18 Deg F/min
Oil Cooler Inlet	Deg F	40	220	18 Deg F/min
Exhaust Temperature	Deg F	60	1300	
Boost pressure	In Hg	27	60	1 In Hg/sec
Crankcase vacuum	In H20	-5	5	
Exhaust back pressure	In Hg	0	20	
Fuel pressure	psi	0	100	
Oil Gallery pressure	psi	0	100	16 psi/min
Cooling jet pressure	psi	0	100	16 psi/min
B.T.U. / Minute		0	6500	
Blowby	C.F.H.	0	80	

"Suggested Static and Dynamic Limits for Rejecting Bad Quality Data"

SEQUENCE V-D OPERATING REGIME

		Phase I (Rate/Chg.)	Phase II (Rate/Chg.)	Phase III (Rate/Chg.)
Speed, RPM	Max.	7000	7000	7000
	Min.	0	0	0
Torque, ft-lbs	Max.	130	130	130
	Min.	0	0	0
Oil In, °F	Max.	350 (5.0 °F/min.)	350 (3.5 °F/min.)	350 (1.7 °F/min)
	Min.	50 (1.0 °F/min.)	50 (2.0 °F/min.)	50 (1.7 °F/min)
Coolant Out, °F	Max.	240 (15.0 °F/min)	240 (14.4 °F/min)	240 (3.6 °F/min)
	Min.	32 (2.2 °F/min)	32 (10.0 °F/min)	32 (2.0 °F/min)
Carb. Air, °F	Max.	250 (3.2 °F/min)	250 (3.2 °F/min)	250 (3.2 °F/min)
	Min.	32 (3.3 °F/min)	32 (3.3 °F/min)	32 (5.0 °F/min)
Carb. Air Press., In. H_2O	Max.	20	20	20
	Min.	-200.0	-200.0	-200.0
Cooldown Time, Minutes	Max.	---	---	---
	Min.	---	---	5 (9.0 °F/min)
DewPoint, °F	Max.	110	110	110
	Min.	32	32	32
Exhaust Back Press., In. H_2O	Max.	400	400	400
	Min.	0	0	0
Blowby Coolant, °F	Max.	240 (15.0 °F/min)	240 (14.4 °F/min)	240 (3.6 °F/min)
	Min.	32 (2.2 °F/min)	32 (10.0 °F/min)	32 (20.0 °F/min)
Blowby Gas, °F	Max.	350	350	350
	Min.	32	32	32
Marine Manifold, °F	Max.	240	240	240
	Min.	32	32	32
Int. Vacuum, In. Hg.	Max.	33	33	33
	Min.	0	0	0
Timing	Max.	76°BTDC	76°BTDC	50°BTDC
	Min.	7°ATC	7°ATC	7°ATC
Barom. Press., In. Hg.	Max.	---	33	---
	Min.	---	20	---
Crank. Press., In. H_2O	Max.	20	20	20
	Min.	-10	-10	-10
Fuel Flow, lb/hr	Max.	25.0	25.0	10.0
	Min.	0	0	0

"Suggested Static and Dynamic Limits for Rejecting Bad Quality Data"

L-38 TEST

PARAMETER		STATIC LIMITS MINIMUM	STATIC LIMITS MAXIMUM	RATE OF CHANGE LIMIT
Average speed	RPM	0	6000	Up: 88 RPM/sec Down: 165 RPM/sec
Brake Load	Lb-ft	0	32.6	
B.H.P.		0	13.5	
Intake air to engine	Deg F	32	160	10 Deg F/min
Dynamometer water	Deg F	32	212	
Water In	Deg F	32	212	Up: 12 Deg F/min Down: 28 Deg F/min
Water Out	Deg F	32	212	Up: 12 Deg F/min Down: 28 Deg F/min
Oil Gallery	Deg F	32	400	Up: 10 Deg F/min Down: 22 Deg F/min
Oil Sump	Deg F	32	400	Up: 10 Deg F/min Down: 14 Deg F/min
Heater	Watts	0	3000	
Intake Pressure or vac.	InHg	-0.5	-15	
Crankcase vacuum	InH2O	-15	15	Up: 1.6 InH2O/sec Down: 5 InHg/sec
Exhaust Back press.	InHg	-2	10	1.2 InHg/sec
Oil Gallery Press.	psi	0	100	30 psi/sec
Fuel time	sec/lb	0	400	
Intake air	lb/hr	0	185	
Rocker Air flow	CFH	0	40	
Off gas flow	CFH	0	40	