NBS SPECIAL PUBLICATION 661

U.S. DEPARTMENT OF COMMERCE/National Bureau of Standards

ASTM/NBS Basestock Consistency Study Data

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[2]Some divisions within the center are located at Boulder, CO 80303.

ASTM/NBS Basestock Consistency Study Data

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NATIONAL BUREAU OF STANDARDS, Ernest Ambler, Director

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FOREWORD

by

National Bureau of Standards

The National Bureau of Standards (NBS) initiated the Recycled Oil Program in 1976 under the Energy Policy and Conservation Act (P.L. 94-163, section 383). The Act directs NBS to develop test procedures that can be used to determine the substantial equivalency between recycled and virgin oil products. In 1978, NBS concluded the first phase of the program, recycled oil used as burner fuel (NBS Technical Note 1130), and the phase two work on automotive crankcase lubricants was initiated.

NBS interacted extensively with various companies and organizations in American Society for Testing and Materials (ASTM) Committee D-2 on Fuels and Lubricants. In 1979, a task force was formed in ASTM Committee D-2, Technical Division P on Recycled Petroleum Products, Section II on Used Oils and Basestocks, to examine the consistency of the current production basestocks from re-refineries. The joint ASTM/NBS study began in March, 1980 and was concluded in March, 1981. During this period, monthly production samples of re-refined and virgin base oils from 10 companies were shipped to NBS, and coded samples were sent out to fourteen participating laboratories for various analyses. Over fifty tests were performed on these coded samples over the thirteen month period. The test data collection and collation was initially conducted by Mobil Oil Corp. The data were transferred to NBS in March 1982 for further compilation and analysis. NBS, however, under administrative guidelines, terminated the Recycled Oil Program in September 1982. The Department of Energy under its Office of Industrial Programs, awarded a research contract to the Chemical Stability and Tribology Group at NBS to conduct extensive statistical analyses and develop correlation methods and models to fully utilize such valuable data.

This report is the first one issued under the DOE contract. The main purpose of this report is to make available an invaluable data base to all interested parties for immediate reference and application. No attempt has been made in this report to make conclusions as to the consistency of the lubricating base oils nor is it meant that any should be inferred without careful analysis of this complex body of information. The order in which the data is arranged, the summary statistics and the plots are presented in a manner which is amenable to data analysis. NBS welcomes any comments, suggestions or constructive critiques from the readers concerning future data analysis.

Stephen M. Hsu
Group Leader
Chemical Stability and Tribology Group
National Bureau of Standards

FOREWORD

by

American Society for Testing and Materials
Committee D2, Technical Division P

The contents of this report, i.e., data on characteristics and month-to-month consistency of re-refined and virgin basestocks, are the fruit of hard work by many individuals and organizations.

Following the first meeting of Technical Division P in December 1977, minutes of early meetings and correspondence show an immediate, broad, and deep interest in basestock characteristics and consistency. In 1978, a letter from M. E. LePera, U.S. Army, MERADCOM, addressed to the Chairman, N. A. Hunstad, of Technical Division B, on Automotive Lubricants and the Chairman, P. L. Strigner, of Technical Division P, undoubtedly planted the seed when he said that "a new basestock characterization methodology was urgently needed." His reference was to basestocks for engine oils. His need was for revisions to the important, well-known specification for automotive engine oil, MIL-L-46152. He was moving in response to the Resource Conservation and Recovery Act of 1976 (PL 94-580) which required government standards-writing agencies "to revise specifications to allow use of recycled materials to the maximum extent possible" without jeopardizing the intended use of the item. It was uncertain as to what the expression "basestock characterization methodology" embraced. Assuming that it embraced basestock characteristics, interactions with additives and consistency, then these were in a large measure not well understood for lubricating basestocks, especially for re-refined base oil.

In late 1978, Technical Divisions B and P created a joint task group under the chairmanship of H. E. Tiffany, API, to aid T. Bowen, U.S. Army, MERADCOM, who was charged with revising MIL-L-46152. A number of methods to characterize basestocks, and especially basestock consistency, were mentioned as being important. Taking the comments into consideration, a revised specification (MIL-L-46152A) was issued which did not exclude re-refined basestocks. It did identify a number of important basestock characteristics for all basestocks, irrespective of origin, i.e., tests and limits but failed to address the question of basestock consistency owing to the absence of adequate guidelines.

Early in 1979, K.A. Frassa, Mobil Oil, who had attended the December, 1978 meeting of Division P, sent a letter to me in which he made four key points. (1) He stated "I believe it is generally accepted that good re-refining processes can produce satisfactory re-refined oil; however, the consistency of production is not known." (2) He observed that a parallel activity was underway in NBS. (3) He suggested co-operation with NBS. (4) He suggested the formation of a task group under Section II of Division P to pursue this activity.

NBS had been charged under the Energy Policy and Conservation Act of 1976 (PL 94-163, Section 383) "to develop test procedures for the determination of substantial equivalency of re-refined or otherwise processed used oil with new oil for a particular end use." D. Becker of NBS was placed in charge of the NBS Recycled Oil Program to develop the test procedures--clearly a formidable task.

The officers of Division P (Dr. J. Comeford, Vice Chairman; R. F. Pedall, Secretary; and myself) promptly agreed to deal with K. Frassa's suggestions by the next meeting of the division. The interest in a basestock consistency study in cooperation with NBS was spontaneous. Logically, a task group was formed under the joint sponsorship of ASTM and NBS with K. Frassa as chairman, and lodged in Section II whose chairman was C. Thompson of DOE, BETC. The magnitude of the undertaking was evident. The cooperating individuals and their organizations are listed elsewhere, all of whom are thanked a thousandfold for their very worthwhile contributions.

It is appropriate to also acknowledge the fine efforts of W. Starr also of Mobil Oil who succeeded K. Frassa as chairman of the task group and who issued periodic comprehensive progress reports.

Of course, it is appropriate to acknowledge the important efforts of D. Becker and co-workers of NBS who arranged for the collection and distribution of the large array of samples and who are now arranging for the publication of this report. Subsequent reports which will deal with in depth examinations of the data and their significance may also be published by NBS. We hope to have a final report as well, published by ASTM, possibly as a Special Technical Publication (STP).

The data contained herein are expected to have far reaching applications in specifications, including MIL-L-46152 and its revisions. The huge quantities of samples on hand at NBS also have great value for other studies, e.g., of the consistency of finished products and the effect of basestock on additive performance. Indeed, Section IV of Technical Division P in cooperation with Technical Division N on Hydraulic Fluids has already been using them to formulate hydraulic fluid samples from re-refined and virgin basestocks in order to study the comparative properties of these products and consistency.

Paul Strigner, Chairman,
Technical Division P

CONTENTS

I

THE ASTM/NBS BASESTOCK CONSISTENCY STUDY

I. The ASTM/NBS Basestock Consistency Study

A. Organization and Scope

As described in the two forewords, the study was co-sponsored by the American Society for Testing and Materials (ASTM) and the National Bureau of Standards (NBS). Under the various government Acts (Energy Policy and Conservation Act of 1975, Resource Conservation and Recovery Act of 1976, and Oil Recycling Act of 1980), the recycling of lubricating oil has been encouraged. One of the main concerns both in government and industry, is the lack of a technical data base on the consistency in quality of the re-refined lubricating base oils. The possibility of contaminants, either intermittent or otherwise, in the used oil collected for re-refining causes concern that batch-to-batch variation of re-refined base oils may have a significant affect on the finished oil performance.

Historically, the virgin base oil companies are required to maintain constant crude source and the same processing technology to maintain quality control after extensive performance evaluations. Control of feedstock consistency for re-refined base oils is more difficult. Studies in the past have established that a properly re-refined basestock can be formulated to give comparable engine test and field performance to a similarly formulated virgin base oil.

This consistency question was addressed in a cooperative study begun in March 1980 under the sponsorship of ASTM and the National Bureau of Standards. In this 13-month study, four virgin oil and six re-refined oil companies submitted monthly production samples to NBS. There, the samples were subdivided, coded, and sent to 14 participating laboratories for analysis of the physical and chemical properties as well as for evaluation in various bench tests. An eleventh control sample was sent monthly for reference.

Various re-refining processes included in the study are: acid/clay; clay treatment; short path distillation; pretreat/vacuum distillation/clay finish; pretreat/hydrogenation. The processes for the virgin base oils are mainly solvent extraction/distillation with and without the hydro-finishing step.

Since it is not clear what physical and chemical properties of the base oils are important in quality control, a total of over fifty tests measuring over sixty-four characteristics were performed by the participating laboratories. Some tests, because of their complexity, time requirement and/or cost, were conducted only on predetermined selected samples.

The participating laboratories were Bartlesville Energy Technical Center; Chevron USA; Filmite Oil Corporation; Gulf Research and Development Corporation; Lubrizol Corporation; MERADCOM (U.S. Army); Mobil Research and Development Corporation; Motor Oils Refining Company; National Bureau of Standards; National Research Council of Canada; Savant, Inc.; Shell Research Ltd: (Thornton); Suntech Group; and Texaco, Inc.

B. Data Presentation

The data are grouped into six main catagories: (1) rheology; (2) physical properties; (3) chemical properties; (4) hydrocarbon type analysis; (5) general performance tests; and (6) oxidation and wear bench tests. Within each category, test results are arranged according to the similarity of the tests or test properties.

In the tables, a single dash, - , means no sample exists for that oil and month, and a double dash, -- , means no analysis was performed on that sample for the specific test.

For each test or each property tested by several laboratories or several methods, the data are grouped together for easy comparison. Each test, whenever applicable or feasible, has (1) a data table arranged in a month vs. oil source matrix, (2) a plot of the data vs oil source indicating the range and data distribution, and (3) a time series plot showing variation as a function of time for each oil source. The time series plot is intended to be a simple graphical display useful for initial data analysis to aid in revealing various features of the data. In the time series plots, virgin basestocks are plotted using solid lines and re-refined basestocks are plotted using dashed lines. These plots show the relative numerical range and variability between the re-refined and the virgin base oils. It is not intended to show each individual time series plot for each oil. The summary statistics (mean, standard deviation, minimum and maximum) appear at the bottom of each table when applicable. The calculation of these values simply ignores any non-numeric code (e.g. > or letters).

In the data tables, oil I is the internal reference oil sent out each month from the same drum to establish test repeatability. A casual examination of the data reveals that apparent variability in the data could be derived from: (1) test method precision; (2) operator error (outlier); (3) production sample variability. Even after the inconsistent samples have been determined, questions such as the significance of the test result, and what is truly being measured and how the measured property relates to performance or quality remain to be answered. In addition, product performance can only be measured when the basestocks are compounded with additives. Therefore, only those characteristics affecting the additive response may be the controlling parameters in monitoring consistency. At this time, such a commonly recognized set of properties does not exist.

Based on the these considerations, interpretation of the data presented here should be conducted with extreme care, lest false conclusions be derived.

II

RHEOLOGY

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: KINEMATIC VISCOSITY AT 40 DEG C (cSt) ASTM D445 LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	23.39	-	31.08	48.66	38.90	26.59	62.11	28.82	66.25	37.61	61.33
APR 80	24.61	53.16	29.98	48.16	38.75	25.46	57.88	28.47	64.50	42.79	-
MAY 80	24.08	56.43	30.80	47.00	38.94	24.60	56.69	28.95	61.39	41.11	-
JUN 80	23.97	56.87	32.00	46.69	38.93	26.57	57.51	29.79	62.40	39.88	-
JUL 80	24.76	57.28	30.25	49.13	38.98	25.42	59.48	29.80	55.43	42.84	-
AUG 80	23.87	58.53	30.58	48.48	38.67	25.13	57.55	32.93	64.07	41.31	-
SEP 80	23.39	55.93	31.34	49.53	38.71	28.19	58.29	30.68	57.67	41.49	-
OCT 80	23.57	59.27	30.58	50.14	38.84	30.72	62.02	30.65	68.32	38.60	-
NOV 80	23.91	53.88	29.31	49.02	38.92	28.09	61.14	28.64	58.81	46.91	-
DEC 80	23.27	58.99	29.63	49.51	38.88	31.03	61.80	29.72	58.02	49.52	-
JAN 81	24.66	58.26	32.09	50.07	38.74	-	57.38	27.01	62.23	42.92	-
FEB 81	24.94	63.00	30.05	49.23	38.76	-	63.09	31.07	57.26	42.30	68.85
MAR 81	25.08	87.89	31.12	49.18	38.99	-	64.33	29.61	54.56	38.18	65.68
MEAN	24.115	59.957	30.678	48.831	38.847	27.180	59.944	29.703	60.839	41.958	65.287
STD.DEV.	.630	9.167	.847	1.047	.109	2.281	2.566	1.455	4.256	3.346	3.775
MIN	23.27	53.16	29.31	46.69	38.67	24.60	56.69	27.01	54.56	37.61	61.33
MAX	25.08	87.89	32.09	50.14	38.99	31.03	64.33	32.93	68.32	49.52	68.85

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: KINEMATIC VISCOSITY AT 40 DEG C (cSt) ASTM D445 LABORATORY: L2

DATE	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
	A	B	C	D	I	E	F	G	H	J	K
MAR 80	23.87	–	31.20	48.89	38.88	26.70	62.21	29.43	66.59	37.60	61.71
APR 80	26.75	53.33	30.13	48.18	38.98	25.58	57.99	28.61	64.75	42.83	–
MAY 80	24.30	56.62	30.74	47.03	38.95	24.42	56.71	28.81	61.32	41.06	–
JUN 80	24.04	56.82	32.04	46.83	38.90	26.59	57.63	29.82	62.37	40.02	–
JUL 80	24.65	57.66	30.30	49.17	38.95	25.50	59.31	29.85	55.48	43.12	–
AUG 80	24.98	58.74	30.68	48.76	38.93	25.36	57.75	33.16	64.47	41.51	–
SEP 80	23.53	56.30	31.63	50.15	38.99	25.59	58.59	30.91	57.63	41.80	–
OCT 80	23.67	59.32	30.58	50.13	39.01	30.86	62.38	30.78	68.47	38.69	–
NOV 80	23.89	53.86	29.75	49.10	38.98	28.11	61.29	28.68	59.18	47.16	–
DEC 80	23.31	59.30	29.79	49.83	38.98	31.10	61.85	29.79	58.23	49.85	–
JAN 81	24.69	58.52	32.12	50.09	38.99	–	57.66	26.59	62.55	43.06	–
FEB 81	24.91	63.21	30.20	49.48	38.99	–	63.21	31.31	57.26	42.26	68.97
MAR 81	24.91	87.81	30.99	49.14	38.84	–	64.65	29.74	54.58	38.19	66.51
MEAN	24.423	60.124	30.781	48.983	38.952	26.981	60.095	29.806	60.991	42.088	65.730
STD.DEV.	.898	9.101	.786	1.084	.051	2.328	2.597	1.577	4.335	3.430	3.692
MIN	23.31	53.33	29.75	46.83	38.84	24.42	56.71	26.59	54.58	37.60	61.71
MAX	26.75	87.81	32.12	50.15	39.01	31.10	64.65	33.16	68.47	49.85	68.97

ASTM/NBS BASESTOCK CONSISTENCY STUDY

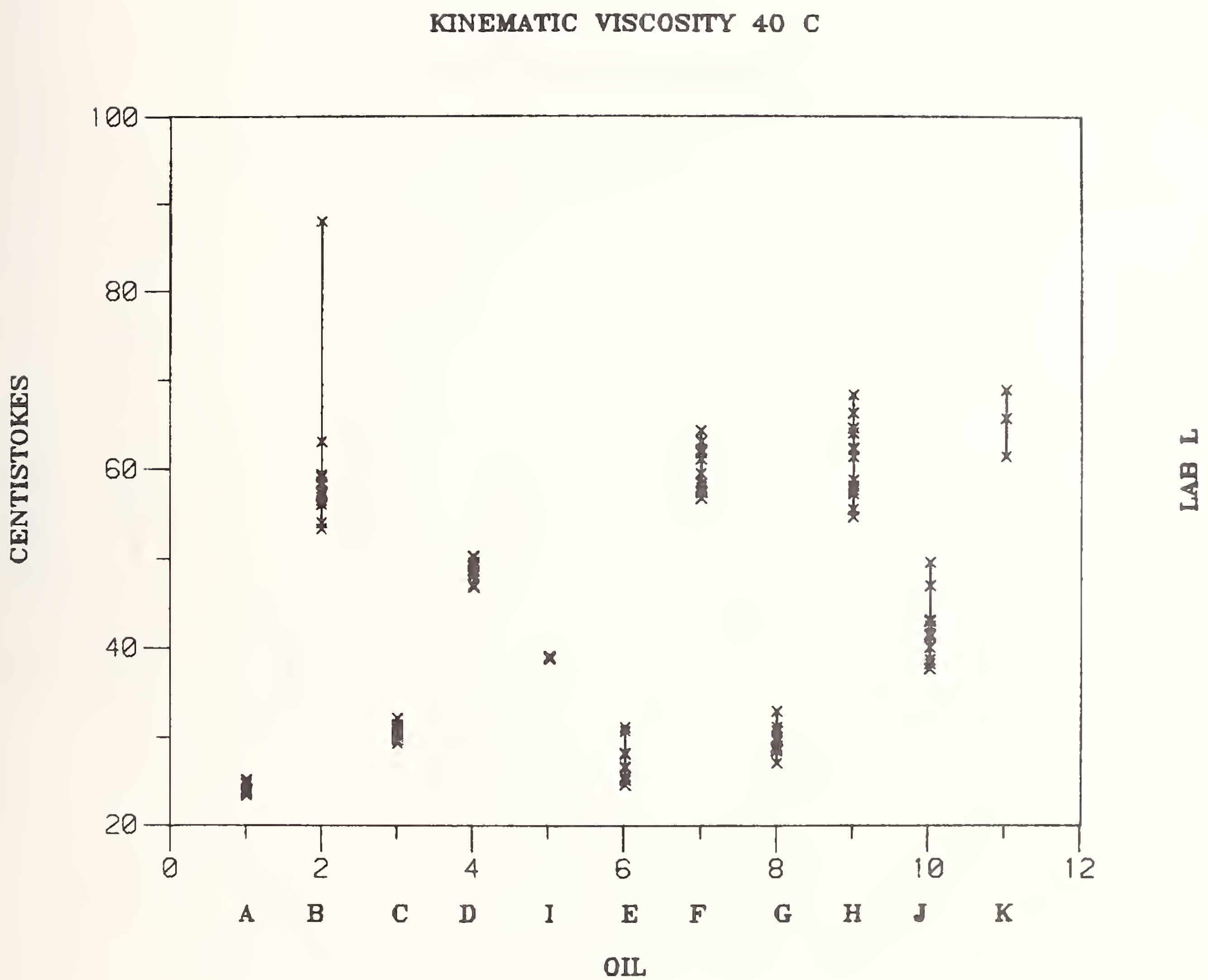
TEST: KINEMATIC VISCOSITY AT 40 DEG C (cSt) ASTM D445 LABORATORY: P

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	23.81	-	31.08	48.51	38.86	26.40	62.07	28.87	66.06	37.60	61.24
APR 80	24.55	53.09	30.05	47.68	38.87	25.41	57.84	28.55	64.31	42.63	-
MAY 80	24.12	56.58	30.78	47.09	38.99	24.64	56.78	28.75	61.56	40.80	-
JUN 80	23.98	56.59	32.01	46.27	38.76	26.50	57.47	29.70	62.19	40.16	-
JUL 80	24.65	57.51	30.26	49.29	38.95	25.26	59.27	29.97	55.55	42.95	-
AUG 80	23.79	58.78	30.62	48.43	38.93	25.24	57.56	32.75	64.00	41.42	-
SEP 80	23.42	55.83	31.48	49.43	38.76	28.28	58.14	30.76	57.70	41.58	-
OCT 80	23.58	59.11	30.39	50.06	38.86	30.76	62.06	30.64	68.28	38.35	-
NOV 80	23.82	53.43	29.65	48.87	38.82	27.87	60.84	28.62	58.94	46.84	-
DEC 80	23.21	59.00	29.43	49.57	38.76	30.82	61.81	29.71	57.89	49.37	-
JAN 81	24.70	58.44	32.02	49.82	38.95	-	57.20	27.08	62.63	43.13	-
FEB 81	24.89	63.21	30.09	49.38	38.99	-	62.55	31.35	57.27	42.08	68.50
MAR 81	24.70	87.19	30.84	48.90	38.78	-	64.28	29.66	54.43	37.86	66.19
MEAN	24.094	59.897	30.669	48.715	38.868	27.118	59.836	29.724	60.832	41.905	65.310
STD.DEV.	.551	9.010	.818	1.115	.088	2.256	2.520	1.445	4.225	3.359	3.709
MIN	22.12	53.09	29.43	46.27	38.76	24.64	56.78	27.08	54.43	37.60	61.24
MAX	24.89	87.19	32.02	50.06	38.99	30.82	64.28	32.75	68.28	49.37	68.50

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: KINEMATIC VISCOSITY AT 40 DEG C (cSt) ASTM D445 LABORATORY: Y

DATE	VIRGIN BASESTOCK A	B	C	D	REF I	RE-REFINED BASESTOCKS E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	--	--	37.6	61.6
APR 80	24.7	53.2	30.1	48.3	39.0	25.6	57.7	28.5	64.7	43.0	-
MAY 80	24.0	56.8	30.6	47.1	38.9	24.6	56.7	28.8	61.3	40.9	-
JUN 80	24.0	56.8	32.1	46.9	38.9	26.6	57.7	29.8	62.4	40.1	-
JUL 80	24.5	57.4	30.3	49.1	39.0	25.4	59.1	29.6	N.A.	42.9	-
AUG 80	24.0	58.8	30.9	49.6	38.9	25.3	57.7	32.9	64.3	41.4	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	24.24	56.60	30.80	48.20	38.94	25.50	57.78	29.92	63.17	40.98	61.60
STD.DEV.	.34	2.07	.79	1.19	.05	.72	.86	1.75	1.60	2.01	.00
MIN	24.0	53.2	30.1	46.9	38.9	24.6	56.7	28.5	61.3	37.6	61.6
MAX	24.7	58.8	32.1	49.6	39.0	26.6	59.1	32.9	64.7	43.0	61.6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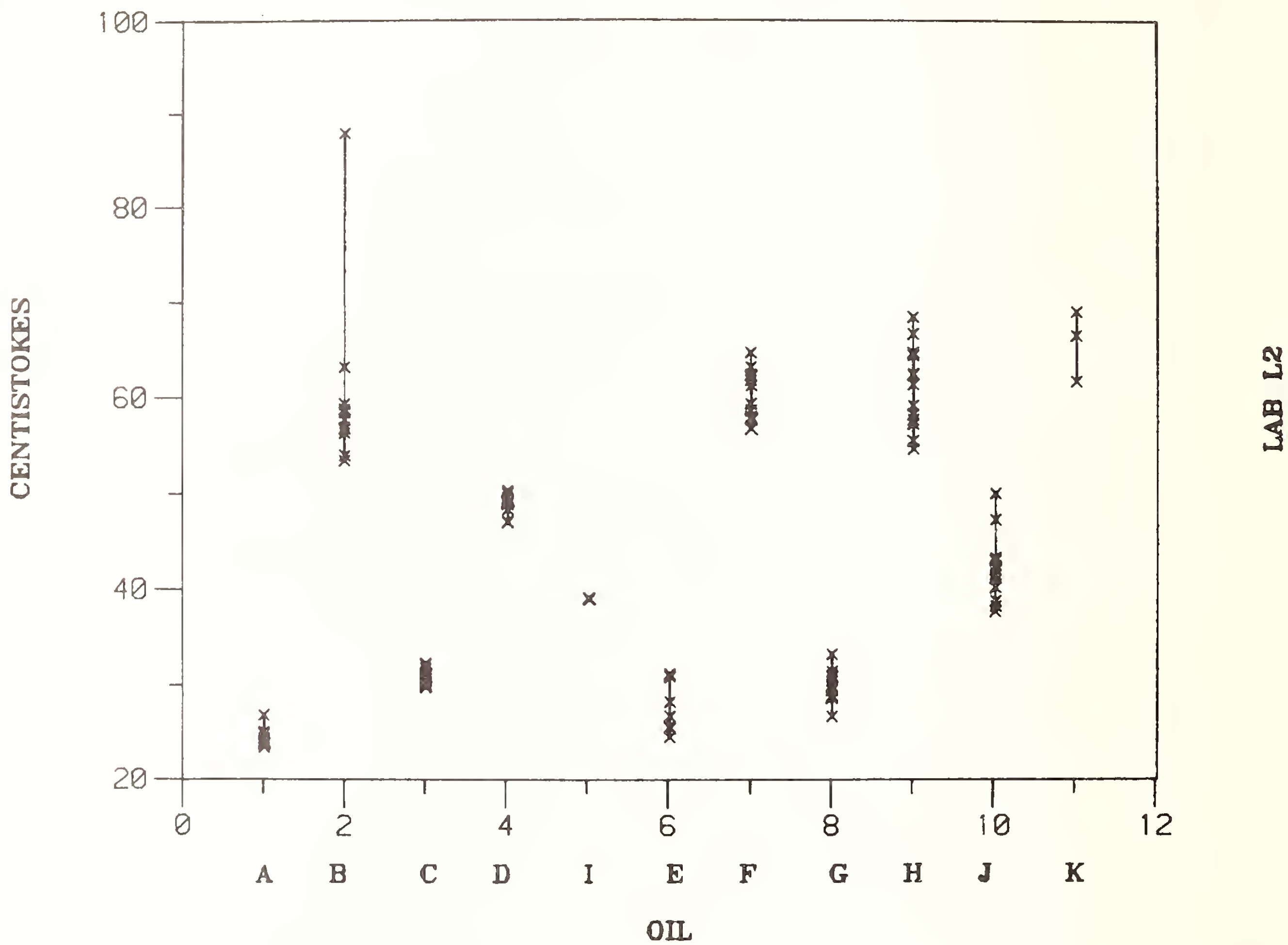

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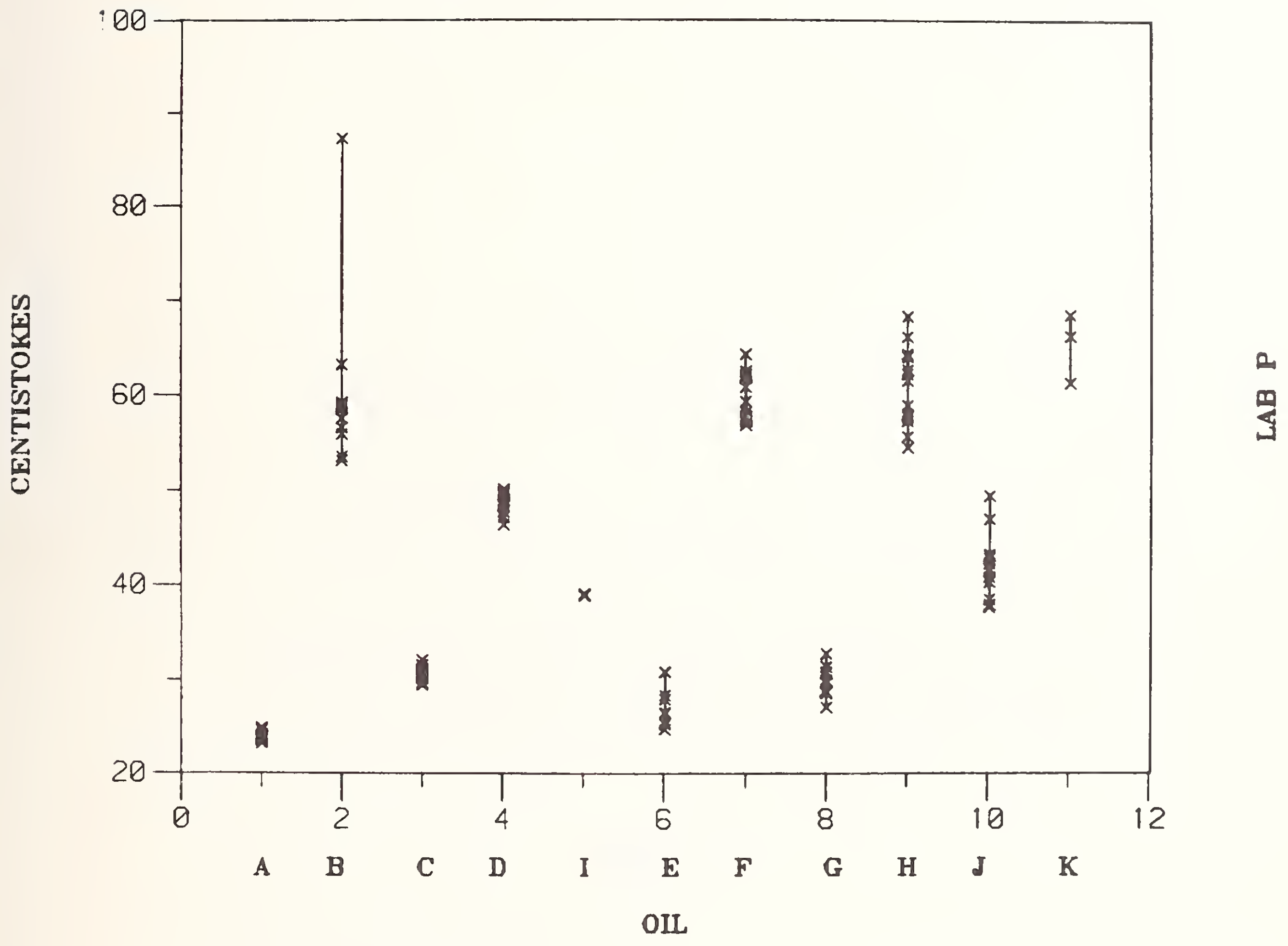

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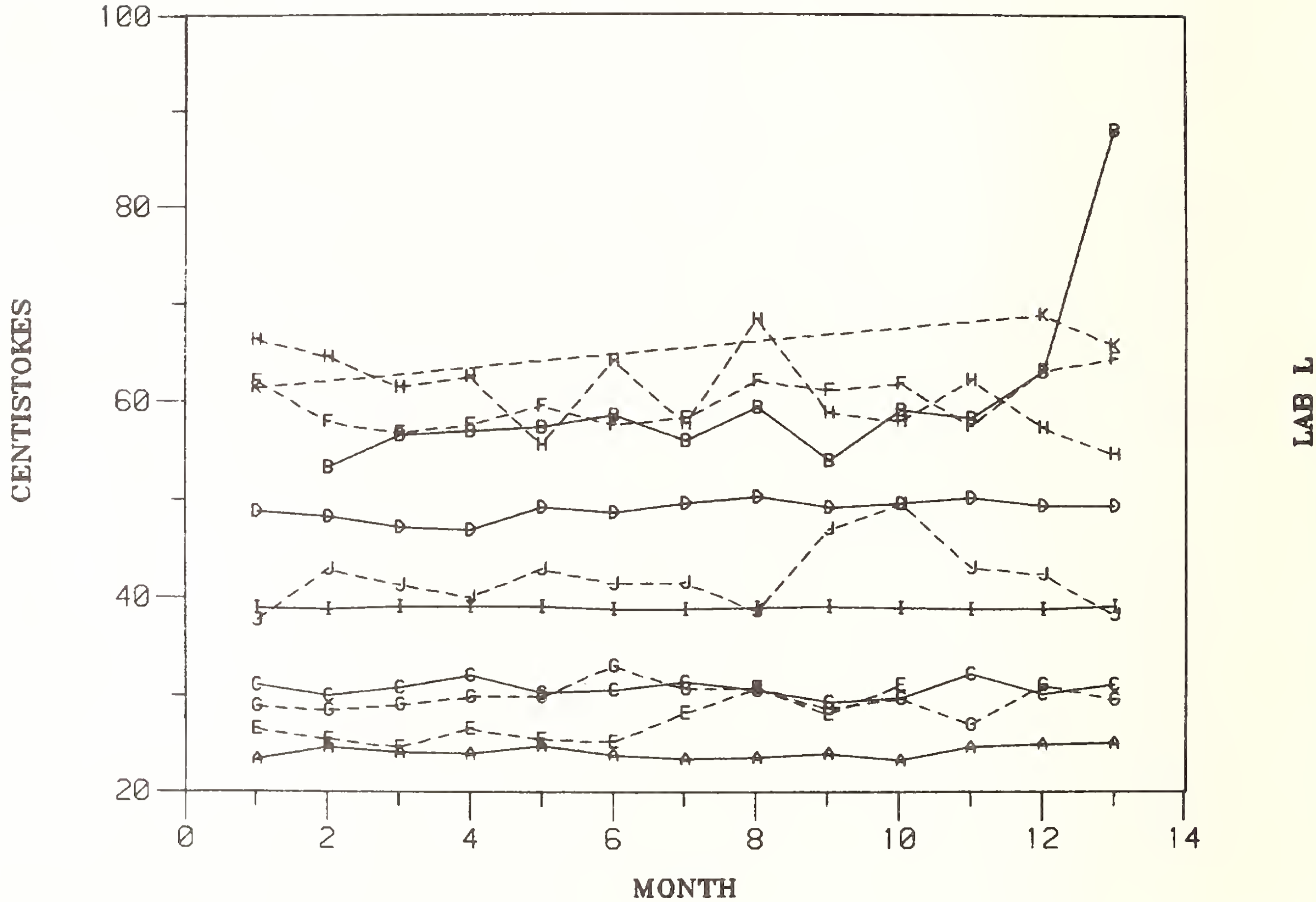

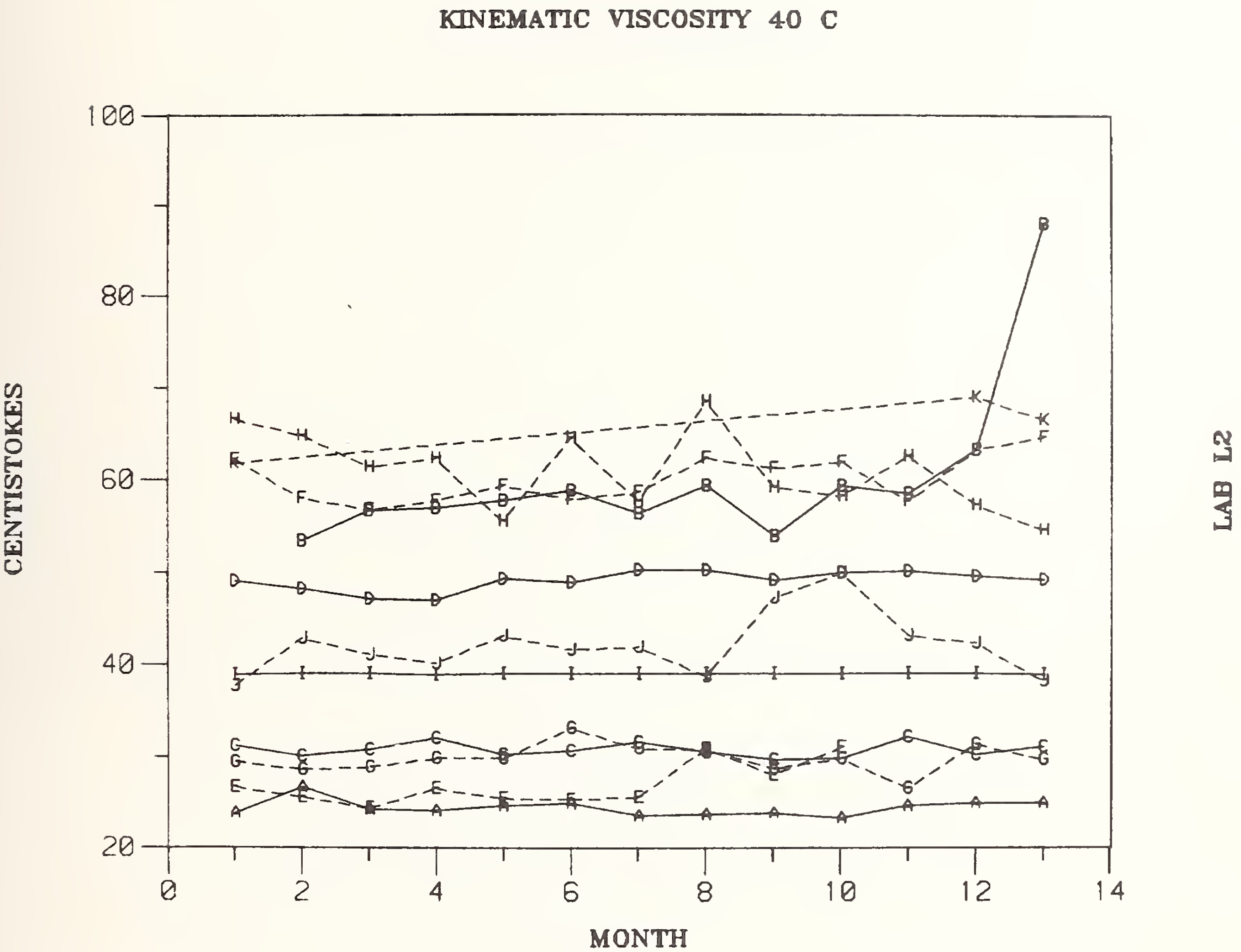
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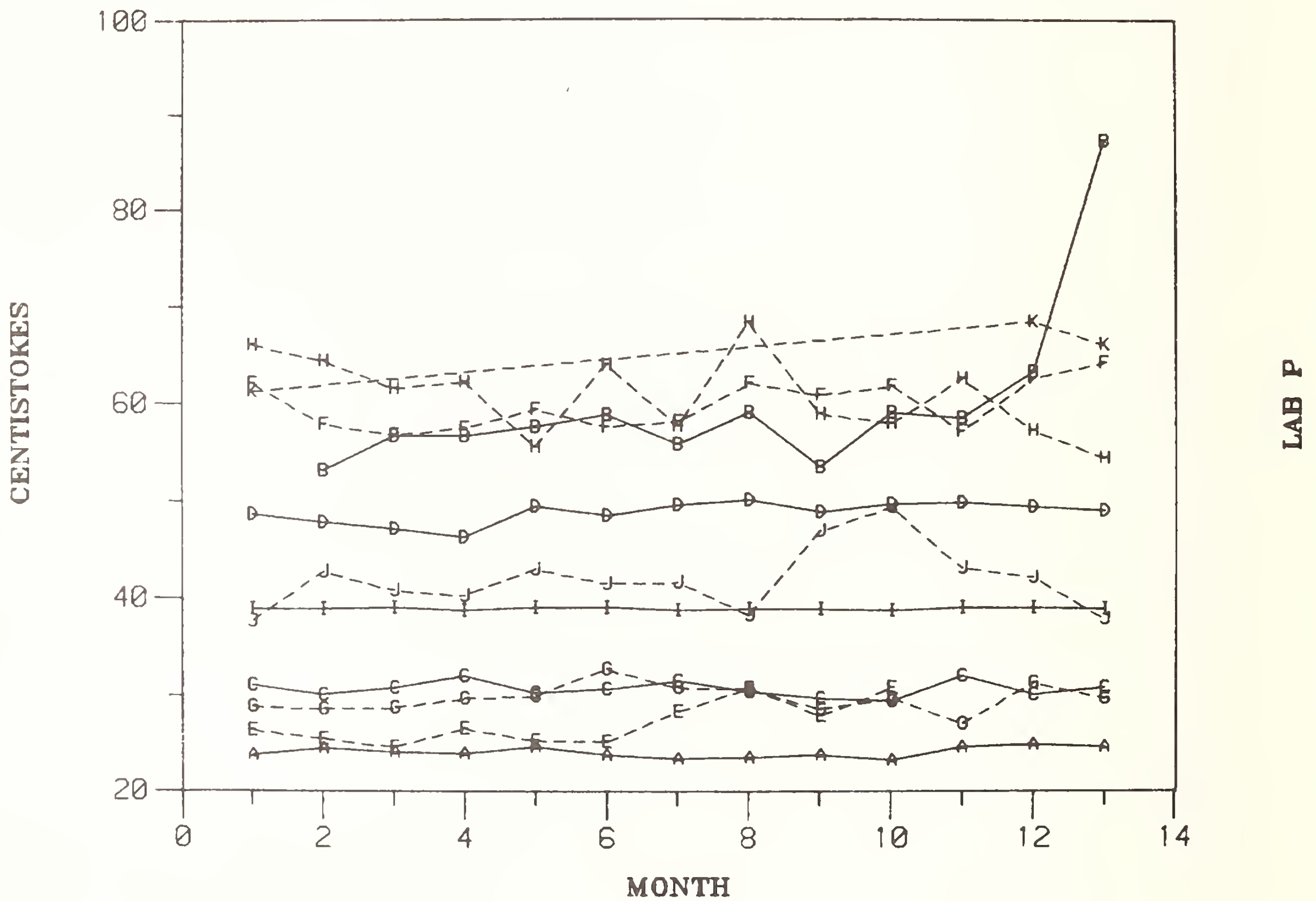


ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: KINEMATIC VISCOSITY AT 100 DEG C (cSt) ASTM D445 LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	4.52	-	5.40	6.89	6.10	4.76	8.64	4.99	8.82	5.83	8.51
APR 80	4.61	7.48	5.25	6.83	6.11	4.64	8.25	4.92	8.69	6.34	-
MAY 80	4.56	7.77	5.34	6.81	6.14	4.55	8.17	4.98	8.48	6.19	-
JUN 80	4.55	7.77	5.46	6.74	6.10	4.77	8.31	5.01	8.64	6.06	-
JUL 80	4.60	7.80	5.23	6.92	6.10	4.63	8.35	5.09	7.93	6.41	-
AUG 80	4.52	7.93	5.27	6.93	6.11	4.92	8.15	5.58	8.83	6.27	-
SEP 80	4.47	7.68	5.33	7.00	6.12	4.97	8.32	5.22	8.33	6.26	-
OCT 80	4.49	8.00	5.25	7.05	6.11	5.59	8.68	5.29	9.20	5.95	-
NOV 80	4.52	7.47	5.18	6.97	6.13	4.93	9.01	4.97	8.31	6.78	-
DEC 80	4.44	7.97	5.16	7.01	6.11	5.23	8.68	5.08	8.24	7.00	-
JAN 81	4.61	7.91	5.40	7.07	6.12	-	8.55	4.77	8.66	6.36	-
FEB 81	4.62	8.35	5.21	6.99	6.11	-	8.70	5.27	8.20	6.29	8.99
MAR 81	4.63	10.42	5.33	6.97	6.17	-	8.81	5.11	7.91	6.01	8.76
MEAN	4.549	8.046	5.293	6.937	6.118	4.899	8.509	5.098	8.480	6.288	8.753
STD.DEV.	.062	.784	.092	.097	.020	.315	.269	.205	.373	.321	.240
MIN	4.44	7.47	5.16	6.74	6.10	4.55	8.15	4.77	7.91	5.83	8.51
MAX	4.63	10.42	5.46	7.07	6.17	5.59	9.01	5.58	9.20	7.00	8.99

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: KINEMATIC VISCOSITY AT 100 DEG C (cSt) ASTM D445 LABORATORY: L2

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	4.48	–	5.34	6.85	6.18	4.73	8.59	4.95	8.40	5.78	8.45
APR 80	4.58	7.40	5.25	6.81	6.10	4.67	8.15	4.90	8.59	6.31	–
MAY 80	4.51	7.66	5.29	6.68	6.10	4.53	8.03	4.97	8.37	6.14	–
JUN 80	4.52	7.70	5.40	6.68	6.07	4.71	8.30	4.97	8.53	6.06	–
JUL 80	4.56	7.87	5.23	6.85	6.08	4.59	8.28	5.04	7.91	6.32	–
AUG 80	4.45	7.84	5.28	6.83	6.09	4.58	8.15	5.58	8.73	6.23	–
SEP 80	4.48	7.62	5.28	6.90	6.15	5.05	8.31	5.27	8.33	6.14	–
OCT 80	4.47	7.96	5.35	6.99	6.04	5.16	8.57	5.17	9.11	5.89	–
NOV 80	4.45	7.38	5.06	6.86	6.09	4.91	8.85	4.94	8.20	7.05	–
DEC 80	4.49	7.89	4.89	6.94	6.04	5.16	8.50	5.07	8.31	6.98	–
JAN 81	4.67	7.83	5.37	6.96	6.05	–	8.12	4.72	8.63	6.31	–
FEB 81	4.57	6.91	5.18	6.93	6.07	–	8.61	5.19	8.14	6.21	8.86
MAR 81	4.57	10.31	5.28	6.92	6.05	–	8.79	5.09	7.85	5.91	8.69
MEAN	4.523	7.864	5.246	6.862	6.085	4.809	8.404	5.066	8.392	6.256	8.667
STD.DEV.	.064	.825	.138	.097	.042	.242	.266	.210	.339	.378	.206
MIN	4.45	6.91	4.89	6.68	6.04	4.53	8.03	4.72	7.85	5.78	8.45
MAX	4.67	10.31	5.40	6.99	6.18	5.16	8.85	5.58	9.11	7.05	8.86

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: KINEMATIC VISCOSITY AT 100 DEG C (cSt) ASTM D445 LABORATORY: P

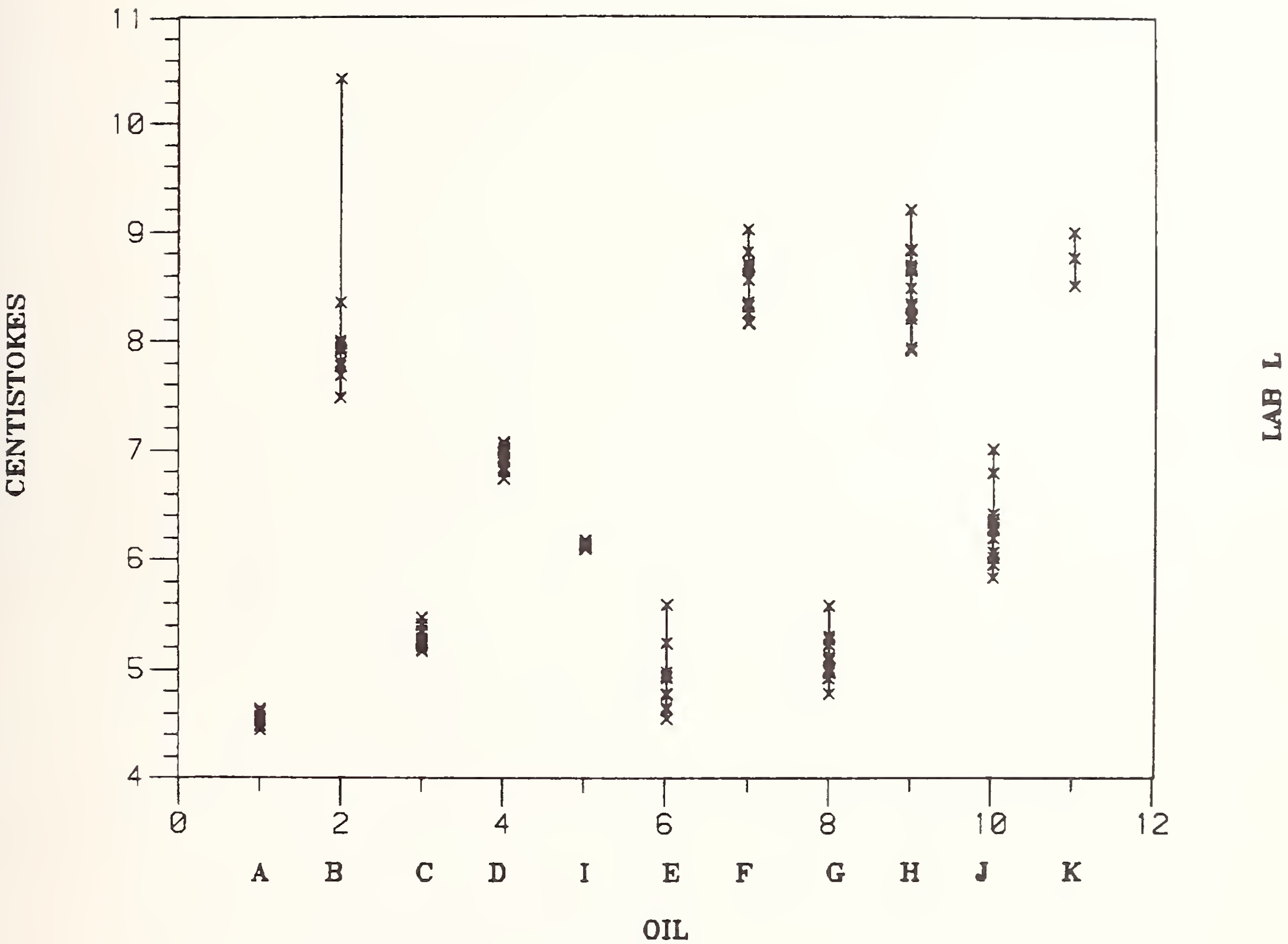
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	4.55	-	5.38	6.86	6.09	4.75	8.63	4.99	8.76	5.82	8.45
APR 80	4.60	7.42	5.22	6.81	6.05	4.62	8.19	4.91	8.64	6.28	-
MAY 80	4.54	7.72	5.32	6.73	6.08	4.53	8.12	4.95	8.39	6.15	-
JUN 80	4.52	7.73	5.42	6.70	6.08	4.74	8.30	4.98	8.58	6.11	-
JUL 80	4.57	7.79	5.23	6.92	6.10	4.61	8.35	5.07	7.95	6.36	-
AUG 80	4.60	7.89	5.28	6.88	6.04	4.60	8.15	5.55	8.79	6.25	-
SEP 80	4.37	7.68	5.31	6.98	6.09	4.94	8.33	5.20	8.33	6.23	-
OCT 80	4.48	7.96	5.23	7.08	6.10	5.20	8.68	5.19	9.18	5.92	-
NOV 80	4.52	7.44	5.16	6.96	6.09	4.91	8.97	4.97	8.28	6.75	-
DEC 80	4.43	7.95	5.15	7.01	6.09	5.19	8.65	5.06	8.22	6.98	-
JAN 81	4.59	7.89	5.39	7.05	6.06	-	8.20	4.77	8.67	6.34	-
FEB 81	4.63	8.31	5.21	7.00	6.10	-	8.64	5.25	8.19	6.26	8.94
MAR 81	4.60	10.35	5.32	6.94	6.10	-	8.79	5.06	7.89	5.92	8.72
MEAN	4.538	8.011	5.278	6.917	6.082	4.809	8.462	5.073	8.452	6.259	8.703
STD.DEV.	.075	.774	.087	.117	.020	.243	.277	.193	.363	.321	.245
MIN	4.37	7.42	5.15	6.70	6.04	4.53	8.12	4.77	7.89	5.82	8.45
MAX	4.63	10.35	5.42	7.08	6.10	5.20	8.97	5.55	9.18	6.98	8.94

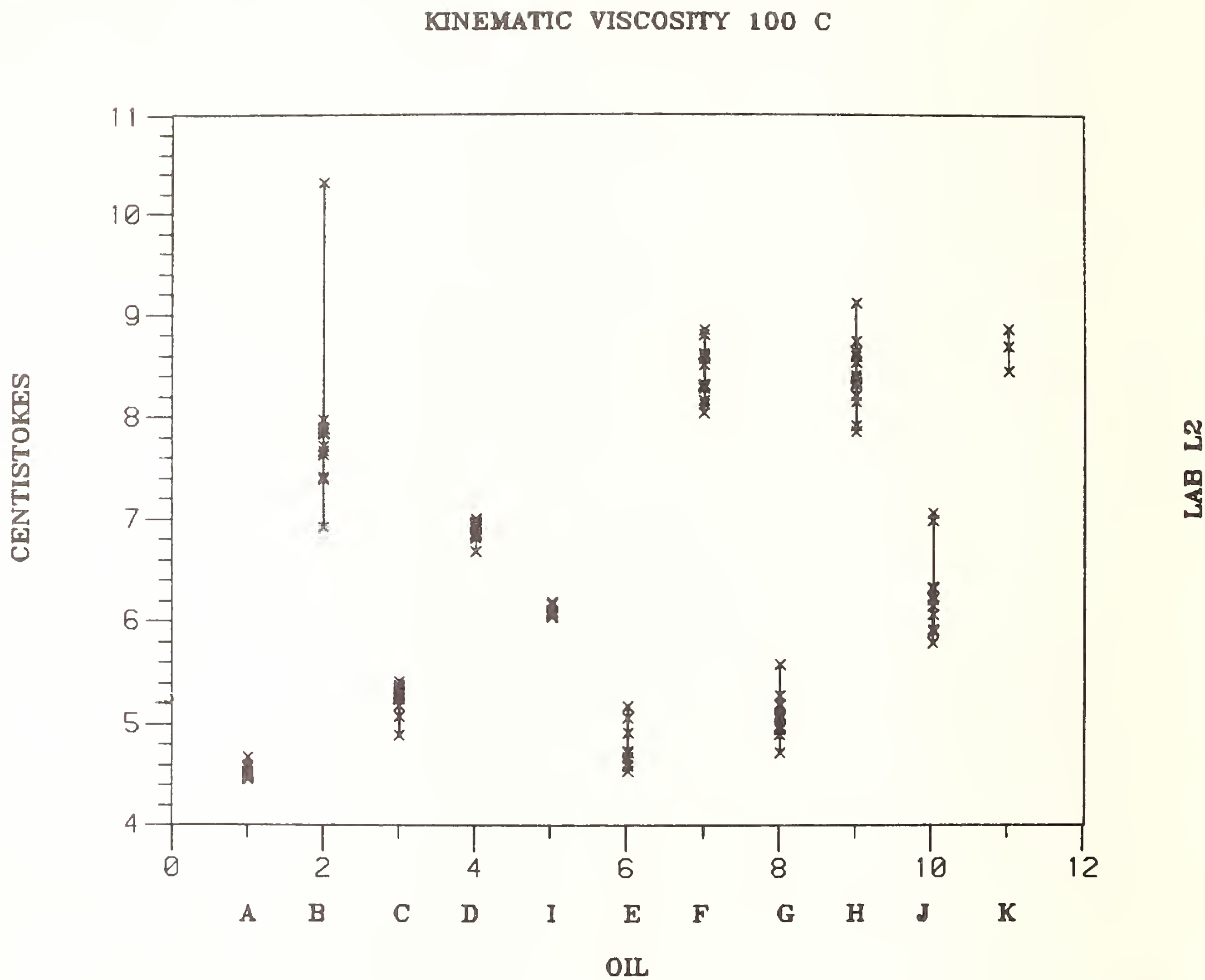
ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: KINEMATIC VISCOSITY AT 100 DEG C (cSt) ASTM D445 LABORATORY: Y

DATE	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	--	--	5.83	8.49
APR 80	4.61	7.44	5.26	6.82	6.10	4.63	--	4.92	8.68	6.28	-
MAY 80	4.53	7.70	5.31	6.70	6.12	4.52	8.13	4.96	8.42	6.17	-
JUN 80	4.52	7.76	5.46	6.80	6.10	4.77	8.30	4.99	8.60	6.10	-
JUL 80	4.60	7.80	5.20	6.90	6.10	4.60	8.30	5.10	8.00	6.40	-
AUG 80	4.50	7.90	5.30	6.90	6.10	4.60	8.50	5.60	8.80	6.30	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	4.552	7.720	5.306	6.824	6.104	4.624	8.307	5.114	8.500	6.180	8.490
STD.DEV.	.050	.173	.096	.083	.009	.091	.151	.280	.312	.201	.000
MIN	4.50	7.44	5.20	6.70	6.10	4.52	8.13	4.92	8.00	5.83	8.49
MAX	4.61	7.90	5.46	6.90	6.12	4.77	8.50	5.60	8.80	6.40	8.49

KINEMATIC VISCOSITY 100 C

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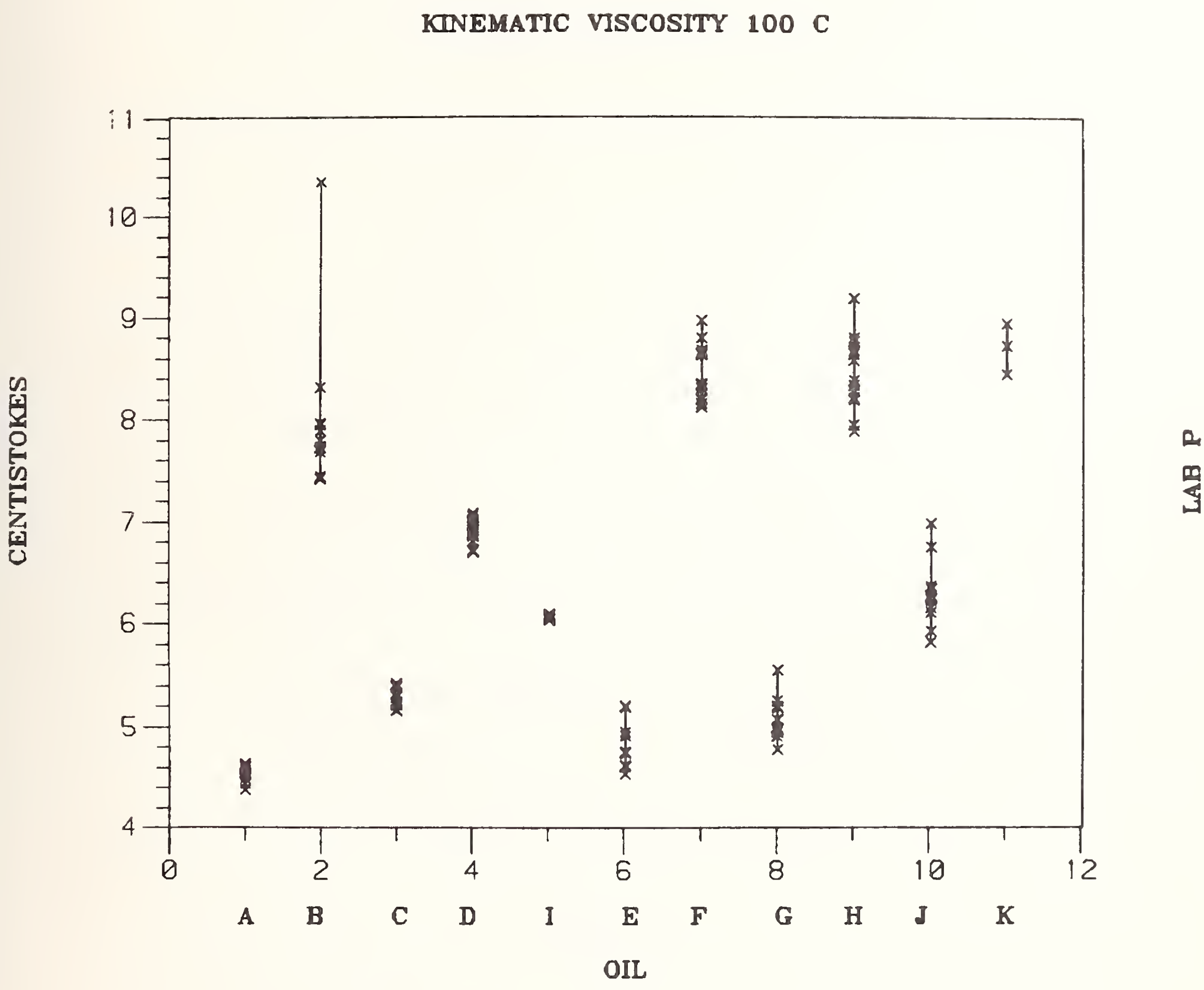
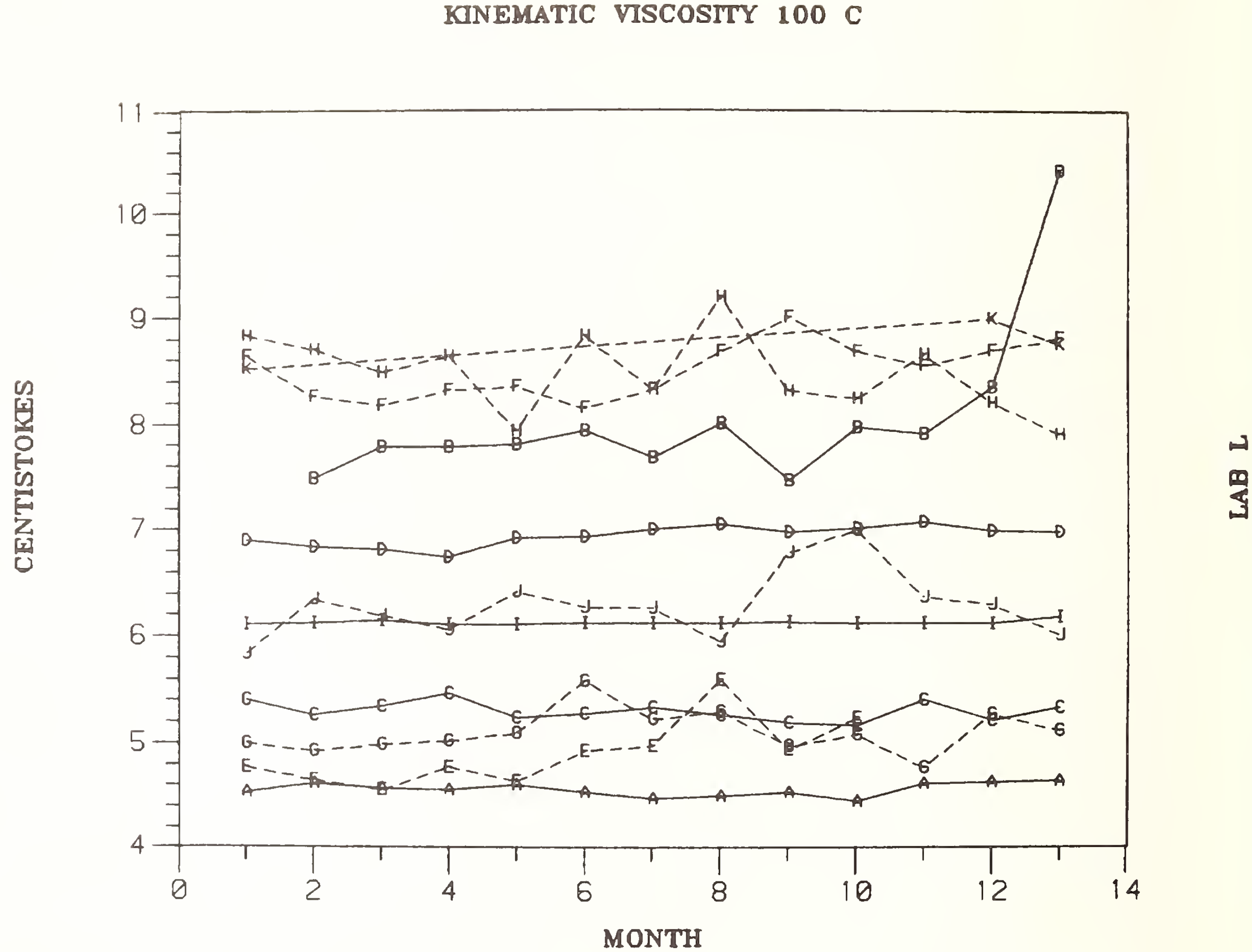
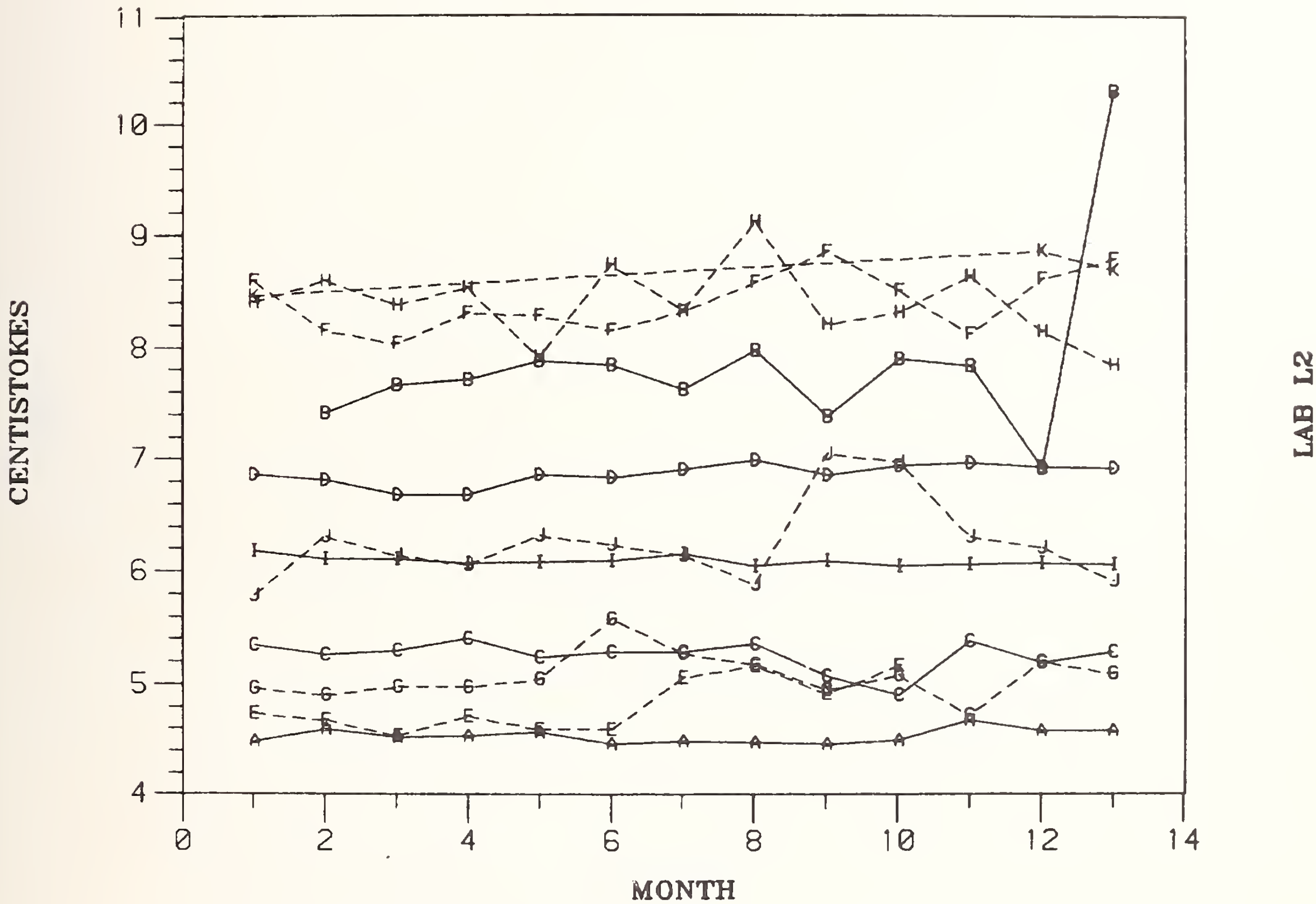
CENTISTOKES
11
10
9
8
7
6
5
4
0
2
4
6
8
10
12
A B C D I E F G H J K
OIL
LAB L2

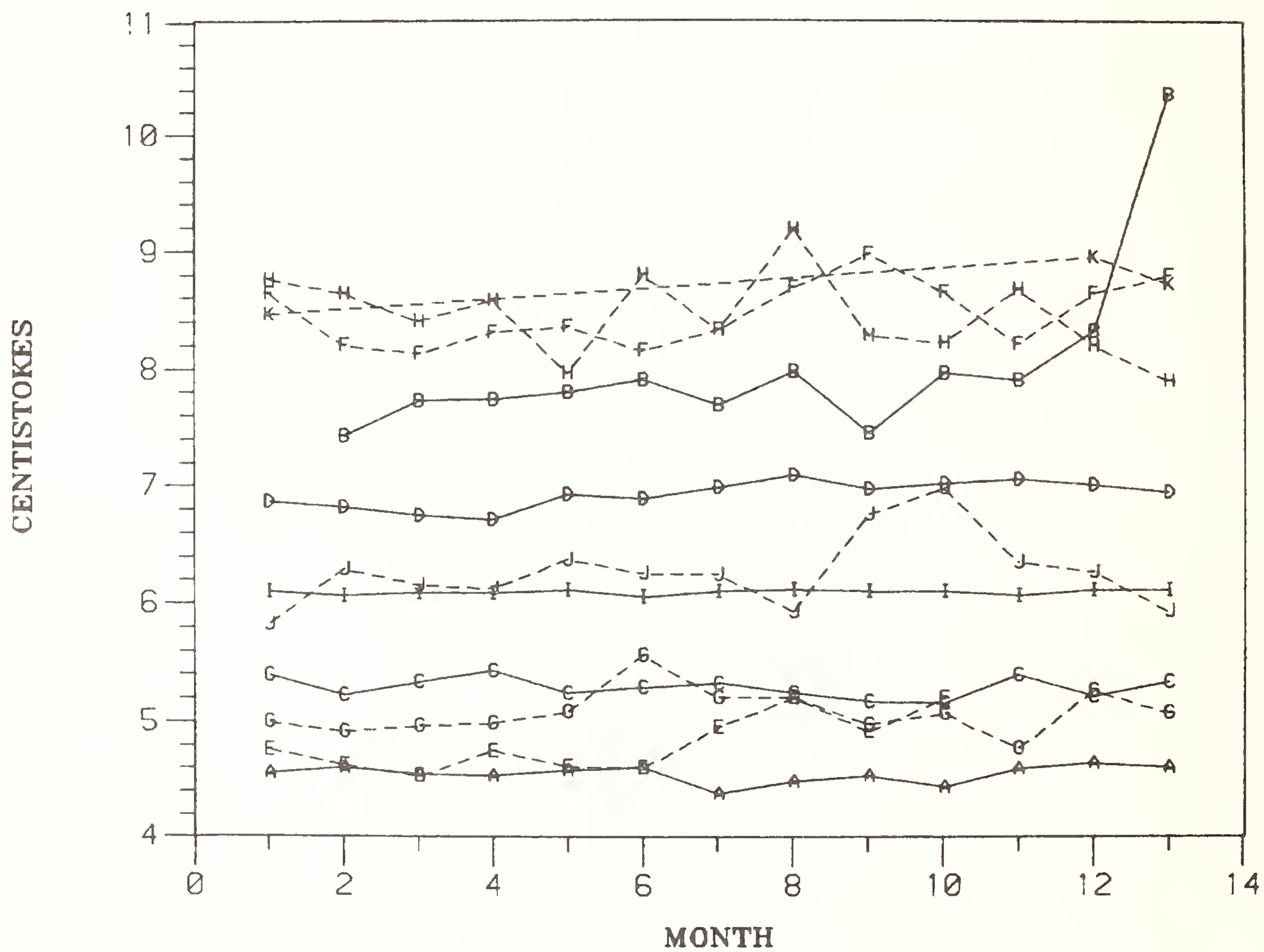

KINEMATIC VISCOSITY 100 C
CENTISTOKES
11
10
9
8
7
6
5
4
0
2
4
6
8
10
12
A B C D I E F G H J K
OIL
LAB P


KINEMATIC VISCOSITY 100 C
CENTISTOKES
MONTH
LAB L
11
10
9
8
7
6
5
4
0
2
4
6
8
10
12
14

KINEMATIC VISCOSITY 100 C



KINEMATIC VISCOSITY 100 C



LAB P

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: VISCOSITY INDEX (UNITS) ASTM D2270 LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	101.	-	108.	95.	101.	96.	112.	97.	106.	94.	110.
APR 80	102.	102.	106.	95.	102.	96.	112.	93.	107.	94.	-
MAY 80	102.	102.	106.	98.	103.	96.	113.	94.	109.	95.	-
JUN 80	103.	100.	106.	97.	101.	97.	115.	90.	111.	95.	-
JUL 80	100.	100.	103.	95.	101.	96.	111.	96.	109.	97.	-
AUG 80	101.	101.	103.	98.	103.	121.	110.	107.	112.	98.	-
SEP 80	101.	100.	102.	97.	103.	100.	113.	100.	115.	97.	-
OCT 80	101.	101.	102.	97.	102.	122.	113.	104.	111.	95.	-
NOV 80	101.	99.	106.	97.	103.	98.	124.	96.	111.	97.	-
DEC 80	100.	101.	103.	97.	102.	98.	114.	96.	111.	97.	-
JAN 81	101.	101.	102.	97.	103.	-	122.	93.	112.	95.	-
FEB 81	99.	101.	103.	97.	102.	-	111.	100.	112.	94.	105.
MAR 81	99.	100.	104.	97.	104.	-	110.	100.	111.	106.	106.
MEAN	100.8	100.7	104.2	96.7	102.3	102.0	113.8	97.4	110.5	96.5	107.0
STD.DEV.	1.1	.9	2.0	1.0	.9	10.4	4.3	4.7	2.3	3.2	2.6
MIN	99.	99.	102.	95.	101.	96.	110.	90.	106.	94.	105.
MAX	103.	102.	108.	98.	104.	122.	124.	107.	115.	106.	110.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: VISCOSITY INDEX (UNITS) ASTM D2270 LABORATORY: L2

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	97.0	–	104.0	93.0	105.0	92.0	110.0	88.0	95.0	92.0	107.0
APR 80	74.0	99.0	105.0	94.0	101.0	98.0	109.0	90.0	104.0	93.0	–
MAY 80	95.0	98.0	103.0	93.0	101.0	96.0	109.0	95.0	106.0	93.0	–
JUN 80	99.0	98.0	102.0	93.0	100.0	91.0	114.0	86.0	108.0	94.0	–
JUL 80	96.0	101.0	103.0	92.0	100.0	90.0	109.0	92.0	109.0	92.0	–
AUG 80	79.0	97.0	103.0	93.0	101.0	90.0	110.0	105.0	108.0	95.0	–
SEP 80	101.0	97.0	97.0	91.0	103.0	127.0	112.0	101.0	115.0	89.0	–
OCT 80	98.0	100.0	108.0	94.0	98.0	94.0	109.0	95.0	108.0	92.0	–
NOV 80	93.0	80.0	94.0	93.0	100.0	96.0	120.0	93.0	107.0	107.0	–
DEC 80	104.0	98.0	78.0	93.0	98.0	92.0	108.0	95.0	113.0	95.0	–
JAN 81	106.0	98.0	100.0	93.0	98.0	–	109.0	92.0	110.0	92.0	–
FEB 81	95.0	45.0	100.0	94.0	99.0	–	108.0	93.0	111.0	91.0	101.0
MAR 81	95.0	97.0	101.0	95.0	99.0	–	109.0	97.0	110.0	95.0	100.0
MEAN	94.77	92.33	99.85	93.15	100.23	96.60	110.46	94.00	108.00	93.85	102.67
STD.DEV.	8.98	15.85	7.45	.99	2.05	11.03	3.31	5.07	4.85	4.32	3.79
MIN	74.0	45.0	78.0	91.0	98.0	90.0	108.0	86.0	95.0	89.0	100.0
MAX	106.0	101.0	108.0	95.0	105.0	127.0	120.0	105.0	115.0	107.0	107.0

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: VISCOSITY INDEX (UNITS) ASTM D2270 LABORATORY: P

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	104	-	107	95	101	97	111	96	105	94	109
APR 80	101	100	104	100	99	94	110	92	106	92	-
MAY 80	100	100	105	95	100	93	111	93	106	95	-
JUN 80	100	100	103	96	101	85	115	88	110	96	-
JUL 80	97	99	103	94	101	95	111	93	110	95	-
AUG 80	108	99	104	96	98	94	110	106	111	96	-
SEP 80	90	100	100	96	101	97	114	98	115	95	-
OCT 80	100	100	102	98	101	98	113	98	110	95	-
NOV 80	102	100	103	97	101	98	124	96	110	96	-
DEC 80	100	100	103	97	101	96	113	95	111	97	-
JAN 81	99	100	102	97	99	-	112	92	111	93	-
FEB 81	101	100	103	97	101	-	111	97	112	94	104
MAR 81	100	100	105	97	102	-	110	95	111	98	104
MEAN	100.2	99.8	103.4	96.5	100.5	94.7	112.7	95.3	109.8	95.1	105.7
STD.DEV.	4.04	0.4	1.7	1.5	1.1	3.8	3.8	4.3	2.7	1.6	2.9
MIN	90	99	100	94	98	85	110	88	105	92	104
MAX	108	100	107	100	102	98	124	106	115	98	109

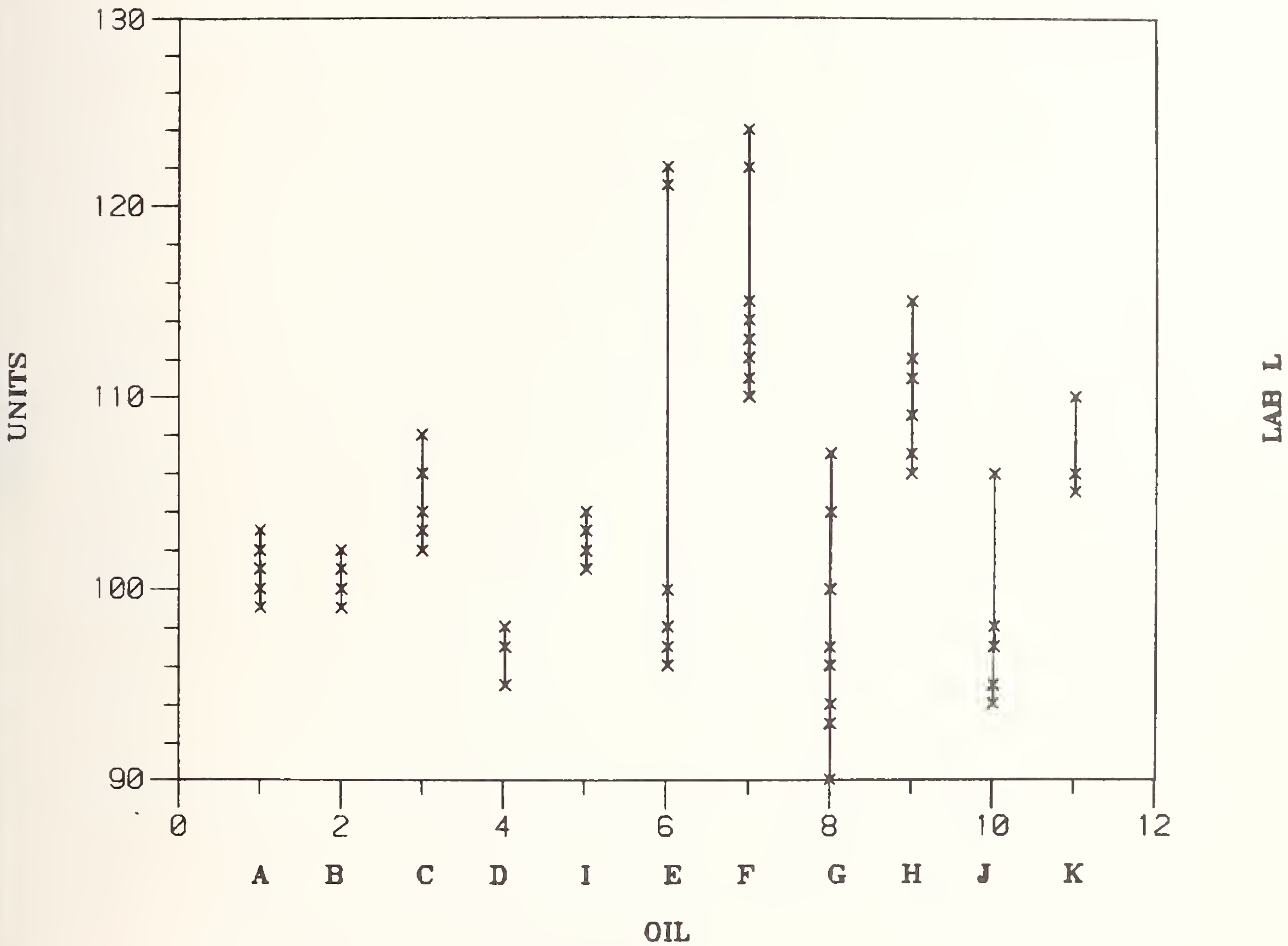
ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: VISCOSITY INDEX (UNITS) ASTM D2270

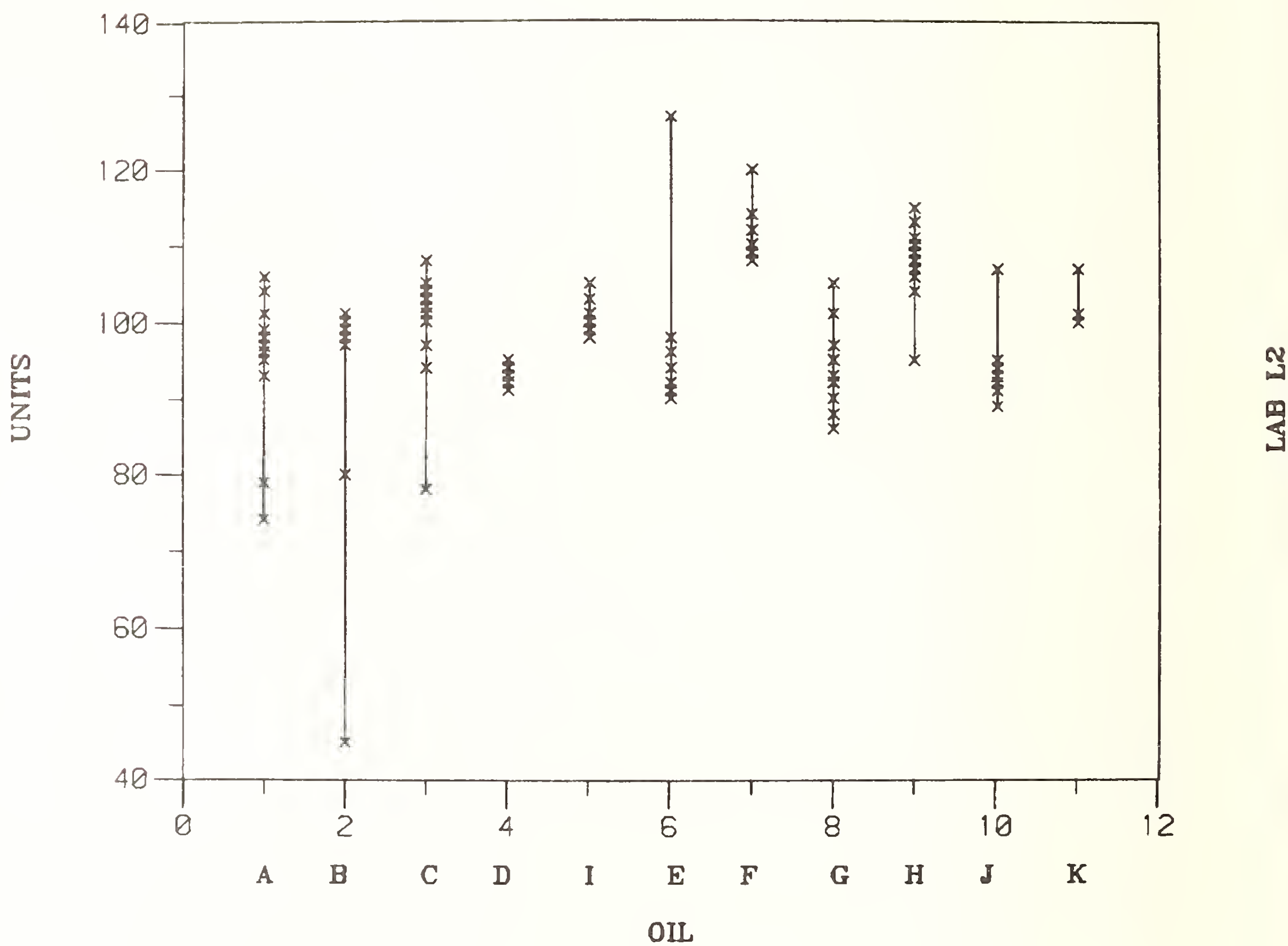
LABORATORY: Y

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	--	--	94.	109.
APR 80	101.	100.	107.	94.	101.	93.	--	93.	106.	91.	-
MAY 80	101.	98.	109.	93.	102.	93.	112.	94.	108.	95.	-
JUN 80	100.	100.	105.	91.	101.	97.	114.	88.	110.	95.	-
JUL 80	102.	100.	103.	94.	101.	92.	110.	99.	N A	96.	-
AUG 80	98.	99.	103.	93.	101.	93.	120.	108.	110.	99.	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 91	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	100.4	99.2	105.4	93.0	101.2	93.6	114.0	96.4	108.5	95.0	109.0
STD.DEV.	1.5	1.0	2.6	1.2	.4	1.9	4.3	7.6	1.9	2.6	-
MIN	98.	98.	103.	91.	101.	92.	110.	88.	106.	91.	109.0
MAX	102.	100.	109.	94.	102.	97.	120.	108.	110.	99.	109.0

VISCOSITY INDEX



VISCOSITY INDEX



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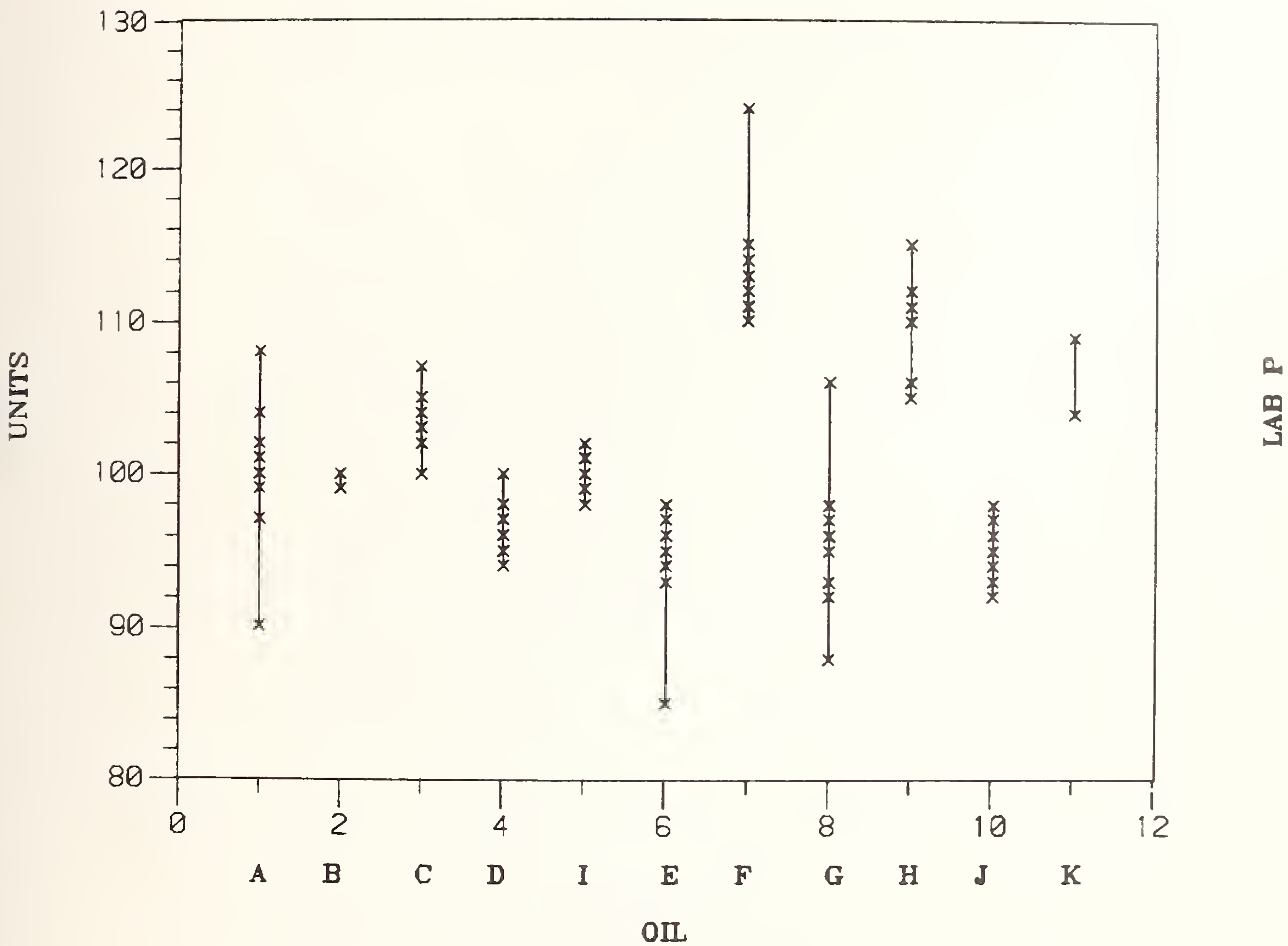

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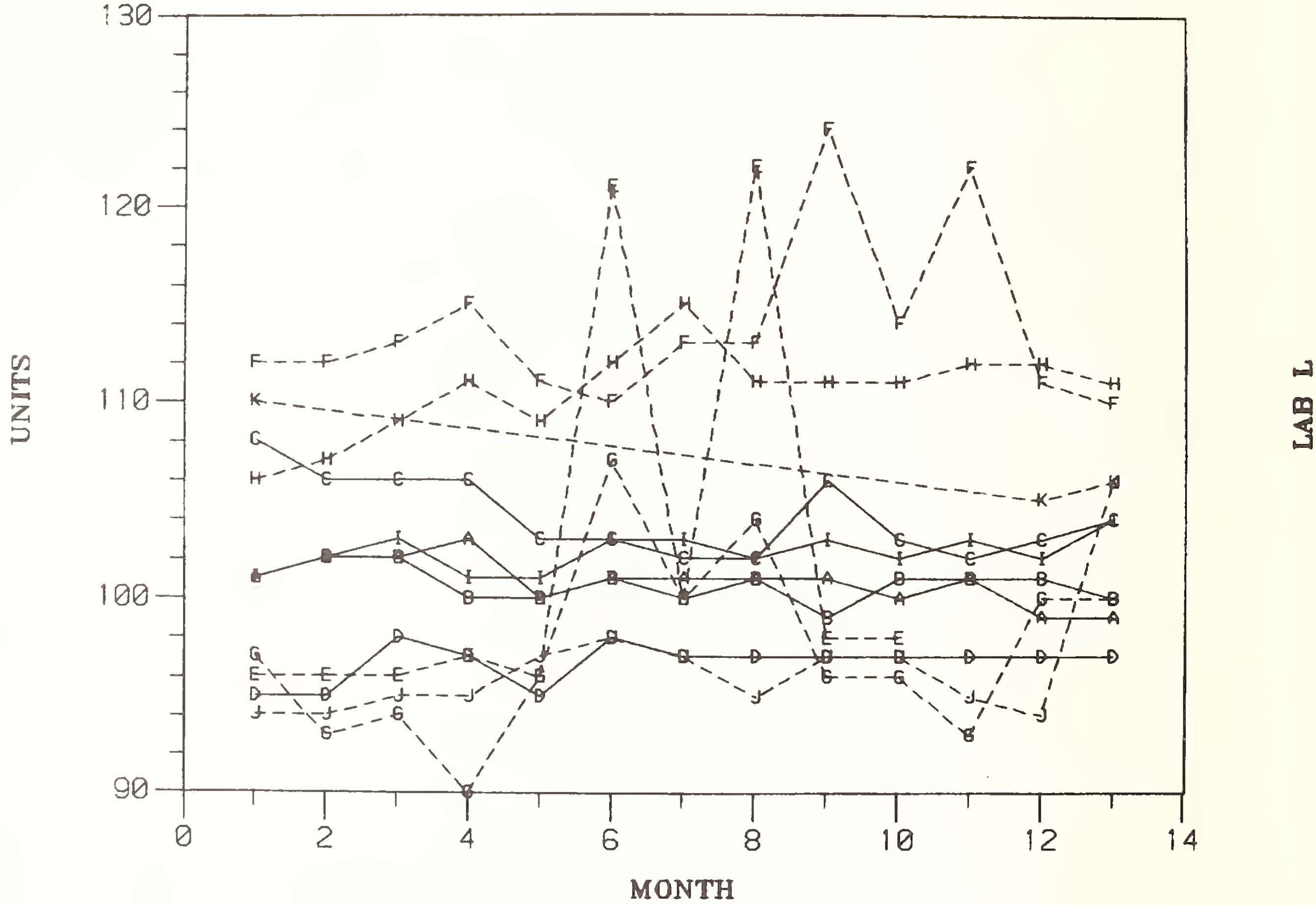

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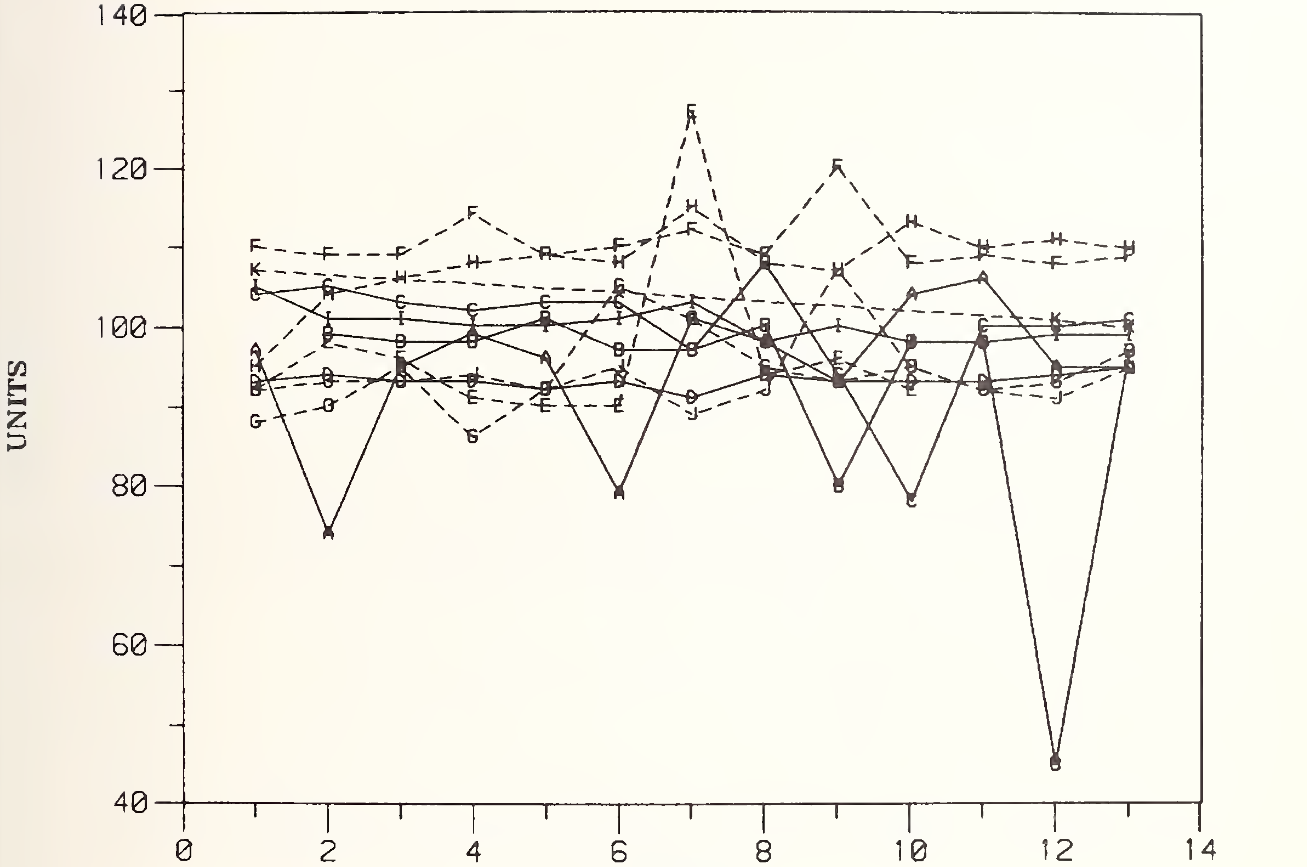

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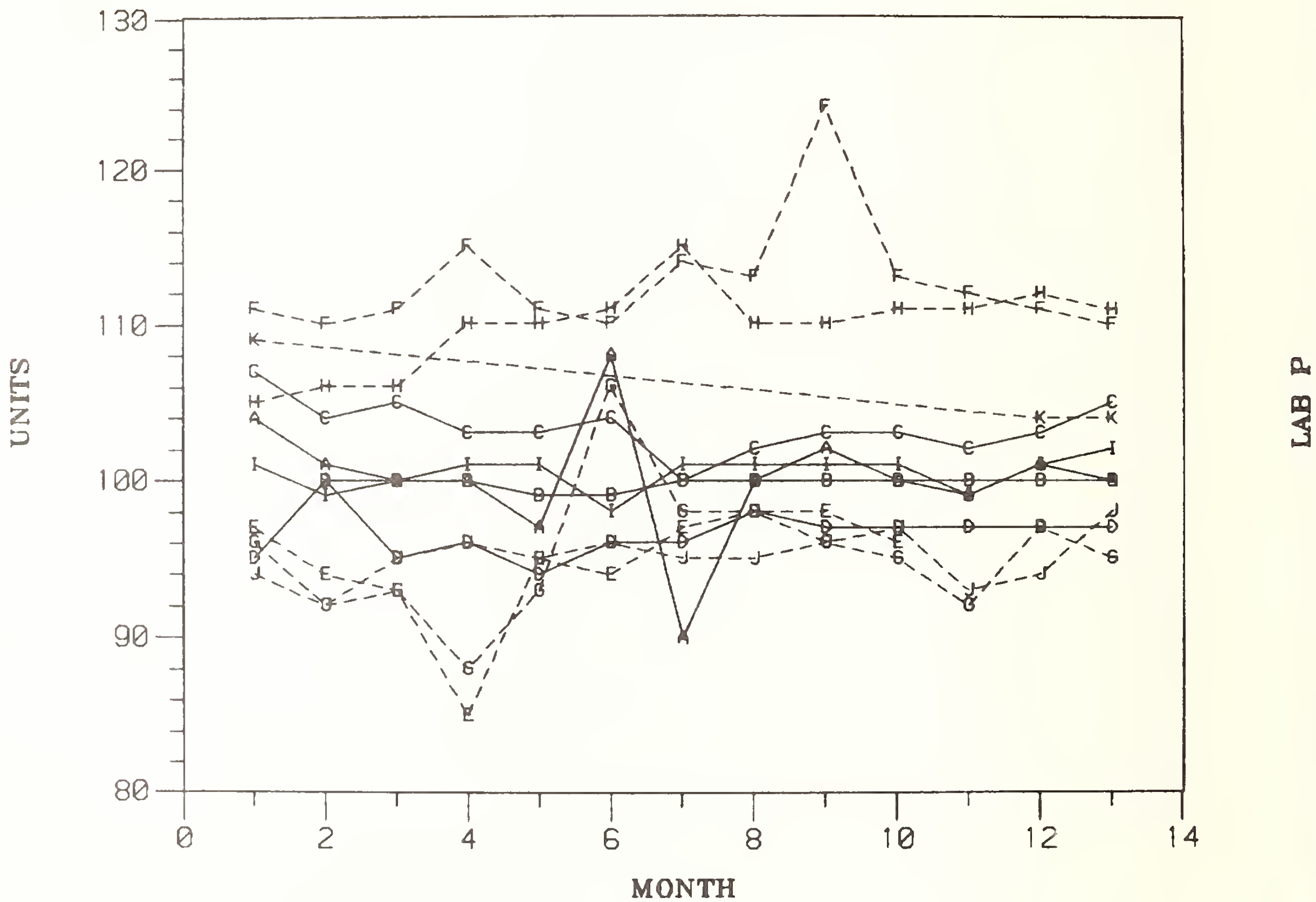


ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: LCW TEMPERATURE VISCOSITY (BROOKFIELD), 0 DEG F (cP) ASTM D2983

LABORATORY: O

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	1360.	-	1690.	3630.	3055.	1460.	5530.	1720.	6390.	2890.	6210.
APR 80	1290.	4900.	1750.	3740.	3010.	1310.	4740.	1690.	5940.	4180.	-
MAY 80	1320.	5200.	1850.	4640.	2810.	1260.	4470.	1690.	5320.	3370.	-
JUN 80	1626.	6720.	2180.	4070.	3370.	1780.	4853.	2270.	5690.	3000.	-
JUL 80	1320.	6080.	1870.	4360.	3130.	1490.	5500.	1840.	4750.	3290.	-
AUG 80	1170.	6640.	1900.	3850.	3320.	1420.	5060.	2100.	5720.	3530.	-
SEP 80	1240.	6730.	2220.	3990.	3220.	1780.	5060.	2130.	4920.	3370.	-
OCT 80	1280.	7660.	2020.	3990.	3340.	1960.	5700.	2140.	7440.	2790.	-
NOV 80	1430.	5930.	1830.	3850.	3160.	1740.	4930.	1740.	5370.	3850.	-
DEC 80	1300.	7690.	1840.	3610.	3410.	2100.	5340.	1780.	5100.	4510.	-
JAN 81	1330.	7210.	2140.	3700.	3350.	-	4870.	1610.	5450.	2980.	-
FEB 81	1340.	8690.	1850.	3860.	3360.	-	5970.	1960.	4600.	3390.	7350.
MAR 81	1330.	16780.	1930.	3940.	3160.	-	6010.	1860.	4360.	2760.	6080.
MEAN	1333.5	7519.2	1928.5	3940.8	3207.3	1630.0	5233.3	1886.9	5465.4	3377.7	6546.7
STD.DEV.	107.0	3106.4	164.4	290.6	176.1	282.6	482.1	211.9	818.5	535.9	698.7
MIN	1170.	4900.	1690.	3610.	2810.	1260.	4470.	1610.	4360.	2760.	6080.
MAX	1626.	16780.	2220.	4640.	3410.	2100.	6010.	2270.	7440.	4510.	7350.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

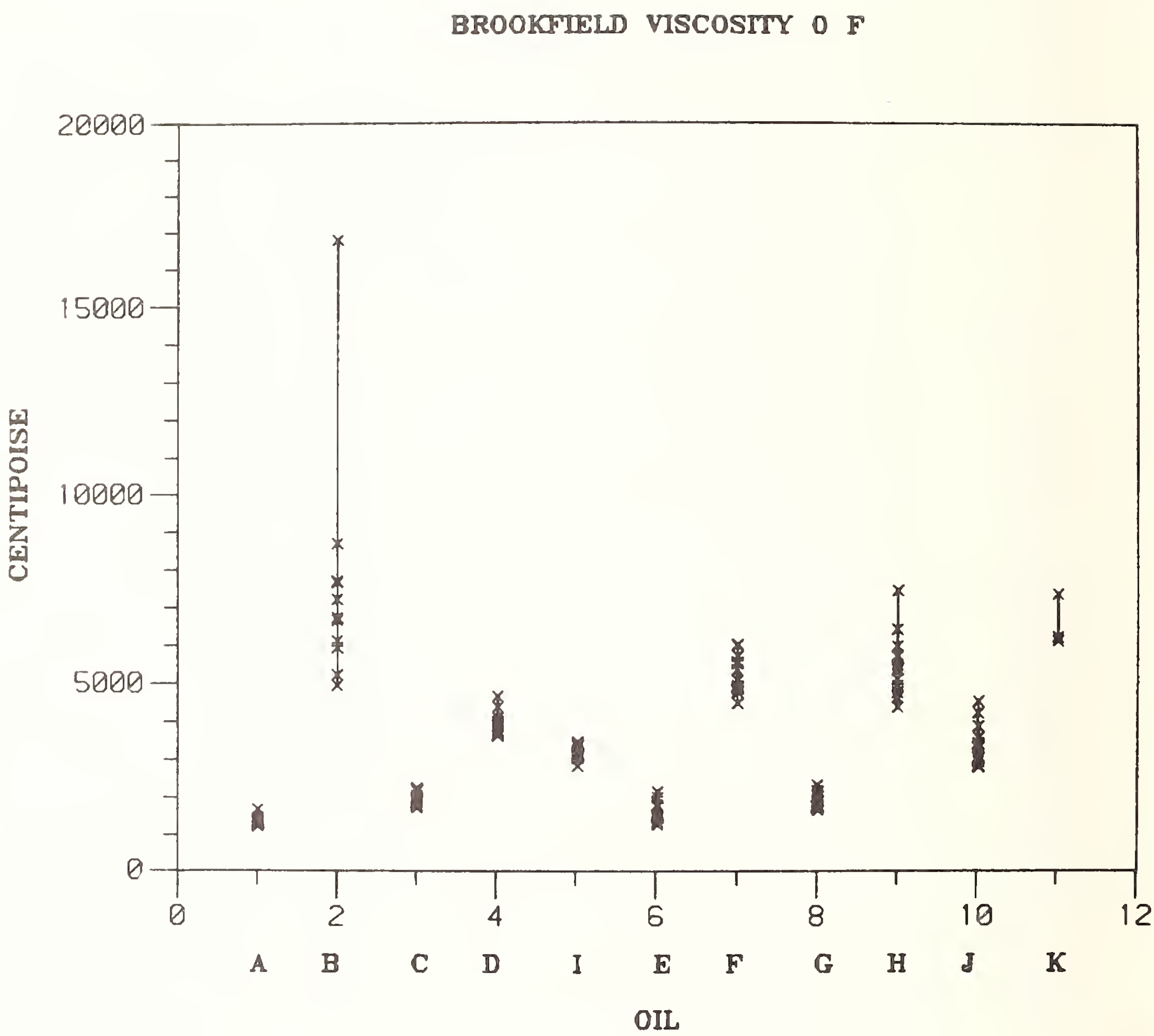
TEST: LCW TEMPERATURE VISCOSITY (BROOKFIELD), -20 DEG F (cP) ASTM D2983 LABORATORY: O

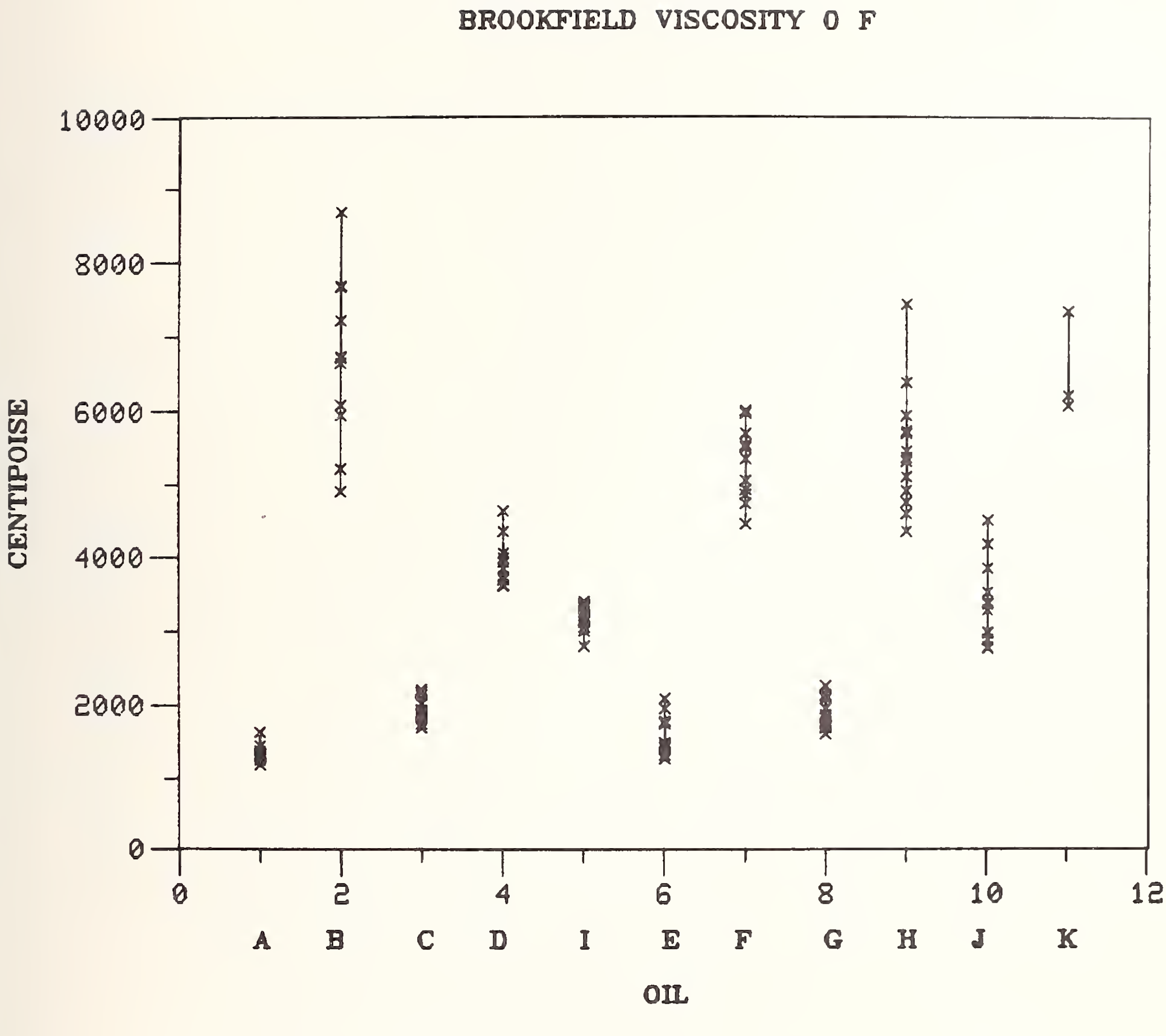
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	7380.	-	10440.	23350.	25850.	7390.	32600.	8640.	38450.	23000.	33350.
APR 80	8640.	57600.	80000.	43300.	35450.	6820.	28600.	9240.	36300.	19440.	-
MAY 80	8540.	172400.	17300.	131400.	23100.	6490.	27600.	9080.	32300.	18100.	-
JUN 80	8150.	120400.	15000.	23800.	26000.	7850.	28850.	11600.	31300.	15440.	-
JUL 80	8200.	81600.	11060.	27200.	22200.	7180.	30650.	9100.	25250.	20850.	-
AUG 80	6830.	138400.	17290.	25100.	33600.	7640.	33600.	12140.	37200.	22200.	-
SEP 80	6800.	136000.	17450.	27000.	33900.	9040.	33300.	11700.	29850.	19850.	-
OCT 80	4620.	106600.	8660.	14860.	33200.	6720.	21250.	6960.	25300.	17860.	-
NOV 80	11960.	SOLID	24200.	29950.	9540.	7480.	29950.	32100.	123000.	25650.	-
DEC 80	8670.	126000.	13620.	27500.	34200.	12280.	34300.	9320.	32100.	26200.	-
JAN 81	8880.	SOLID	14980.	25400.	31100.	-	30700.	8760.	33200.	19650.	-
FEB 81	7320.	CHANEL.	14520.	25650.	31300.	-	41800.	9860.	26900.	19800.	50000.
MAR 81	7000.	900000.	13300.	23400.	29800.	-	42950.	10340.	24000.	15400.	42600.
MEAN	7922.3	204333.3	19832.3	34454.6	28403.1	7889.0	32011.5	11449.2	38088.5	20264.6	41983.3
STD.DEV.	1675.1	262991.3	18493.6	29781.9	7163.7	1701.5	5700.6	6367.9	25938.0	3349.8	8342.1
MIN	4620.	57600.	8660.	14860.	9540.	6490.	21250.	6960.	24000.	15400.	33350.
MAX	11960.	SOLID	80000.	131400.	35450.	12280.	42950.	32100.	123000.	26200.	50000.

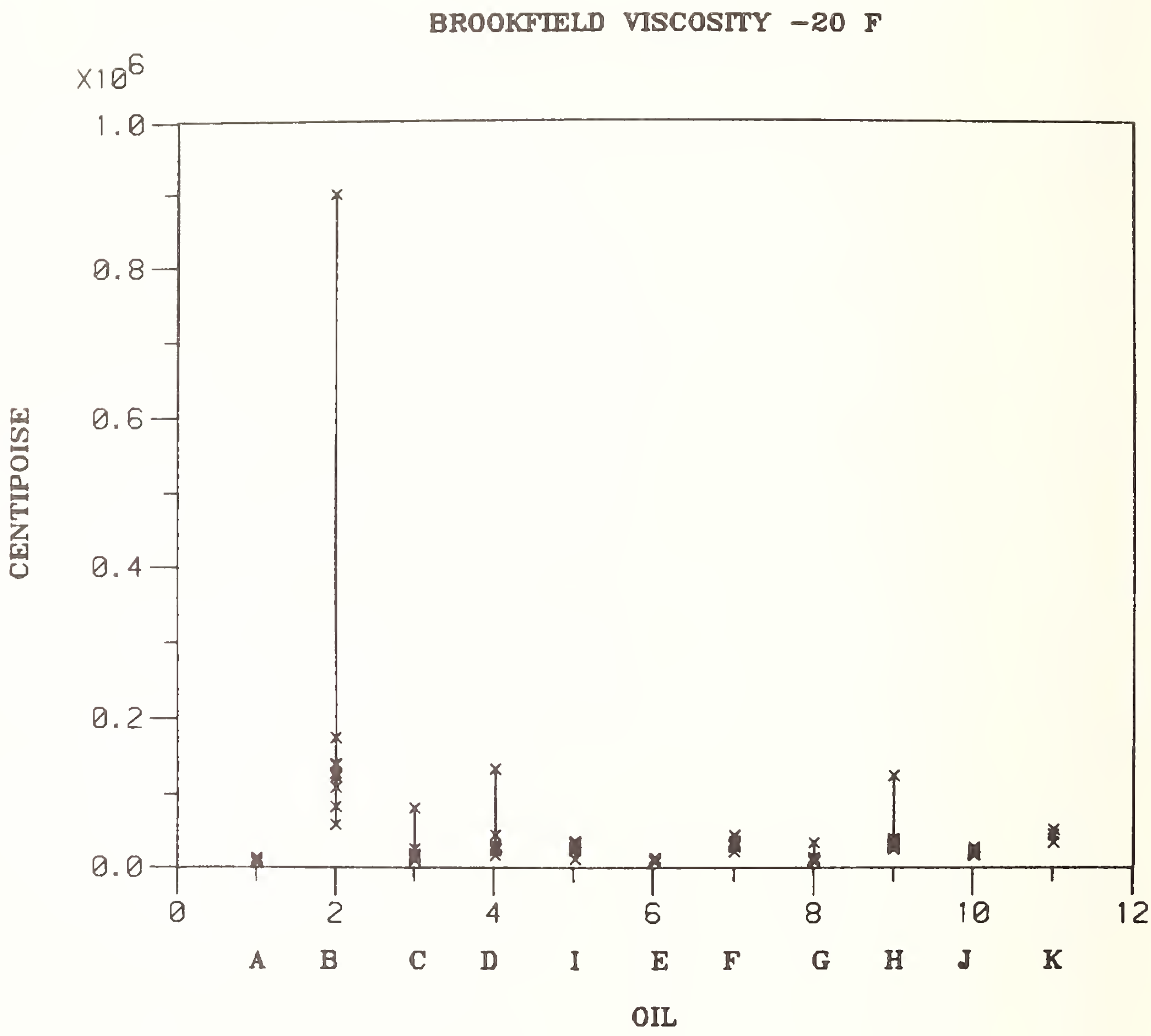
ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: LCW TEMPERATURE VISCOSITY (BROOKFIELD), -40 DEG F (cP) ASTM D2983 LABORATORY: O

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	566000.	-	SOLID	SOLID	SOLID	SOLID	SOLID	178400.	848000.	CHANEL.	SOLID
APR 80	SOLID	SOLID	SOLID	SOLID	SOLID	136800.	SOLID	224000.	880000.	SOLID	-
MAY 80	841000.	SOLID	200000.	SOLID	SOLID	204000.	648000.	155600.	570000.	SOLID	-
JUN 80	SOLID	SOLID	SOLID	SOLID	SOLID	192600.	608333.	246000.	SOLID	SOLID	-
JUL 80	252000.	SOLID	SOLID	SOLID	SOLID	159000.	SOLID	186200.	459000.	SOLID	-
AUG 80	210000.	SOLID	SOLID	SOLID	SOLID	120600.	SOLID	162400.	SOLID	SOLID	-
SEP 80	SOLID	SOLID	SOLID	SOLID	SOLID	194800.	SOLID	343200.	SOLID	SOLID	-
OCT 80	326000.	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	195200.	SOLID	689000.	-
NOV 80	SOLID	SOLID	SOLID	SOLID	234400.	252000.	SOLID	508300.	SOLID	846000.	-
DEC 80	334000.	SOLID	SOLID	SOLID	SOLID	229200.	SOLID	170400.	754000.	SOLID	-
JAN 81	250400.	SOLID	SOLID	SOLID	SOLID	-	SOLID	149400.	SOLID	SOLID	-
FEB 81	CHANEL.	SOLID	SOLID	SOLID	SOLID	-	SOLID	150000.	408000.	337600.	SOLID
MAR 81	264800.	SOLID	SOLID	SOLID	SOLID	-	SOLID	227200.	298800.	877000.	129600.
MEAN	308525.0	SOLID	200000.0	SOLID	234400.0	186125.0	628166.5	222792.3	602542.9	687400.0	129600.0
STD.DEV.	216299.4	-	-	-	-	44871.1	28048.8	100927.1	228013.6	247295.2	-
MIN	210000.	SOLID	200000.	SOLID	234400.	120600.	608333.	149400.	298800.	337600.	129600.
MAX	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	508300.	SOLID	SOLID	SOLID

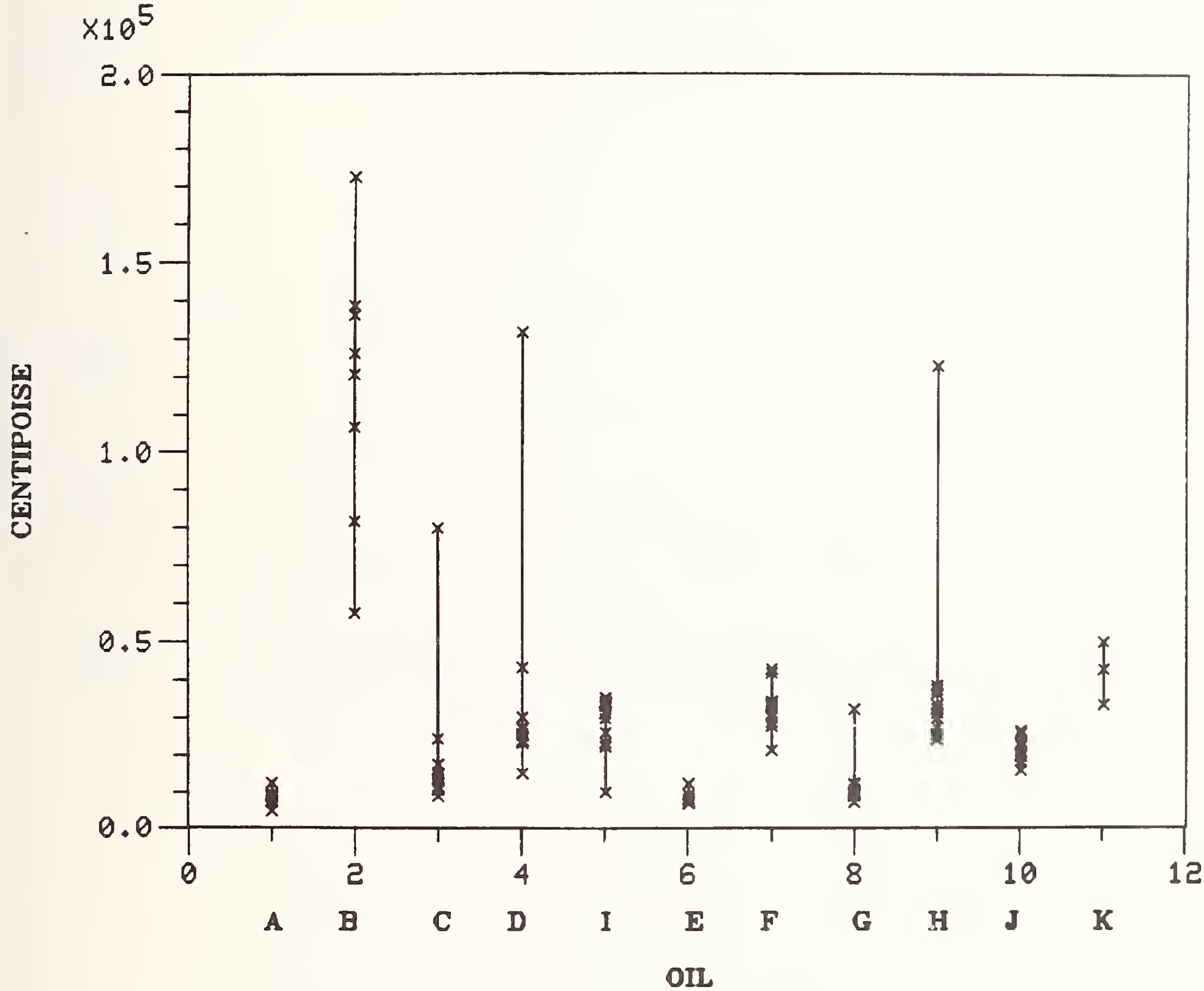

BROOKFIELD VISCOSITY 0 F
CENTIPOISE
20000
15000
10000
5000
0
0
2
4
6
8
10
12
A B C D I E F G H J K
OIL


BROOKFIELD VISCOSITY 0 F
CENTIPOISE
10000
8000
6000
4000
2000
0
0
2
4
6
8
10
12
A B C D I E F G H J K
OIL



BROOKFIELD VISCOSITY -20 F
X10^6
1.0
0.8
0.6
0.4
0.2
0.0
CENTIPOISE
0
2
4
6
8
10
12
A B C D I E F G H J K
OIL

BROOKFIELD VISCOSITY -20 F



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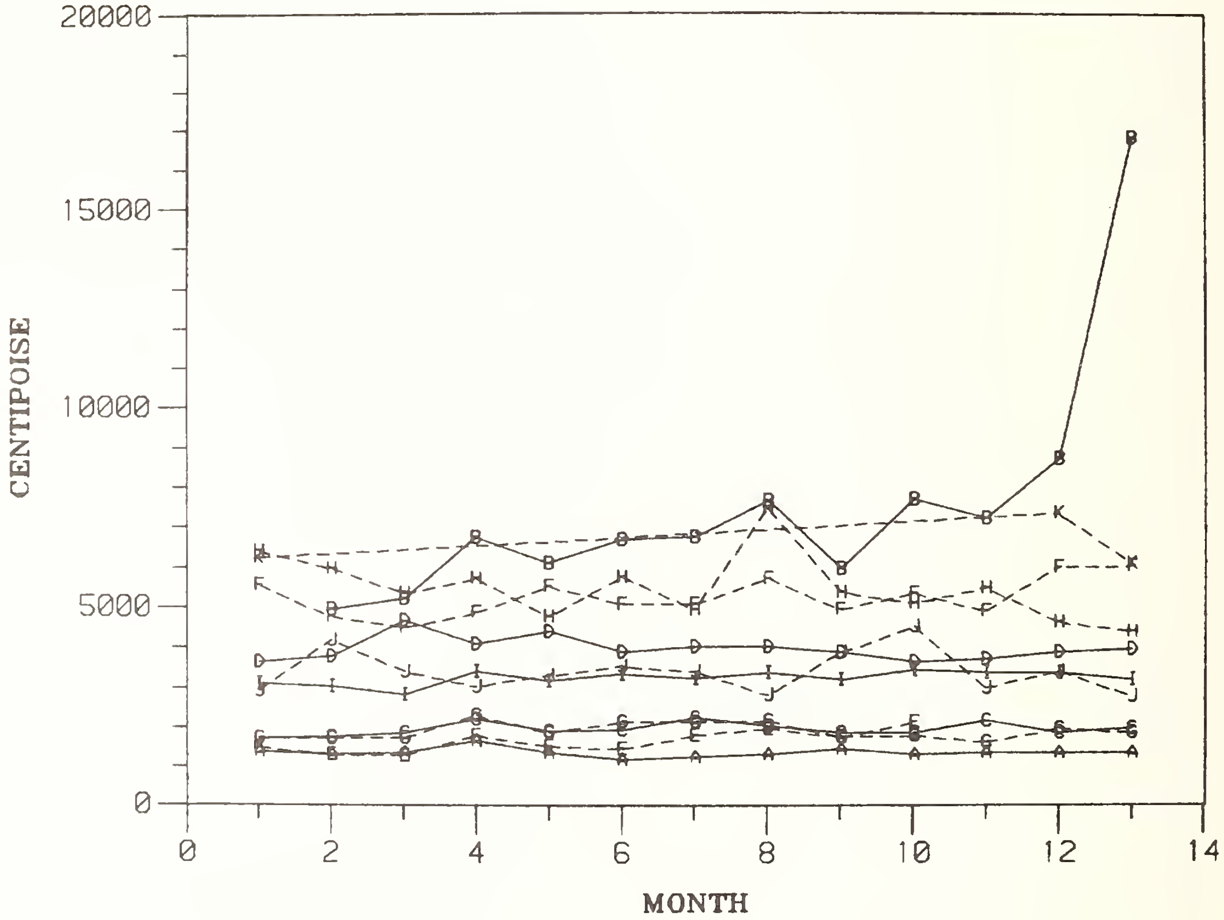

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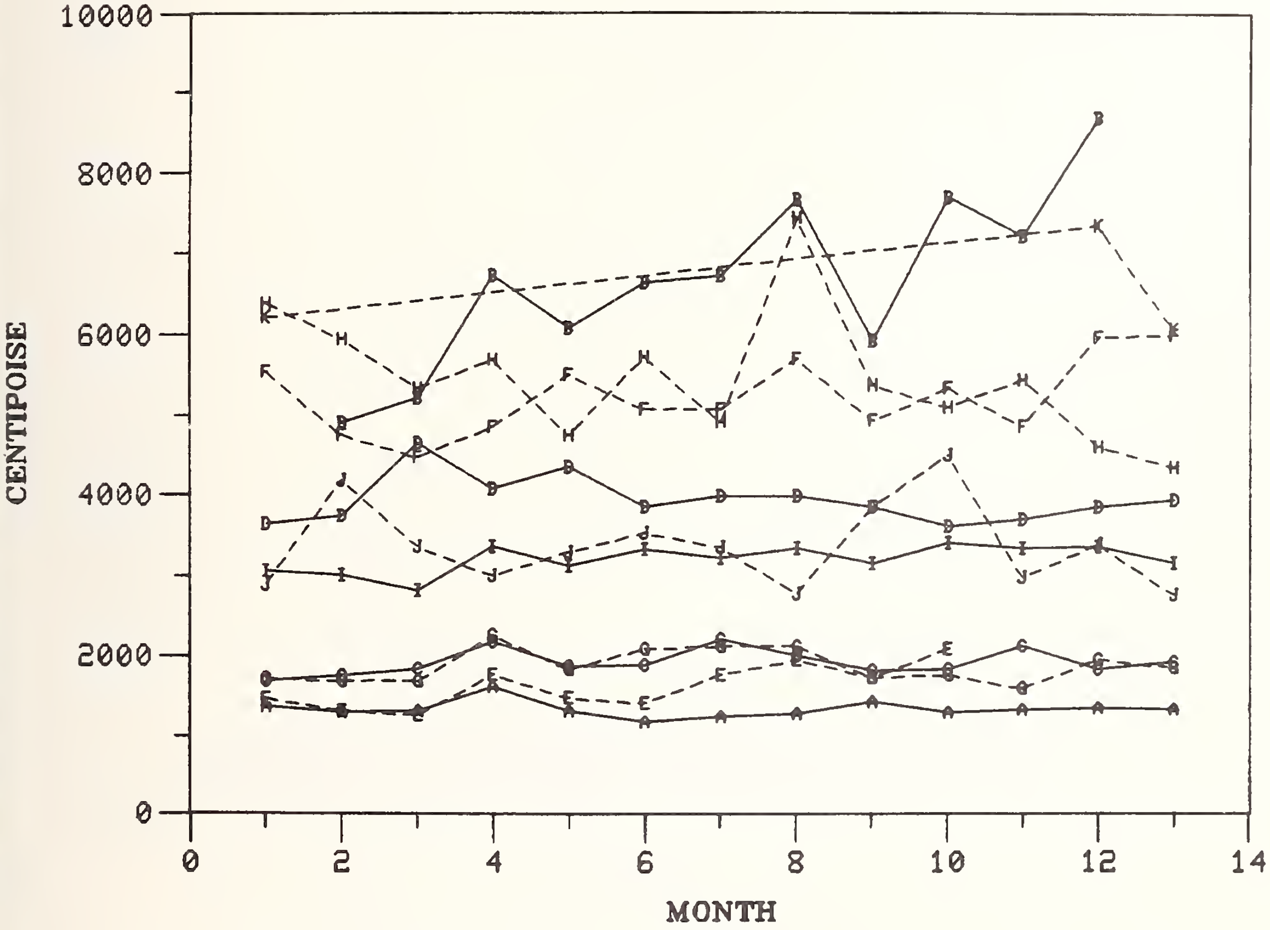

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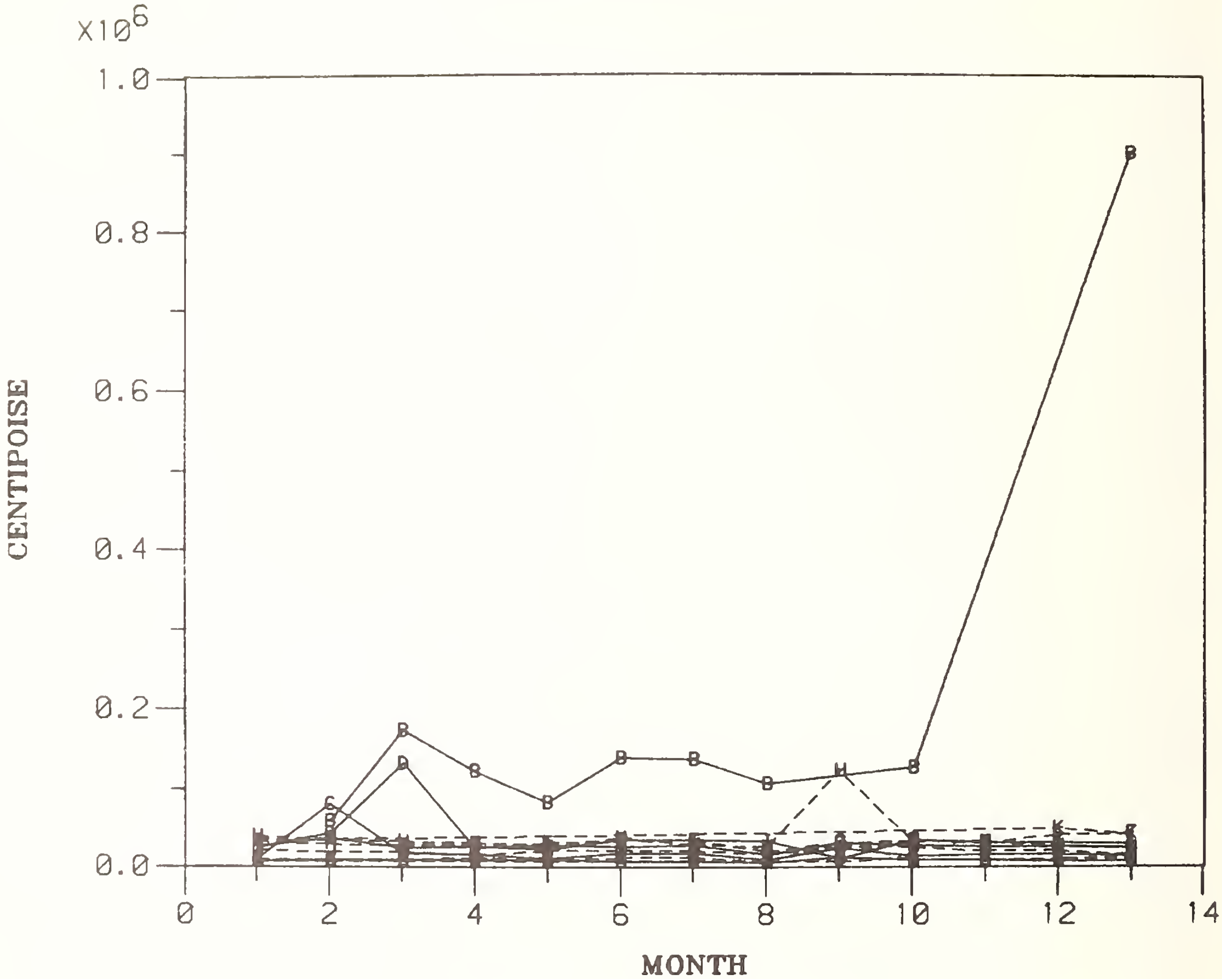
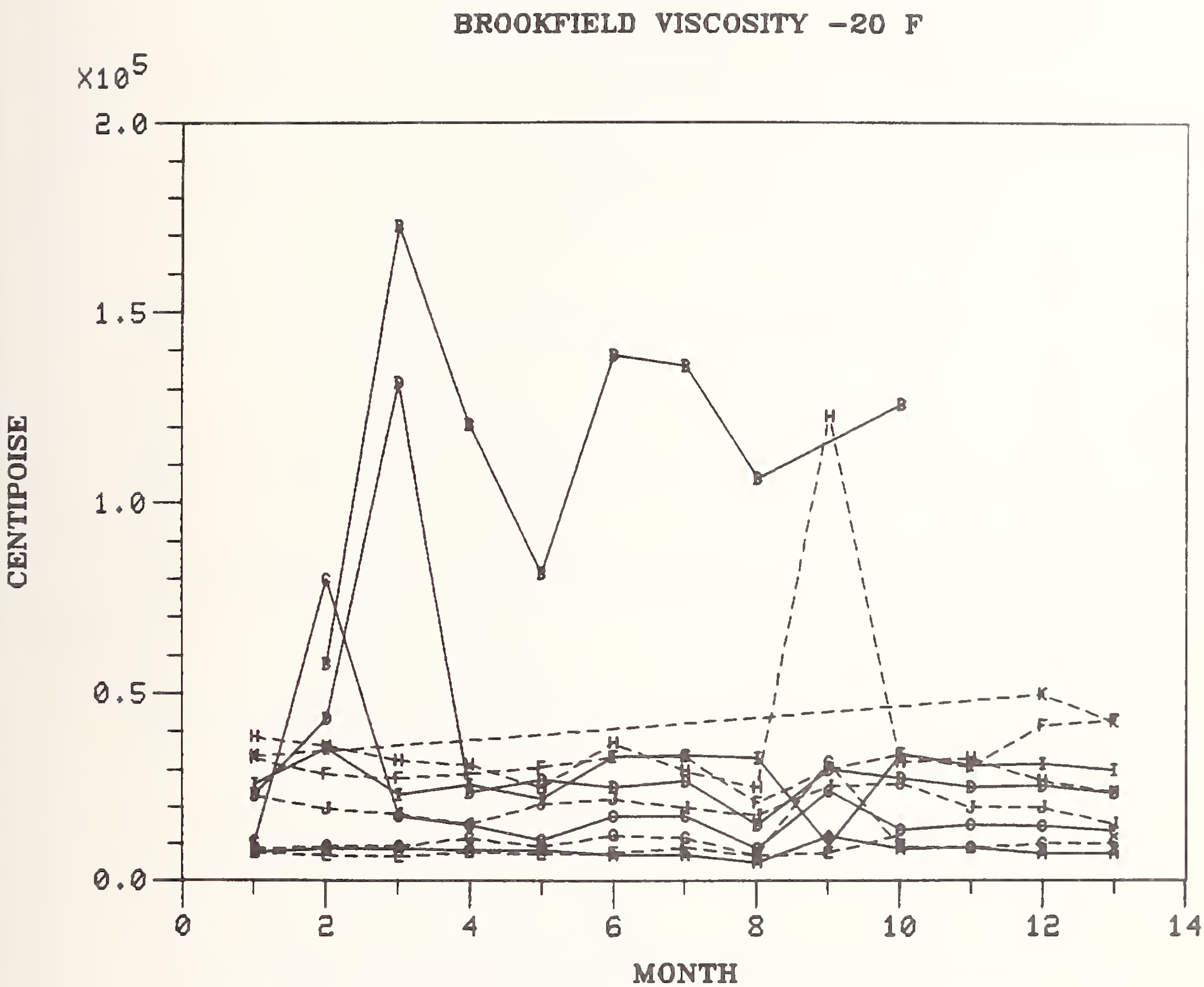




BROOKFIELD VISCOSITY -20 F
X10^5
2.0
1.5
1.0
0.5
0.0
CENTIPOISE
0
2
4
6
8
10
12
14
MONTH

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: APPARENT VISCOSITY (COLD CRANKING SIMULATOR), 0 DEG C (cP) MODIFIED ASTM D2602 LABORATORY: P

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	190.	-	290.	610.	410.	230.	690.	290.	800.	380.	690.
APR 80	190.	650.	270.	580.	410.	220.	650.	280.	770.	480.	-
MAY 80	140.	670.	240.	530.	370.	160.	580.	240.	670.	440.	-
JUN 80	160.	660.	320.	520.	380.	200.	620.	270.	640.	350.	-
JUL 80	170.	650.	280.	510.	360.	200.	540.	310.	530.	500.	-
AUG 80	200.	740.	240.	480.	360.	240.	550.	300.	620.	440.	-
SEP 80	190.	670.	310.	610.	410.	280.	630.	300.	570.	470.	-
OCT 80	190.	700.	250.	550.	420.	270.	670.	300.	760.	380.	-
NOV 80	180.	650.	240.	550.	370.	240.	570.	260.	600.	490.	-
DEC 80	170.	710.	240.	590.	360.	300.	510.	250.	600.	580.	-
JAN 81	160.	570.	270.	440.	310.	-	680.	250.	570.	510.	-
FEB 81	180.	560.	220.	650.	370.	-	740.	330.	590.	450.	770.
MAR 81	140.	1040.	240.	530.	390.	-	710.	240.	570.	420.	830.
MEAN	173.8	689.2	262.3	550.0	378.5	234.0	626.2	278.5	637.7	453.1	763.3
STD.DEV.	19.4	121.8	30.6	57.7	30.0	42.0	71.6	29.1	86.9	62.4	70.2
MIN	140.	560.	220.	440.	310.	160.	510.	240.	530.	350.	690.
MAX	200.	1040.	320.	650.	420.	300.	740.	330.	800.	580.	830.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: APPARENT VISCOSITY (COLD CRANKING SIMULATOR), -5 DEG C (cP) MODIFIED ASTM D2602 LABORATORY: P

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	290.	-	440.	960.	630.	350.	1100.	440.	1290.	610.	1100.
APR 80	290.	1040.	410.	920.	640.	350.	1020.	430.	1230.	770.	-
MAY 80	250.	1060.	390.	840.	590.	280.	900.	380.	1060.	700.	-
JUN 80	250.	1050.	420.	810.	590.	330.	940.	430.	1010.	550.	-
JUL 80	270.	1010.	420.	790.	550.	300.	850.	470.	810.	760.	-
AUG 80	290.	1150.	370.	750.	550.	350.	860.	450.	960.	660.	-
SEP 80	270.	1030.	460.	920.	600.	410.	950.	450.	860.	710.	-
OCT 80	280.	1080.	380.	840.	620.	410.	1020.	450.	1170.	590.	-
NOV 80	270.	1000.	380.	840.	560.	380.	830.	400.	920.	760.	-
DEC 80	270.	1090.	360.	900.	550.	460.	790.	380.	910.	920.	-
JAN 81	240.	910.	420.	720.	520.	-	1030.	380.	890.	770.	-
FEB 81	270.	890.	350.	1010.	580.	-	1120.	510.	900.	710.	1250.
MAR 81	220.	1740.	360.	830.	600.	-	1160.	380.	890.	650.	1340.
MEAN	266.2	1087.5	396.9	856.2	583.1	362.0	966.9	426.9	992.3	704.6	1230.0
STD.DEV.	21.0	217.8	34.0	82.8	35.7	54.3	118.6	40.9	151.3	96.7	121.2
MIN	220.	890.	350.	720.	520.	280.	790.	380.	810.	550.	1100.
MAX	290.	1740.	460.	1010.	640.	460.	1160.	510.	1290.	920.	1340.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: APPARENT VISCOSITY (COLD CRANKING SIMULATOR), -10 DEG C (cP) MODIFIED ASTM D2602 LABORATORY: P

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	450.	-	680.	1560.	1020.	550.	1810.	680.	2130.	1010.	1800.
APR 80	470.	1700.	630.	1500.	1020.	530.	1680.	670.	2050.	1260.	-
MAY 80	420.	1770.	610.	1380.	980.	460.	1500.	620.	1770.	1130.	-
JUN 80	420.	1780.	670.	1330.	960.	540.	1490.	690.	1660.	890.	-
JUL 80	430.	1680.	620.	1290.	880.	470.	1390.	700.	1300.	1210.	-
AUG 80	440.	1910.	570.	1220.	870.	530.	1410.	690.	1570.	1070.	-
SEP 80	420.	1740.	690.	1470.	940.	620.	1540.	680.	1360.	1150.	-
OCT 80	440.	1890.	590.	1370.	970.	650.	1670.	700.	1890.	940.	-
NOV 80	430.	1680.	570.	1350.	890.	580.	1270.	610.	1480.	1220.	-
DEC 80	420.	1860.	550.	1450.	890.	710.	1250.	590.	1470.	1500.	-
JAN 81	370.	1580.	660.	1200.	820.	-	1650.	580.	1420.	1200.	-
FEB 81	400.	1460.	540.	1600.	920.	-	1740.	780.	1430.	1150.	2070.
MAR 81	340.	3100.	530.	1290.	910.	-	1860.	580.	1400.	980.	2230.
MEAN	419.2	1845.8	608.5	1385.4	928.5	564.0	1558.5	659.2	1610.0	1131.5	2033.3
STD.DEV.	33.8	415.2	55.1	124.3	60.0	78.1	195.8	59.2	270.8	160.3	217.3
MIN	340.	1460.	530.	1200.	820.	460.	1250.	580.	1300.	890.	1800.
MAX	470.	3100.	690.	1600.	1020.	710.	1860.	780.	2130.	1500.	2230.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: APPARENT VISCOSITY (COLD CRANKING SIMULATOR), -15 DEG C (cP) MODIFIED ASTM D2602 LABORATORY: P

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	760.	-	1110.	2690.	1820.	930.	3350.	1140.	3950.	1670.	3150.
APR 80	760.	3050.	1040.	2520.	1790.	870.	3020.	1120.	3650.	2120.	-
MAY 80	690.	3050.	990.	2250.	1680.	770.	2550.	1010.	3050.	1910.	-
JUN 80	690.	3150.	1080.	2120.	1630.	870.	2520.	1150.	2870.	1480.	-
JUL 80	690.	3100.	980.	2110.	1480.	760.	2410.	1080.	2210.	2020.	-
AUG 80	660.	3400.	920.	1980.	1460.	820.	2410.	1090.	2720.	1770.	-
SEP 80	640.	3100.	1130.	2060.	1560.	960.	2630.	1080.	2260.	1860.	-
OCT 80	680.	3500.	970.	2200.	1610.	1020.	2870.	1120.	3250.	1540.	-
NOV 80	670.	2980.	900.	2190.	1500.	910.	2040.	940.	2490.	2040.	-
DEC 80	660.	3400.	880.	2340.	1490.	1130.	2170.	930.	2480.	2530.	-
JAN 81	570.	2850.	1070.	1940.	1400.	-	2800.	870.	2400.	1890.	-
FEB 81	600.	2550.	850.	2560.	1550.	-	2950.	1220.	2350.	1930.	3600.
MAR 81	510.	5950.	820.	2080.	1500.	-	3350.	580.	2280.	1570.	2230.
MEAN	660.0	3340.0	980.0	2233.8	1574.6	904.0	2697.5	1025.4	2766.2	1871.5	2993.3
STD.DEV.	69.4	861.2	101.6	231.6	127.1	113.7	407.6	166.8	561.1	282.3	698.3
MIN	510.	2550.	820.	1940.	1400.	760.	2040.	580.	2210.	1480.	2230.
MAX	760.	5950.	1130.	2690.	1820.	1130.	3350.	1220.	3950.	2530.	3600.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: APPARENT VISCOSITY (COLD CRANKING SIMULATOR), -18 DEG C (cP) MODIFIED ASTM D2602 LABORATORY: P

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	1060.	-	1600.	3950.	2670.	1320.	5100.	1630.	6000.	2670.	5100.
APR 80	1070.	4600.	1510.	3700.	2650.	1230.	4500.	1610.	5550.	3350.	-
MAY 80	1020.	5150.	1540.	3650.	2760.	1160.	4100.	1580.	4900.	3050.	-
JUN 80	1050.	5250.	1690.	3400.	2620.	1330.	4200.	1840.	4700.	2460.	-
JUL 80	1080.	5500.	1580.	3600.	2450.	1190.	4200.	1700.	3800.	3400.	-
AUG 80	1000.	5950.	1480.	3400.	2410.	1240.	4200.	1740.	4700.	2930.	-
SEP 80	960.	5350.	1820.	4000.	2560.	1500.	4500.	1730.	3850.	3100.	-
OCT 80	1020.	6000.	1560.	3700.	2640.	1630.	5000.	1770.	5600.	2510.	-
NOV 80	1020.	5250.	1450.	3600.	2490.	1420.	3400.	1470.	4300.	3450.	-
DEC 80	990.	5950.	1400.	3850.	2480.	1940.	3700.	1490.	4250.	4300.	-
JAN 81	830.	5000.	1750.	3150.	2340.	-	4700.	1320.	4000.	3050.	-
FEB 81	860.	4400.	1340.	4200.	2550.	-	4850.	1940.	4000.	3200.	6200.
MAR 81	750.	10300.	1250.	3300.	2350.	-	5650.	1380.	3750.	2440.	6800.
MEAN	977.7	5725.0	1536.2	3653.8	2536.2	1396.0	4469.2	1630.8	4569.2	3070.0	6033.3
STD.DEV.	102.0	1526.4	159.9	297.5	129.5	240.9	603.0	181.1	753.8	510.3	862.2
MIN	750.	4400.	1250.	3150.	2340.	1160.	3400.	1320.	3750.	2440.	5100.
MAX	1080.	10300.	1820.	4200.	2760.	1940.	5650.	1940.	6000.	4300.	6800.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: APPARENT VISCOSITY (COLD CRANKING SIMULATOR), -20 DEG C (cP) MODIFIED ASTM D2602 LABORATORY: P

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	1350.	-	2080.	5150.	3550.	1690.	6900.	2130.	8100.	3400.	6500.
APR 80	1350.	6100.	1940.	4900.	3450.	1580.	5950.	2100.	7400.	4300.	-
MAY 80	1260.	6600.	1940.	4600.	3450.	1440.	5250.	1960.	6400.	3900.	-
JUN 80	1280.	6800.	2120.	4350.	3350.	1650.	5500.	2320.	5950.	3200.	-
JUL 80	1320.	7200.	1980.	4700.	3100.	1500.	5450.	2100.	4900.	4400.	-
AUG 80	1160.	7800.	1860.	4400.	3100.	1540.	5450.	2190.	6300.	3700.	-
SEP 80	1160.	7000.	2340.	5100.	3300.	1850.	5800.	2180.	5000.	3950.	-
OCT 80	1230.	7900.	1950.	4800.	3400.	2020.	6400.	2230.	7300.	3200.	-
NOV 80	1240.	6800.	1810.	4600.	3150.	1760.	4450.	1810.	5500.	4450.	-
DEC 80	1210.	7800.	1740.	4950.	3200.	2250.	4900.	1850.	5450.	5500.	-
JAN 81	1000.	6500.	2220.	4150.	3000.	-	6000.	1630.	5100.	3850.	-
FEB 81	1040.	5650.	1670.	5400.	3300.	-	6100.	2450.	5100.	4150.	8000.
MAR 81	900.	13300.	1540.	4200.	2950.	-	7100.	1710.	4700.	3050.	8600.
MEAN	1192.3	7454.2	1937.7	4715.4	3253.8	1728.0	5788.5	2050.8	5938.5	3926.9	7700.0
STD.DEV.	138.5	1964.9	221.4	381.5	186.5	252.4	746.1	243.4	1093.0	666.0	1081.7
MIN	900.	5650.	1540.	4150.	2950.	1440.	4450.	1630.	4700.	3050.	6500.
MAX	1350.	13300.	2340.	5400.	3550.	2250.	7100.	2450.	8100.	5500.	8600.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: APPARENT VISCOSITY (COLD CRANKING SIMULATOR), -25 DEG C (cP) MODIFIED ASTM D2602 LABORATORY: P

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	2530.	-	4100.	10700.	7500.	3350.	14500.	4300.	17600.	7000.	14000.
APR 80	2580.	13200.	3900.	10200.	7100.	3050.	13000.	4200.	16100.	9200.	-
MAY 80	2380.	14400.	3900.	9600.	7100.	2850.	11300.	4000.	14100.	8300.	-
JUN 80	2450.	15200.	4300.	9100.	6900.	3300.	11700.	4950.	12900.	7000.	-
JUL 80	2560.	15700.	4050.	10000.	6700.	3100.	11900.	4350.	10700.	9400.	-
AUG 80	2260.	16900.	2800.	9500.	6600.	2950.	12100.	4650.	13500.	8000.	-
SEP 80	2190.	15100.	4850.	10800.	7000.	3800.	12500.	4500.	10700.	8200.	-
OCT 80	2270.	17100.	4100.	10400.	7200.	4250.	14000.	4700.	15700.	6800.	-
NOV 80	2340.	14300.	3700.	9800.	6800.	3550.	9400.	3700.	11900.	9600.	-
DEC 80	2260.	17600.	3550.	10500.	6800.	4750.	11100.	3850.	11800.	11700.	-
JAN 81	1800.	14300.	4600.	8700.	6500.	-	12700.	3200.	10800.	7800.	-
FEB 81	1840.	11900.	3400.	11100.	6900.	-	13500.	5000.	10700.	8800.	17100.
MAR 81	1620.	S	3100.	8900.	6000.	-	15500.	3600.	10100.	6200.	18800.
MEAN	2236.9	15063.6	3873.1	9946.2	6853.8	3495.0	12553.8	4230.8	12815.4	8307.7	16633.3
STD.DEV.	305.2	1716.6	570.7	759.0	368.6	611.7	1598.8	543.0	2430.0	1469.4	2433.8
MIN	1620.	11900.	2800.	8700.	6000.	2850.	9400.	3200.	10100.	6200.	14000.
MAX	2580.	S	4850.	11100.	7500.	4750.	15500.	5000.	17600.	11700.	18800.

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: APPARENT VISCOSITY (COLD CRANKING SIMULATOR), -30 DEG C (cP) MODIFIED ASTM D2602 LABORATORY: P

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	5300.	-	9100.	S	16900.	7500.	S	9500.	S	15600.	S
APR 80	5300.	S	8400.	S	16400.	6500.	S	9400.	S	20900.	-
MAY 80	4850.	S	8600.	S	15900.	5900.	S	8900.	S	18500.	-
JUN 80	4950.	S	9700.	20300.	15500.	7100.	S	11100.	S	15500.	-
JUL 80	5450.	S	8800.	S	15100.	6800.	27500.	9500.	24600.	S	-
AUG 80	4700.	S	3900.	20800.	14900.	6400.	S	10500.	S	17600.	-
SEP 80	4500.	S	10600.	S	15500.	8300.	S	9800.	S	17900.	-
OCT 80	4800.	S	9100.	S	15700.	9500.	S	10500.	S	15100.	-
NOV 80	4850.	S	8000.	S	14700.	7700.	S	8000.	S	S	-
DEC 80	4700.	S	7700.	S	15300.	10600.	S	8600.	S	S	-
JAN 81	3400.	S	10000.	18700.	14500.	-	S	6700.	S	S	-
FEB 81	3550.	S	7400.	S	15100.	-	S	10700.	S	S	17100.
MAR 81	3000.	S	6500.	18800.	12700.	-	S	7500.	S	13200.	S
MEAN	4565.4	S	8292.3	19650.0	15246.2	7630.0	27500.0	9284.6	24600.0	16787.5	17100.0
STD.DEV.	769.6	-	1723.1	1059.9	1013.8	1473.5	-	1315.2	-	2406.2	-
MIN	3000.	S	3900.	18700.	12700.	5880.	27500.	6700.	24600.	13200.	17100.
MAX	5450.	S	10600.	S	16850.	10600.	S	11100.	S	20900.	S

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: APPARENT VISCOSITY (COLD CRANKING SIMULATOR), -35 DEG C (cP) MODIFIED ASTM D2602 LABORATORY: P

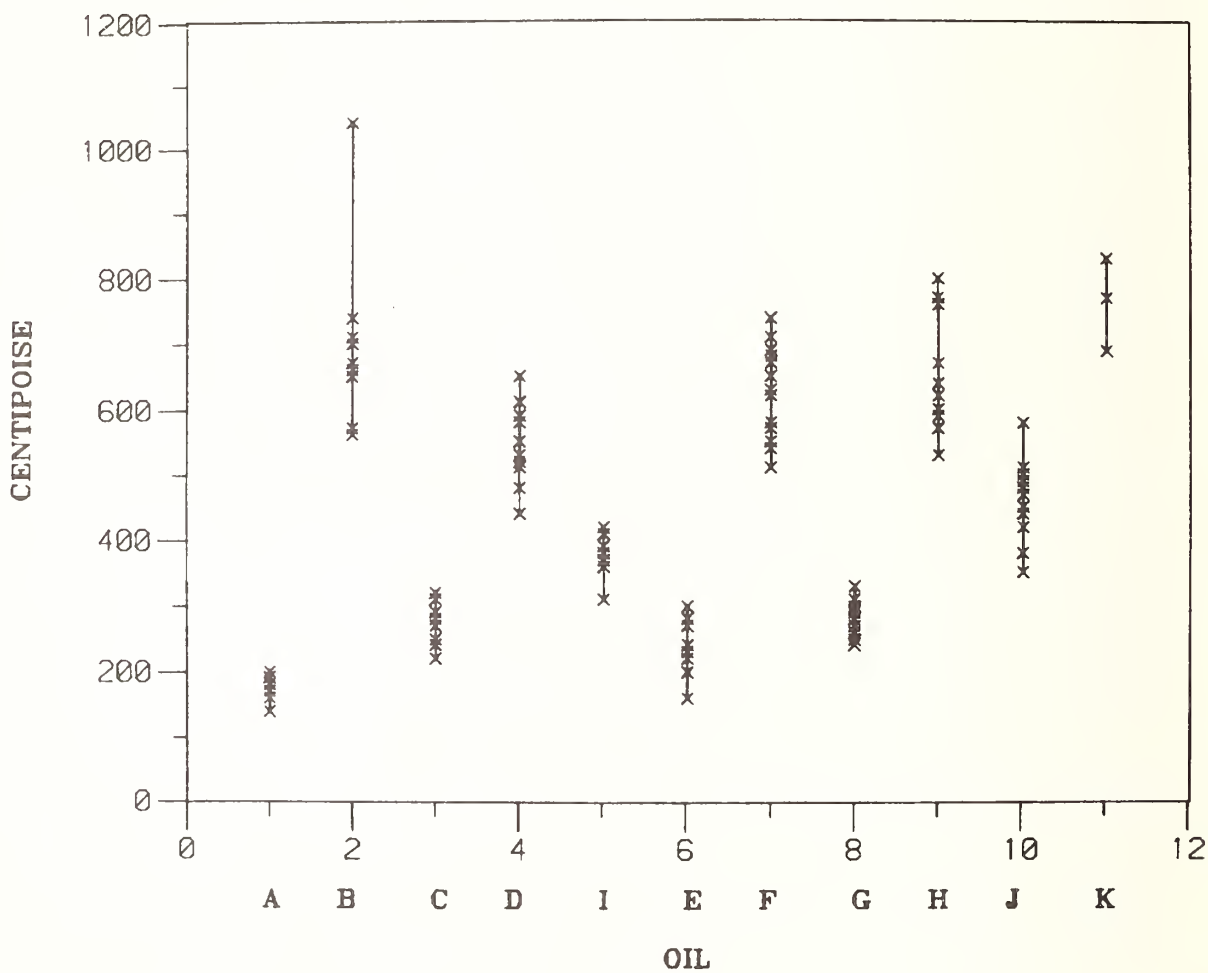
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	11700.	-	26800.	S	S	16900.	S	22200.	S	S	S
APR 80	11900.	S	19700.	S	S	14900.	S	S	S	S	-
MAY 80	10700.	S	19400.	S	S	13200.	S	20600.	S	S	-
JUN 80	10600.	S	21400.	S	S	15500.	S	S	S	S	-
JUL 80	15500.	12300.	19700.	S	S	S	S	21500.	S	S	-
AUG 80	10500.	S	19700.	S	S	14500.	S	S	S	S	-
SEP 80	10200.	S	S	S	S	20100.	S	S	S	S	-
OCT 80	10600.	S	20800.	S	S	21100.	S	23600.	S	S	-
NOV 80	10900.	S	18800.	S	S	17400.	S	18200.	S	S	-
DEC 80	10400.	S	17600.	S	S	S	S	S	S	S	-
JAN 81	7100.	S	S	S	S	-	S	14900.	S	S	-
FEB 81	7400.	S	S	S	S	-	S	S	S	S	S
MAR 81	6200.	S	14500.	S	S	-	S	17100.	S	S	S
MEAN	10284.6	12300.0	19840.0	S	S	16700.0	S	19728.6	S	S	S
STD.DEV.	2376.6	-	3103.1	-	-	2757.3	-	3097.2	-	-	-
MIN	6200.	12300.	14500.	S	S	13200.	S	14900.	S	S	S
MAX	15500.	S	S	S	S	S	S	S	S	S	S

ASTM/NBS BASESTOCK CONSISTENCY STUDY

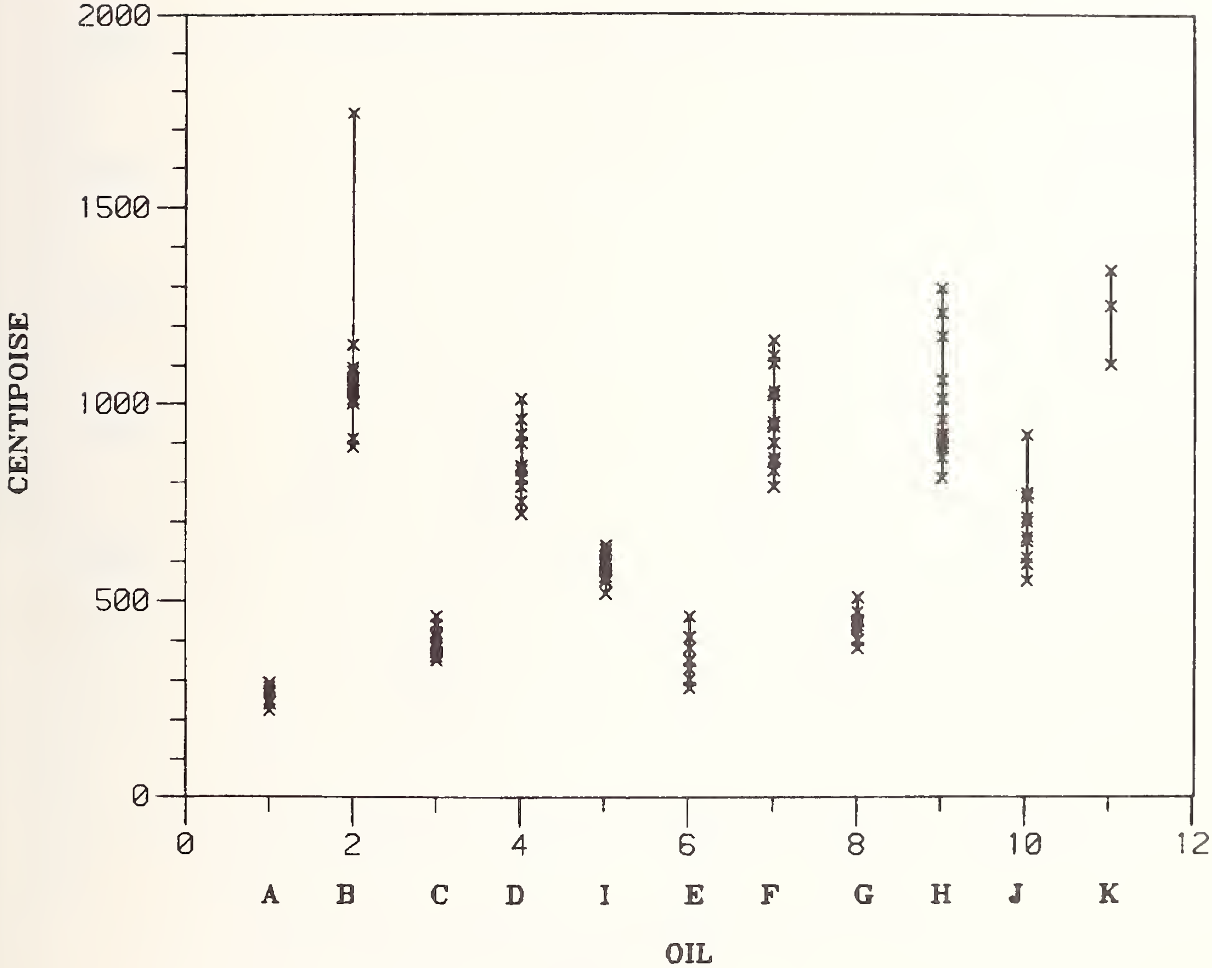
TEST: APPARENT VISCOSITY (COLD CRANKING SIMULATOR), -40 DEG C (cP) MODIFIED ASTM D2602 LABORATORY: P

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	S	-	S	S	S	S	S	S	S	S	S
APR 80	S	S	S	S	S	S	S	S	S	S	-
MAY 80	S	S	S	S	S	S	S	S	S	S	-
JUN 80	24000.	S	S	S	S	S	S	S	S	S	-
JUL 80	S	S	S	S	S	S	S	S	S	S	-
AUG 80	S	S	S	S	S	S	S	S	S	S	-
SEP 80	S	S	S	S	S	S	S	S	S	S	-
OCT 80	S	S	S	S	S	S	S	S	S	S	-
NOV 80	S	S	S	S	S	S	S	S	S	S	-
DEC 80	S	S	S	S	S	S	S	S	S	S	-
JAN 81	S	S	S	S	S	-	S	S	S	S	-
FEB 81	S	S	S	S	S	-	S	S	S	S	S
MAR 81	13700.	S	S	S	S	-	S	S	S	S	S
MEAN	18850.0	S	S	S	S	S	S	S	S	S	S
STD.DEV.	7283.2	-	-	-	-	-	-	-	-	-	-
MIN	13700.	S	S	S	S	S	S	S	S	S	S
MAX	S	S	S	S	S	S	S	S	S	S	S

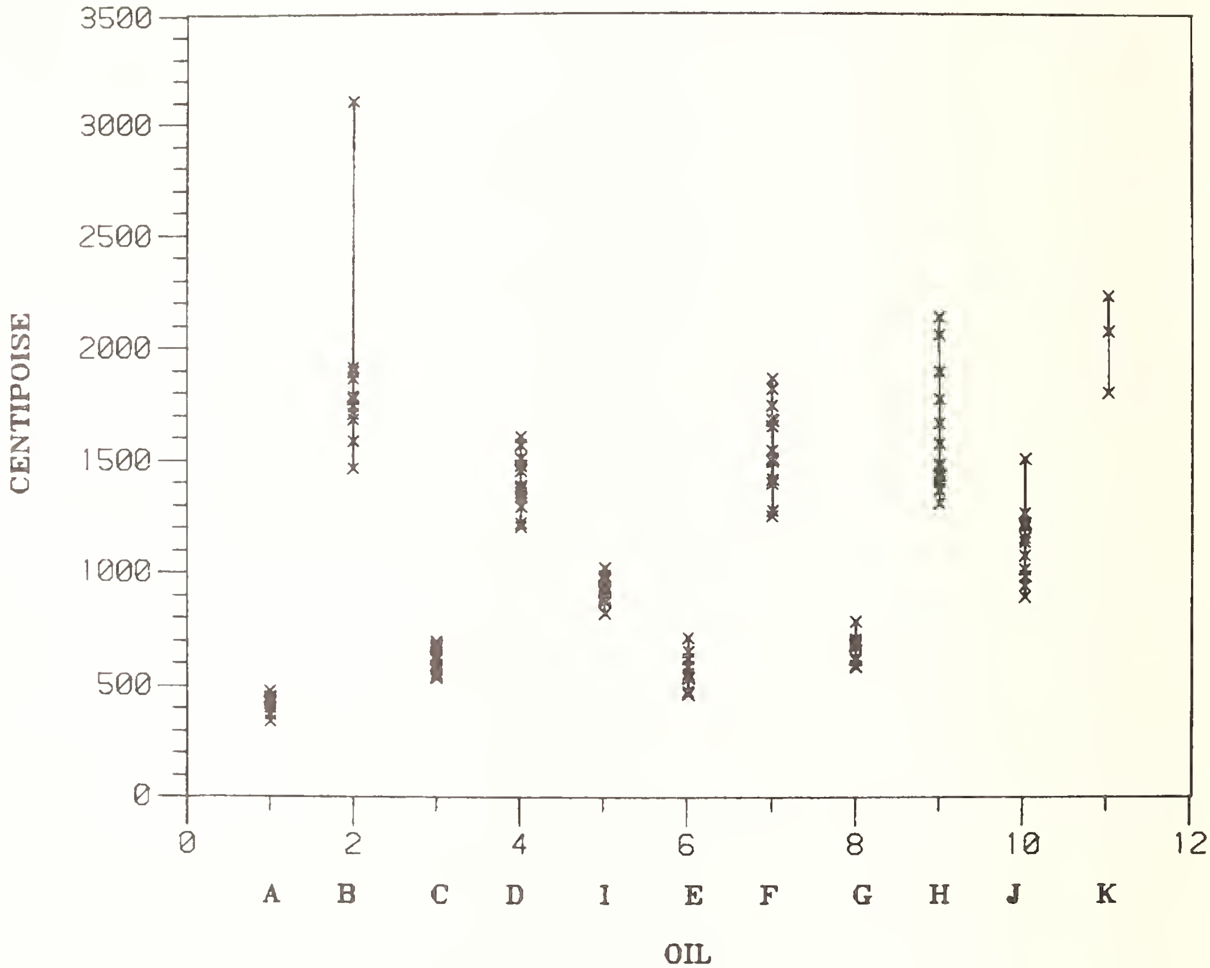
COLD CRANKING SIMULATOR VISCOSITY, 0 C



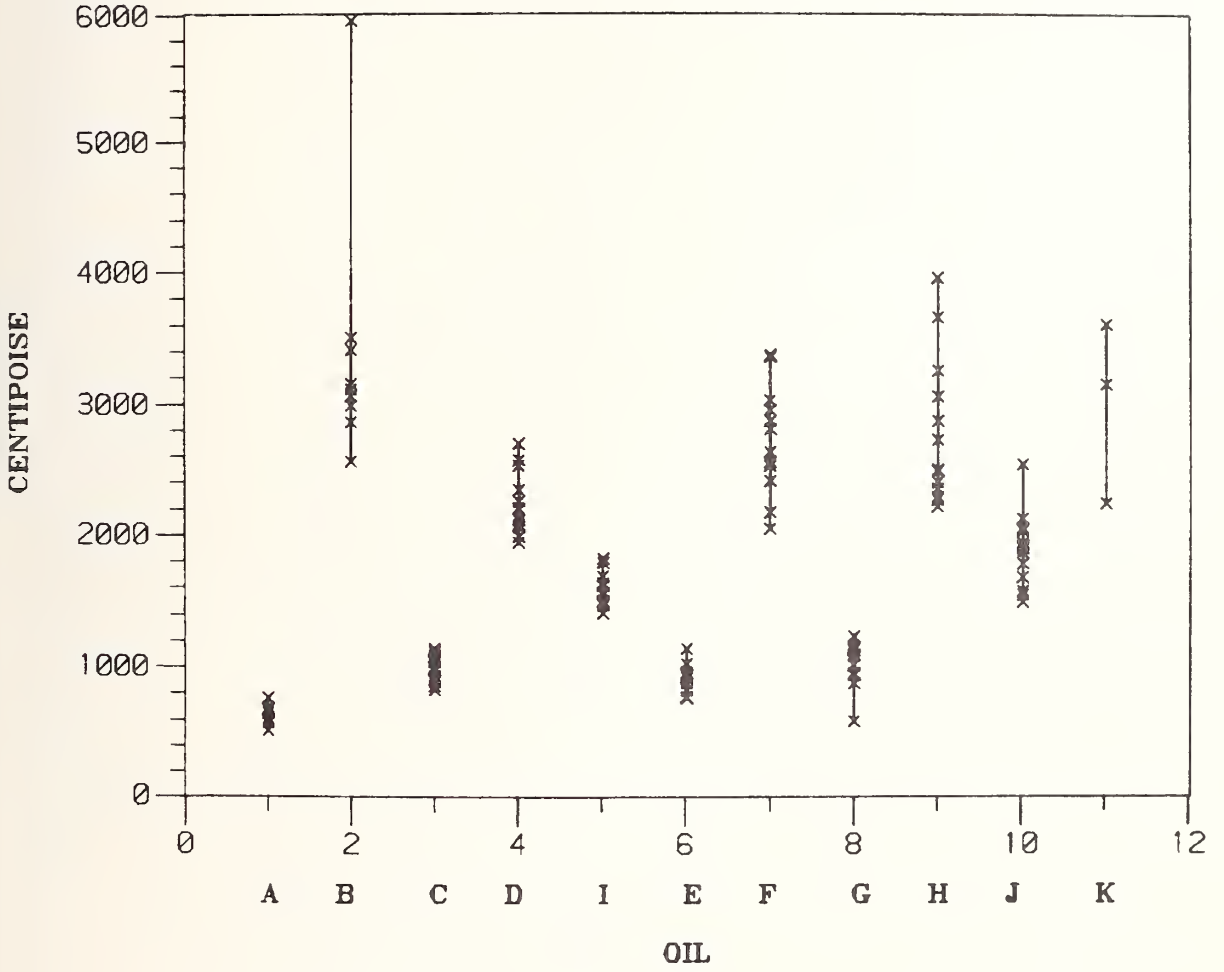
COLD CRANKING SIMULATOR VISCOSITY, -5 C



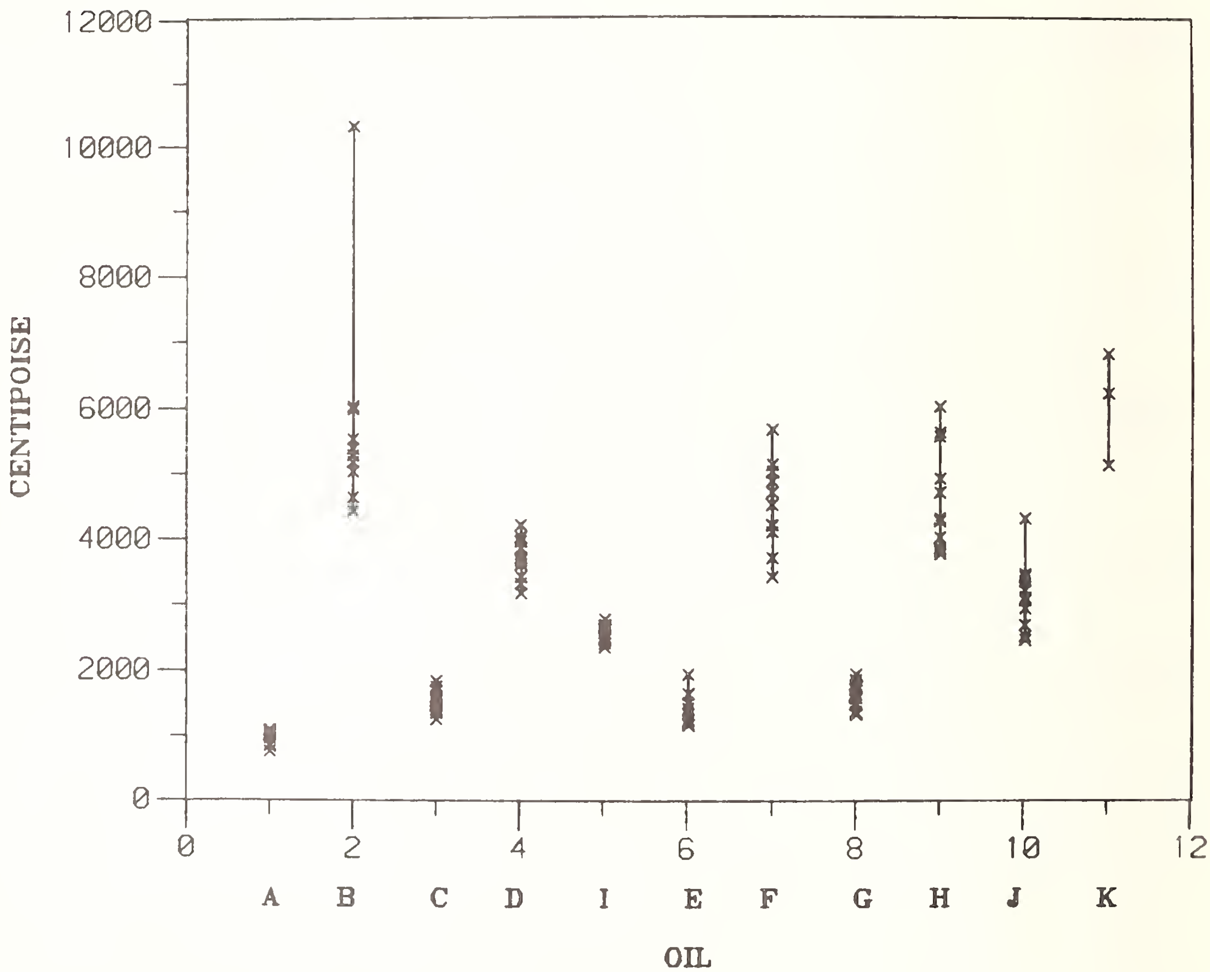
COLD CRANKING SIMULATOR VISCOSITY, -10 C



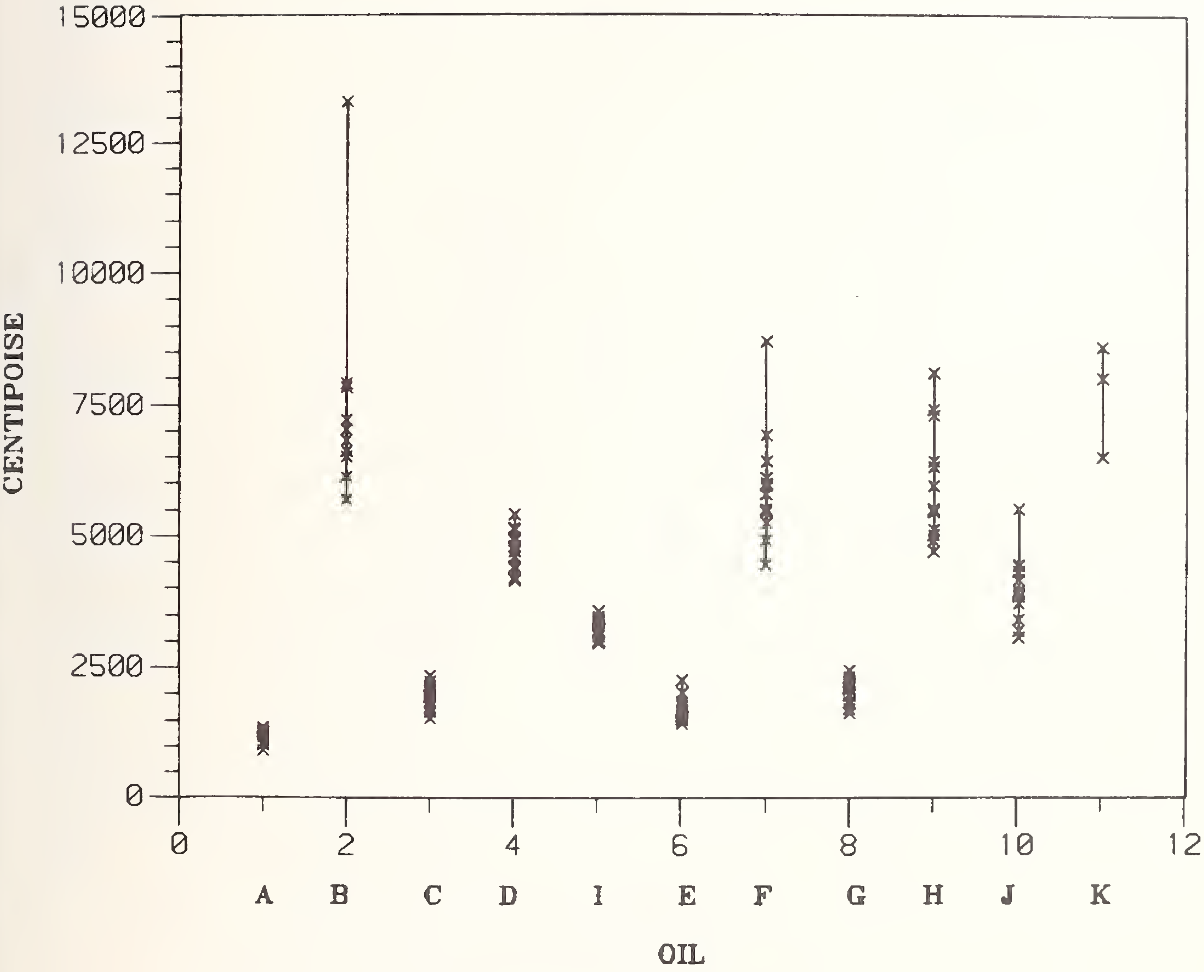
COLD CRANKING SIMULATOR VISCOSITY, -15 C

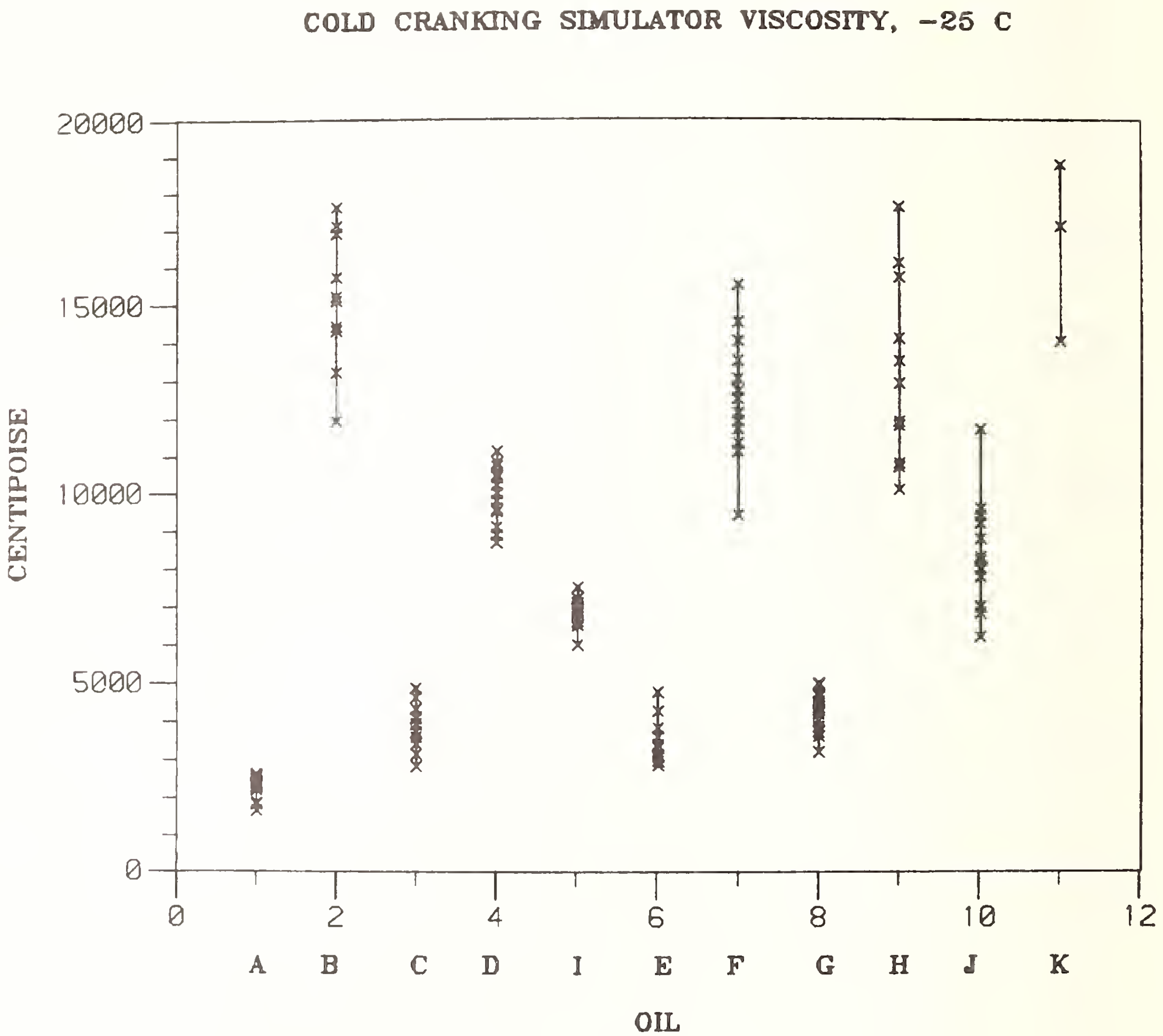


COLD CRANKING SIMULATOR VISCOSITY, -18 C

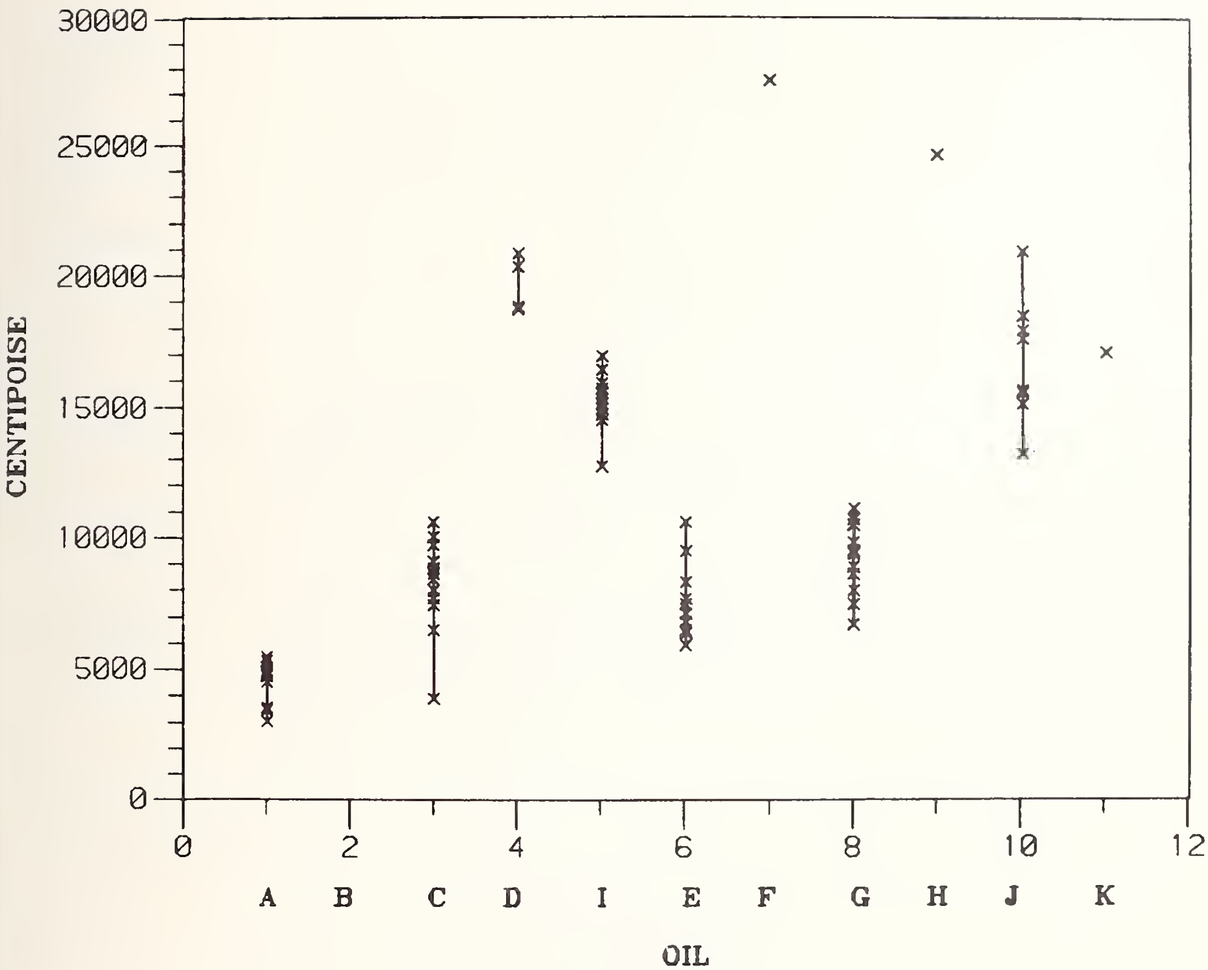


COLD CRANKING SIMULATOR VISCOSITY, -20 C

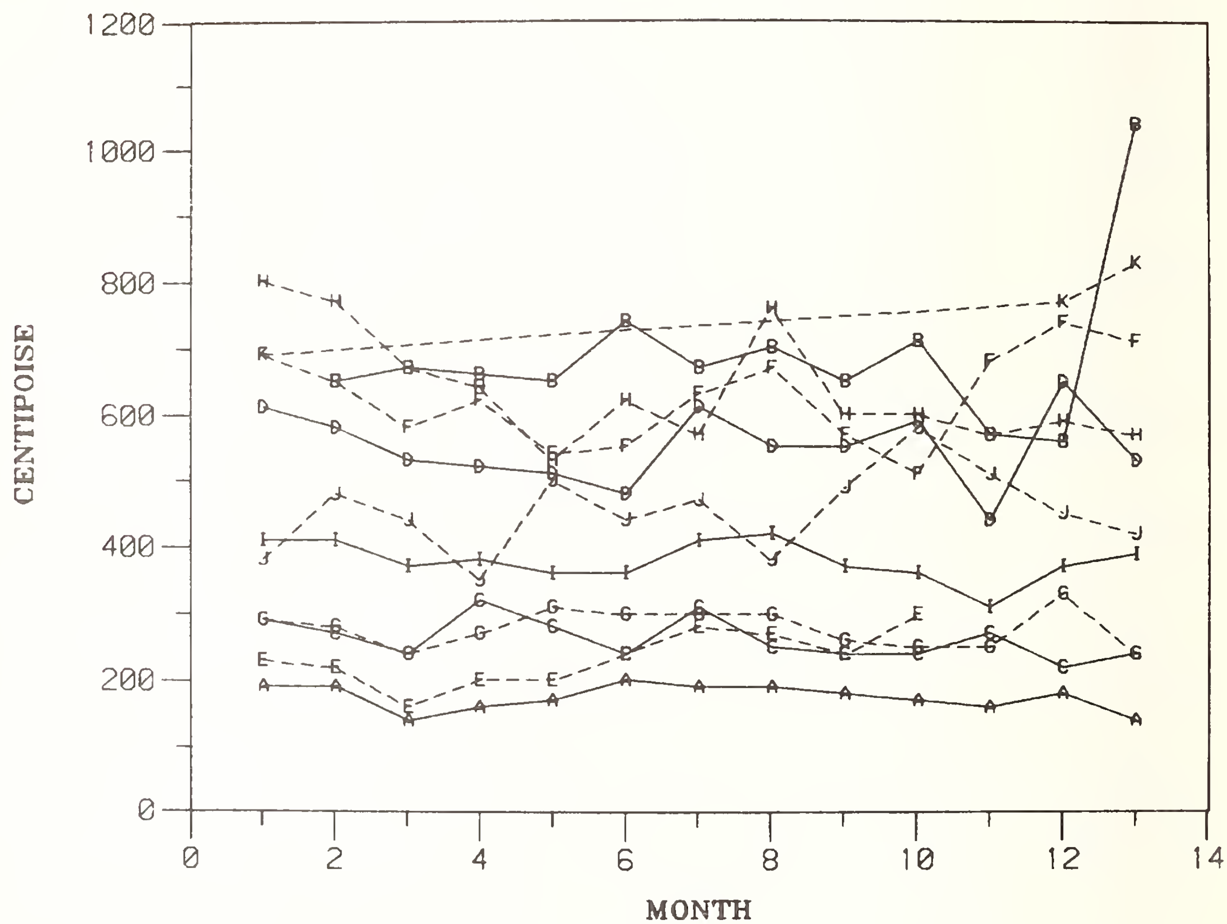



COLD CRANKING SIMULATOR VISCOSITY, -25 C
20000
15000
10000
5000
0
CENTIPOISE
0
2
4
6
8
10
12
A B C D I E F G H J K
OIL

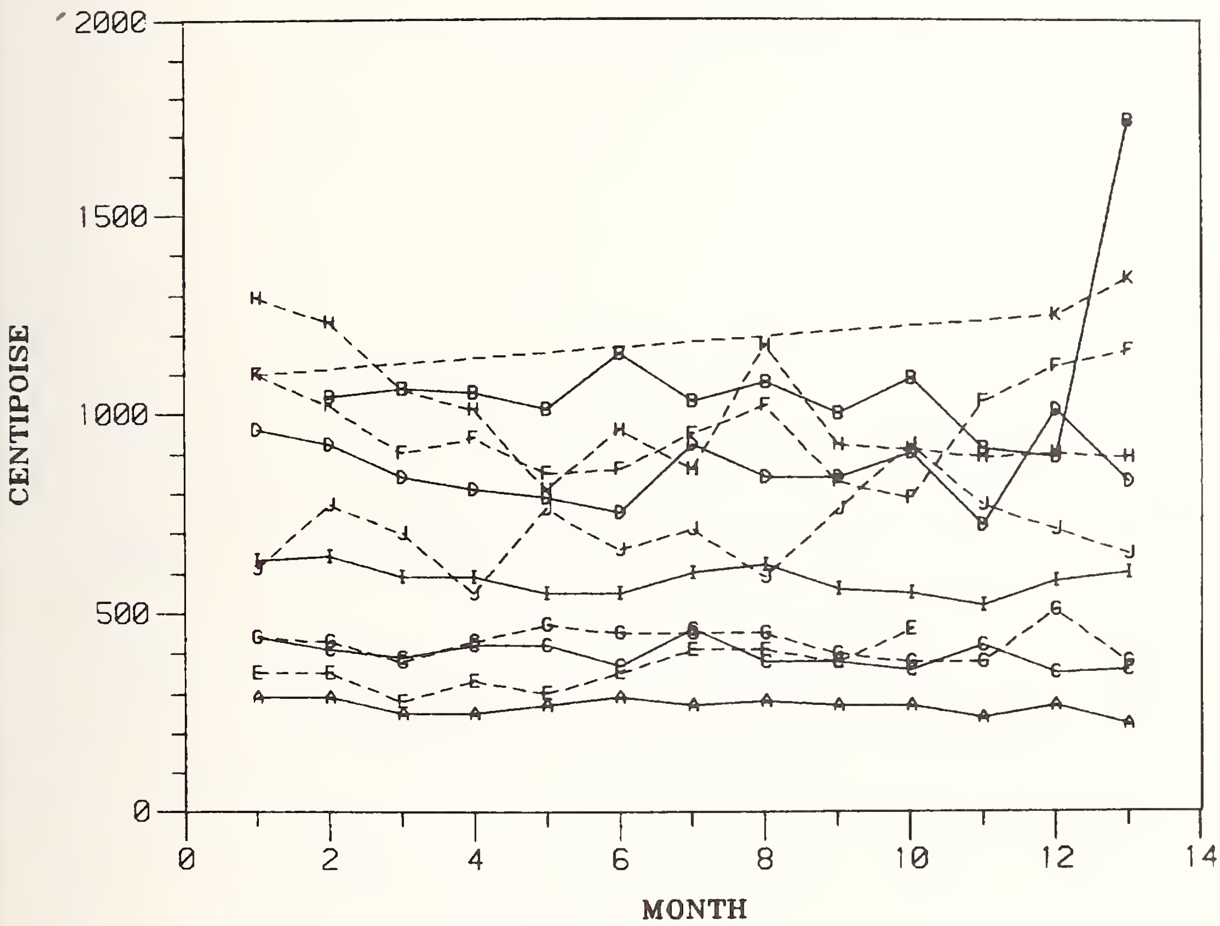
COLD CRANKING SIMULATOR VISCOSITY, -30 C



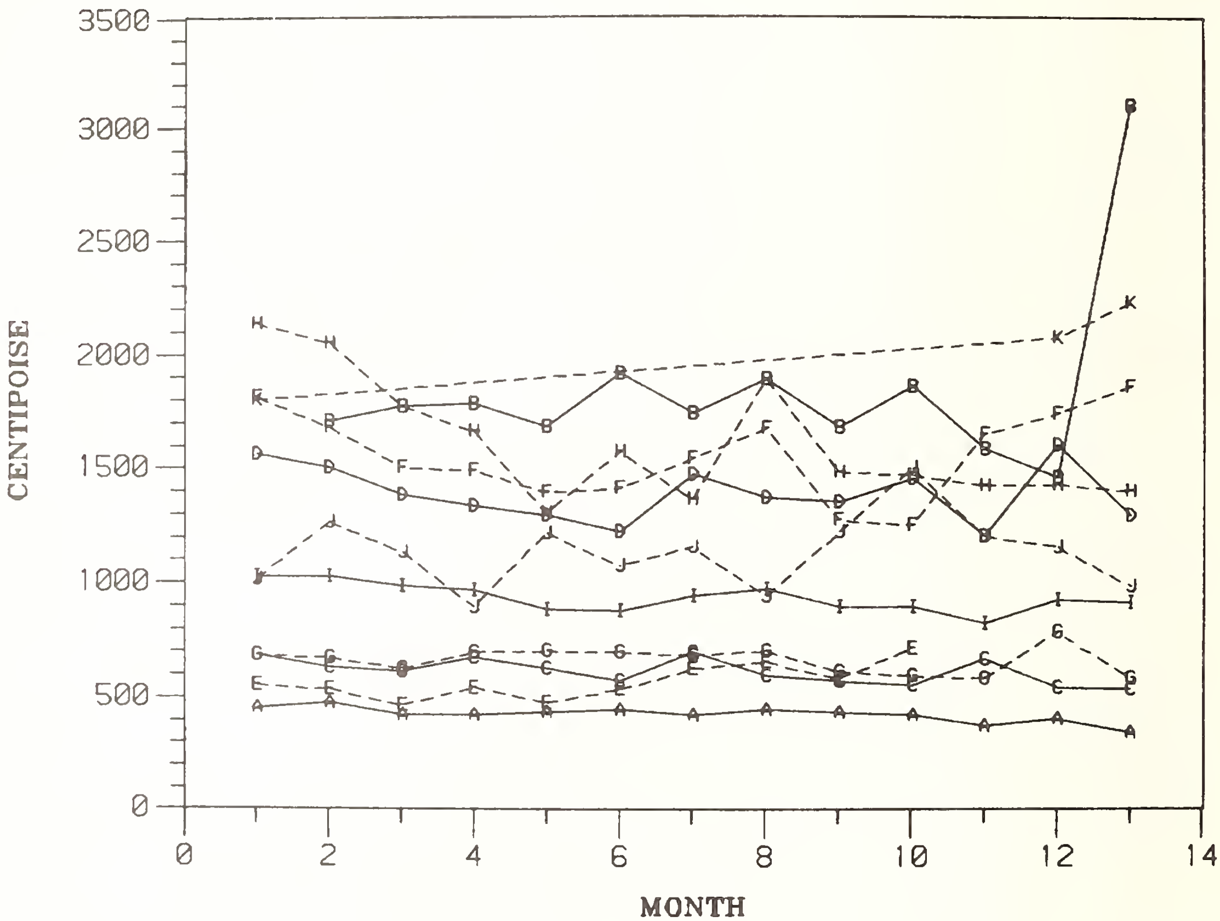
COLD CRANKING SIMULATOR VISCOSITY, 0 C



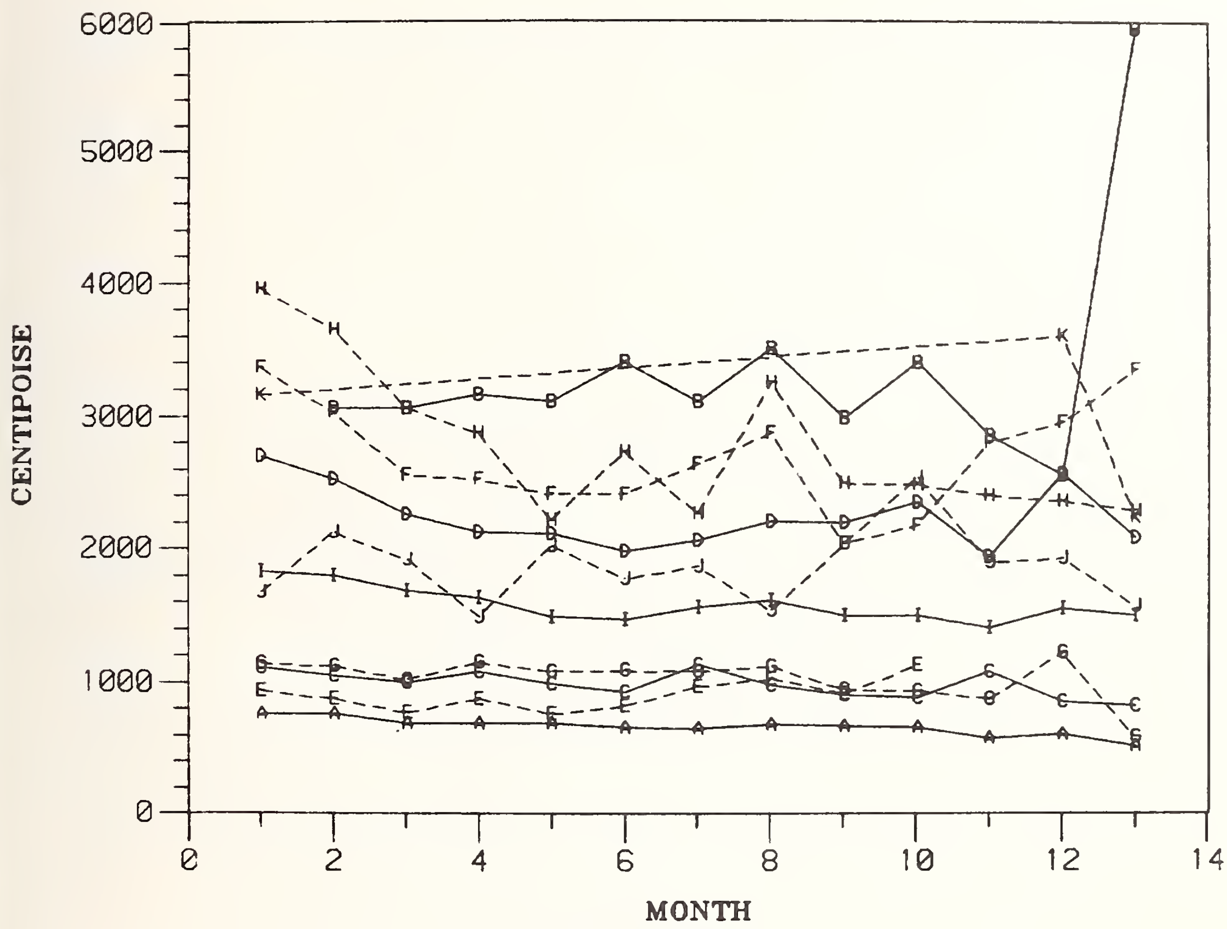
COLD CRANKING SIMULATOR VISCOSITY, −5 C



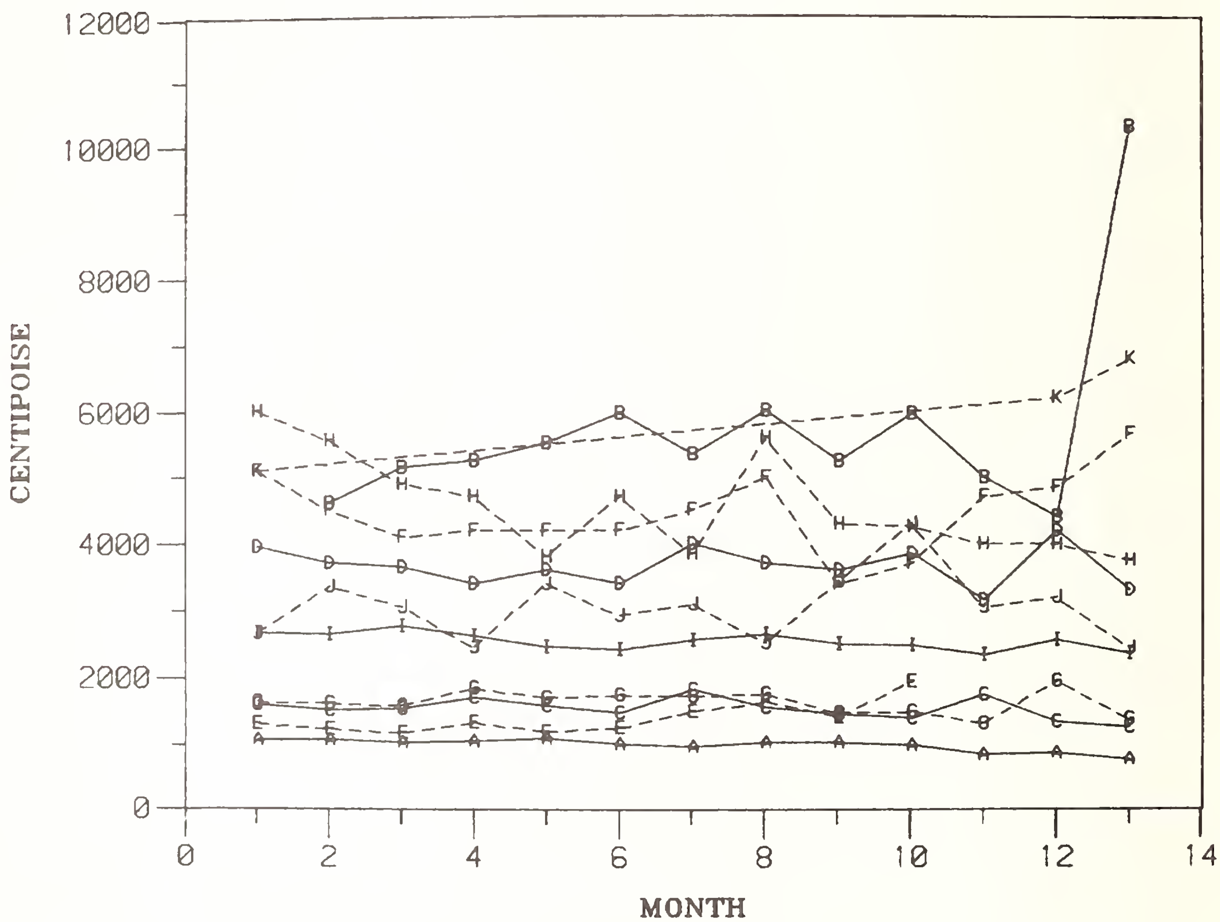
COLD CRANKING SIMULATOR VISCOSITY, -10 C



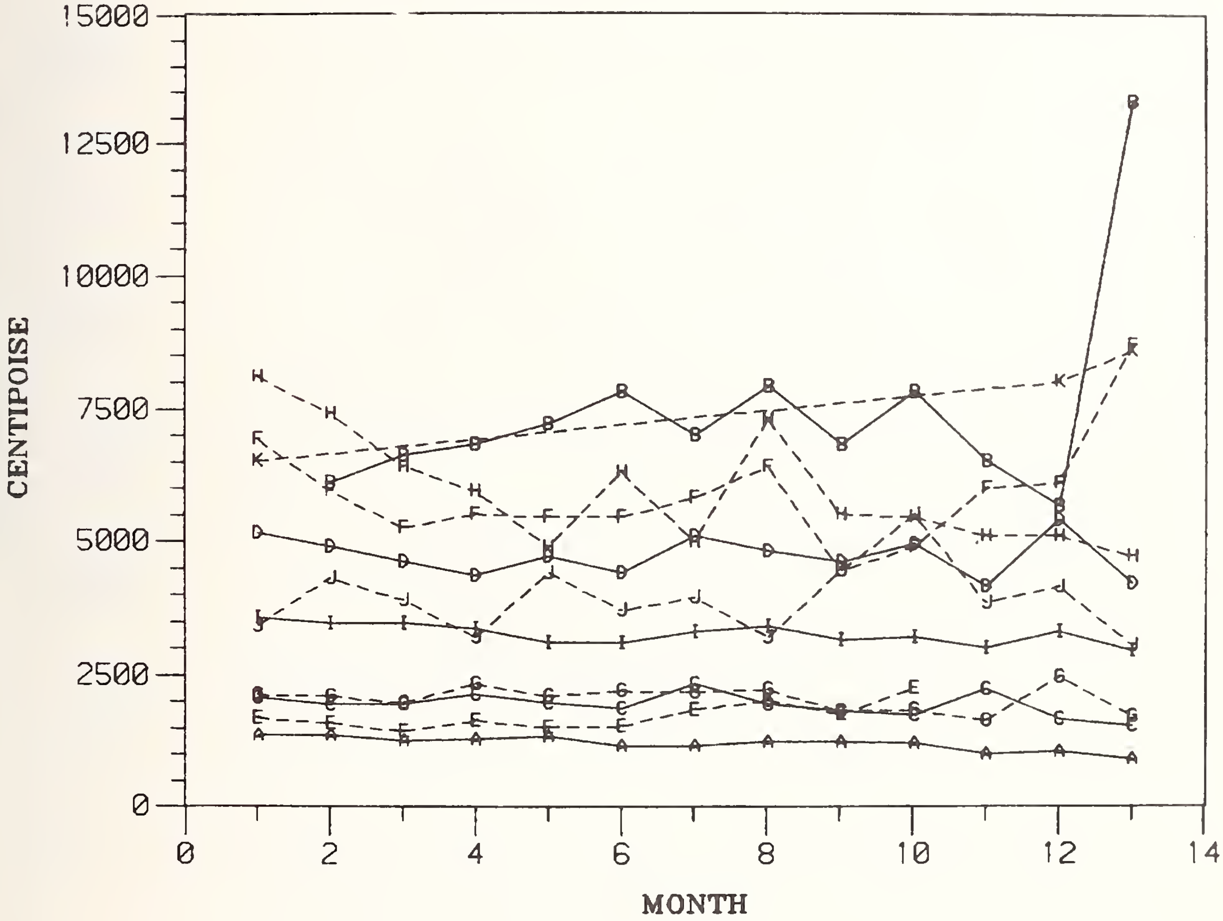
COLD CRANKING SIMULATOR VISCOSITY, −15 C



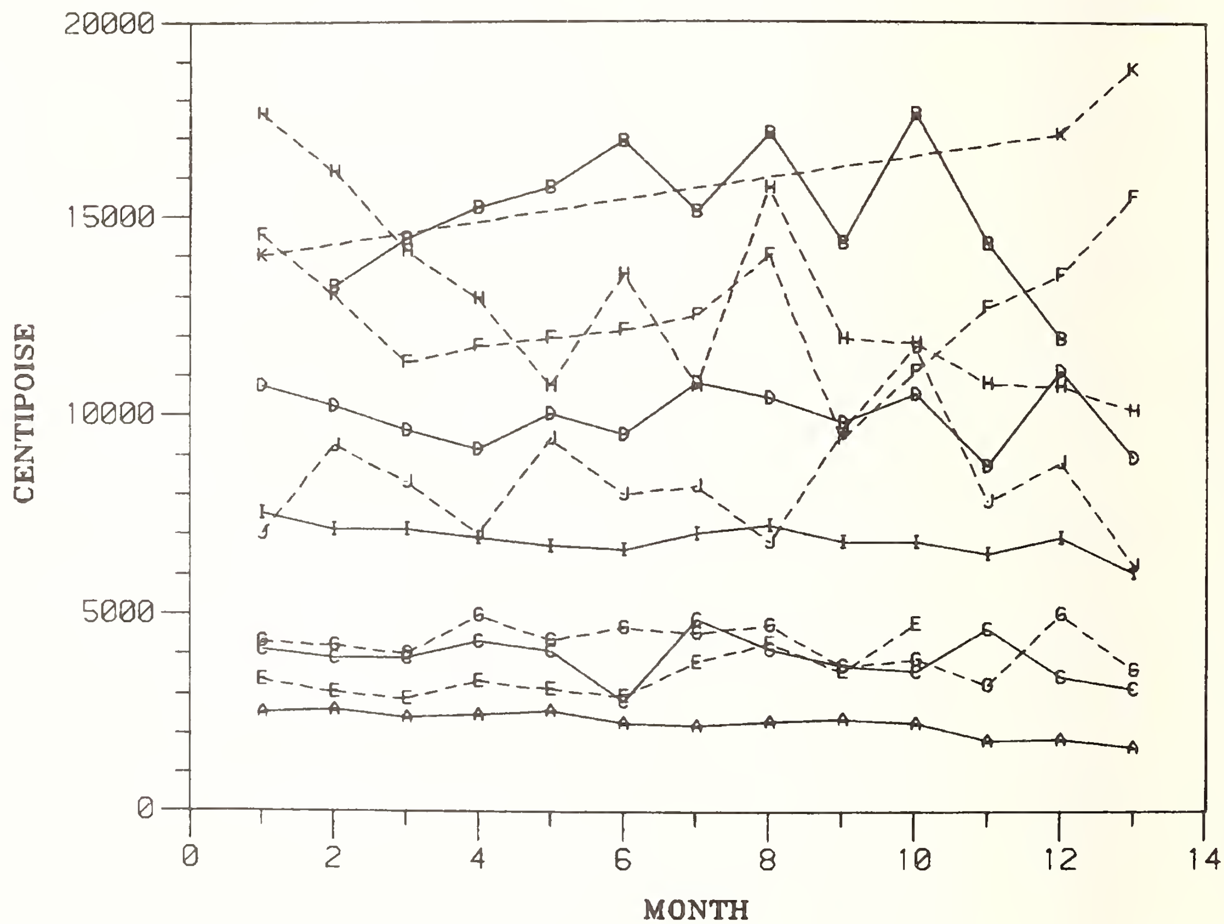
COLD CRANKING SIMULATOR VISCOSITY, −18 C



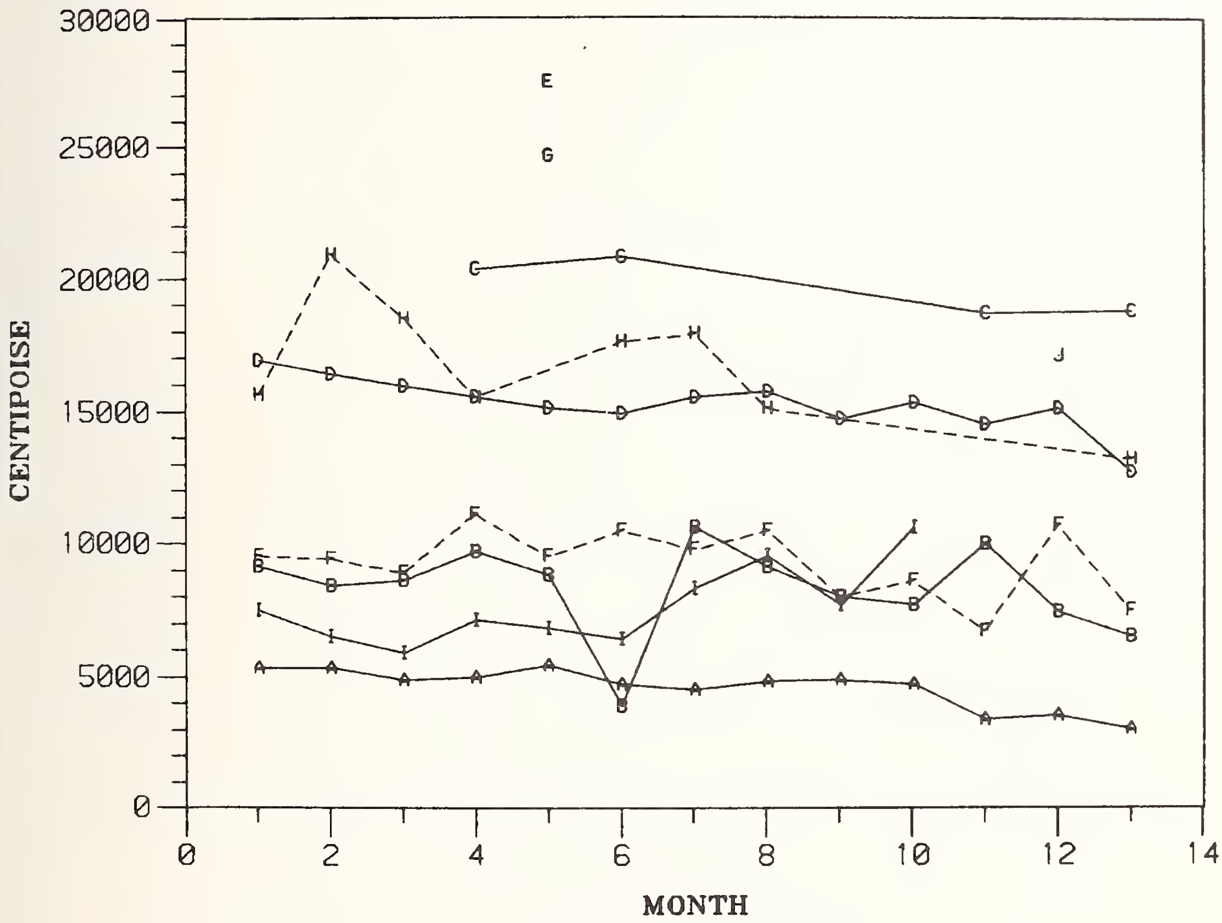
COLD CRANKING SIMULATOR VISCOSITY, -20 C



COLD CRANKING SIMULATOR VISCOSITY, -25 C



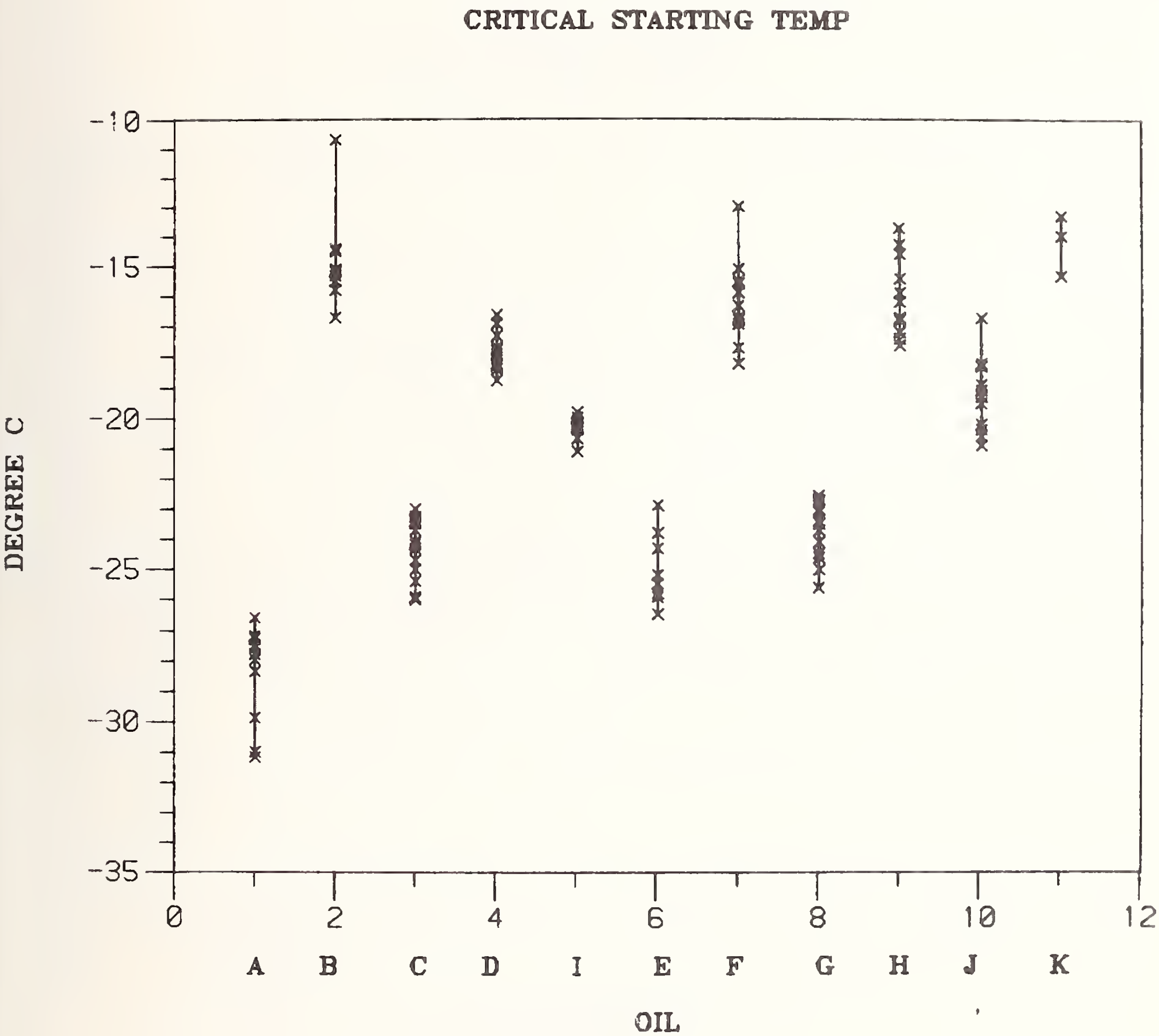
COLD CRANKING SIMULATOR VISCOSITY, −30 C



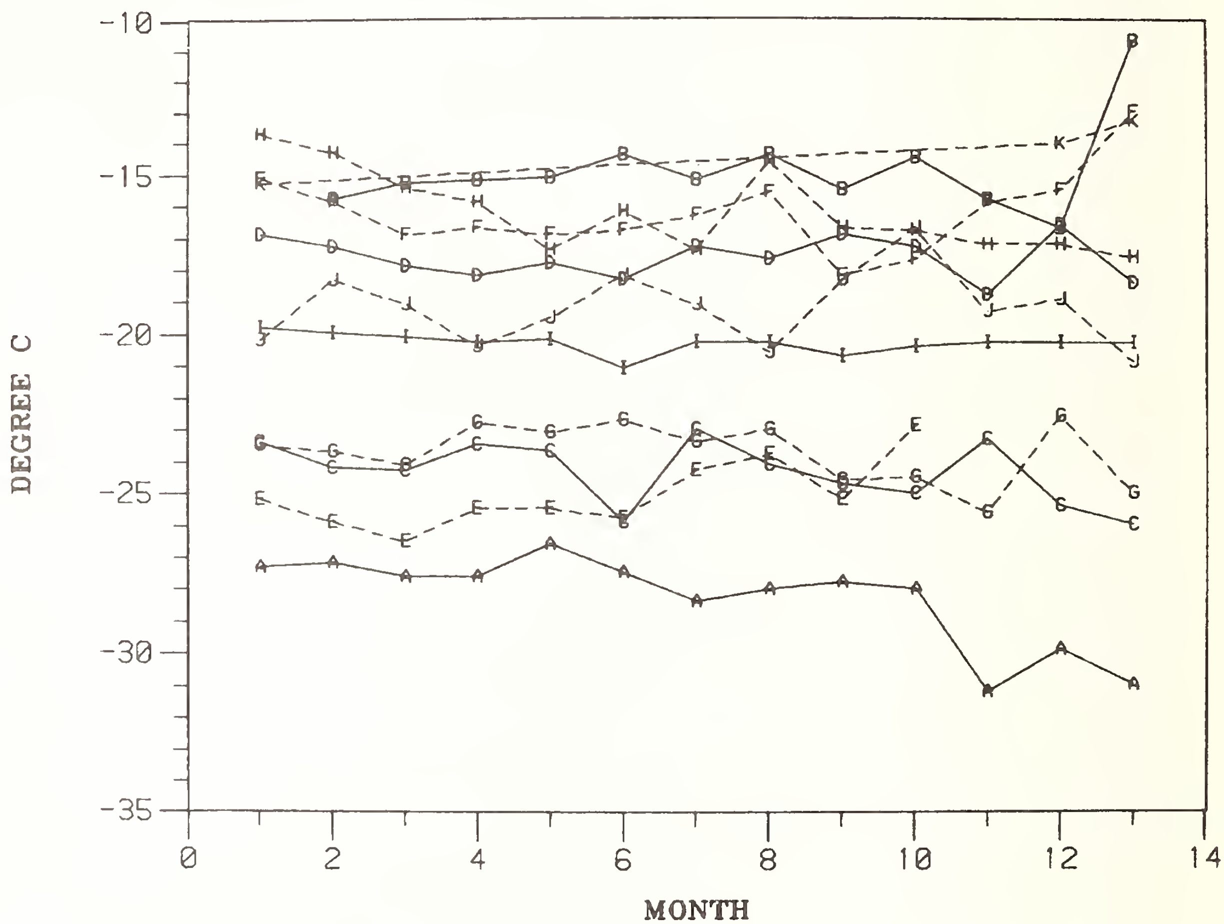
ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: CRITICAL STARTING TEMPERATURE AT 3500 Pa (DEG C) COLD CRANKING SIMULATOR — LABORATORY: P

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	-27.3	-	-23.4	-16.9	-19.8	-25.2	-15.1	-23.5	-13.7	-20.2	-15.3
APR 80	-27.2	-15.8	-24.2	-17.3	-20.0	-25.9	-15.9	-23.7	-14.3	-18.3	-
MAY 80	-27.6	-15.3	-24.3	-17.9	-20.1	-26.5	-16.9	-24.1	-15.4	-19.1	-
JUN 80	-27.6	-15.2	-23.5	-18.2	-20.3	-25.5	-16.7	-22.8	-15.9	-20.4	-
JUL 80	-26.6	-15.1	-23.7	-17.8	-20.2	-25.5	-16.9	-23.1	-17.4	-19.5	-
AUG 80	-27.5	-14.4	-25.9	-18.3	-21.1	-25.8	-16.8	-22.7	-16.2	-18.2	-
SEP 80	-28.4	-15.2	-23.0	-17.3	-20.3	-24.3	-16.3	-23.4	-17.4	-19.1	-
OCT 80	-28.0	-14.4	-24.1	-17.7	-20.3	-23.8	-15.6	-23.0	-14.6	-20.6	-
NOV 80	-27.8	-15.5	-24.7	-16.9	-20.7	-25.2	-18.2	-24.6	-16.7	-18.3	-
DEC 80	-28.0	-14.5	-25.0	-17.3	-20.4	-22.9	-17.7	-24.5	-16.8	-16.7	-
JAN 81	-31.2	-15.8	-23.3	-18.8	-20.3	-	-15.9	-25.6	-17.2	-19.3	-
FEB 81	-29.9	-16.7	-25.4	-16.6	-20.3	-	-15.5	-22.6	-17.2	-18.9	-14.0
MAR 81	-31.0	-10.7	-26.0	-18.4	-20.3	-	-13.0	-25.0	-17.6	-20.9	-13.3
MEAN	-28.32	-14.88	-24.35	-17.65	-20.32	-25.06	-16.32	-23.74	-16.18	-19.19	-14.20
STD.DEV.	1.46	1.47	.99	.66	.32	1.01	1.01	.95	1.31	1.17	1.01
MIN	-31.2	-16.7	-26.0	-18.8	-21.1	-26.5	-18.2	-25.6	-17.6	-20.9	-15.3
MAX	-26.6	-10.7	-23.0	-16.6	-19.8	-22.9	-14.7	-22.6	-13.7	-16.7	-13.3


CRITICAL STARTING TEMP
DEGREE C
-10
-15
-20
-25
-30
-35
0
2
4
6
8
10
12
A
B
C
D
I
E
F
G
H
J
K
OIL

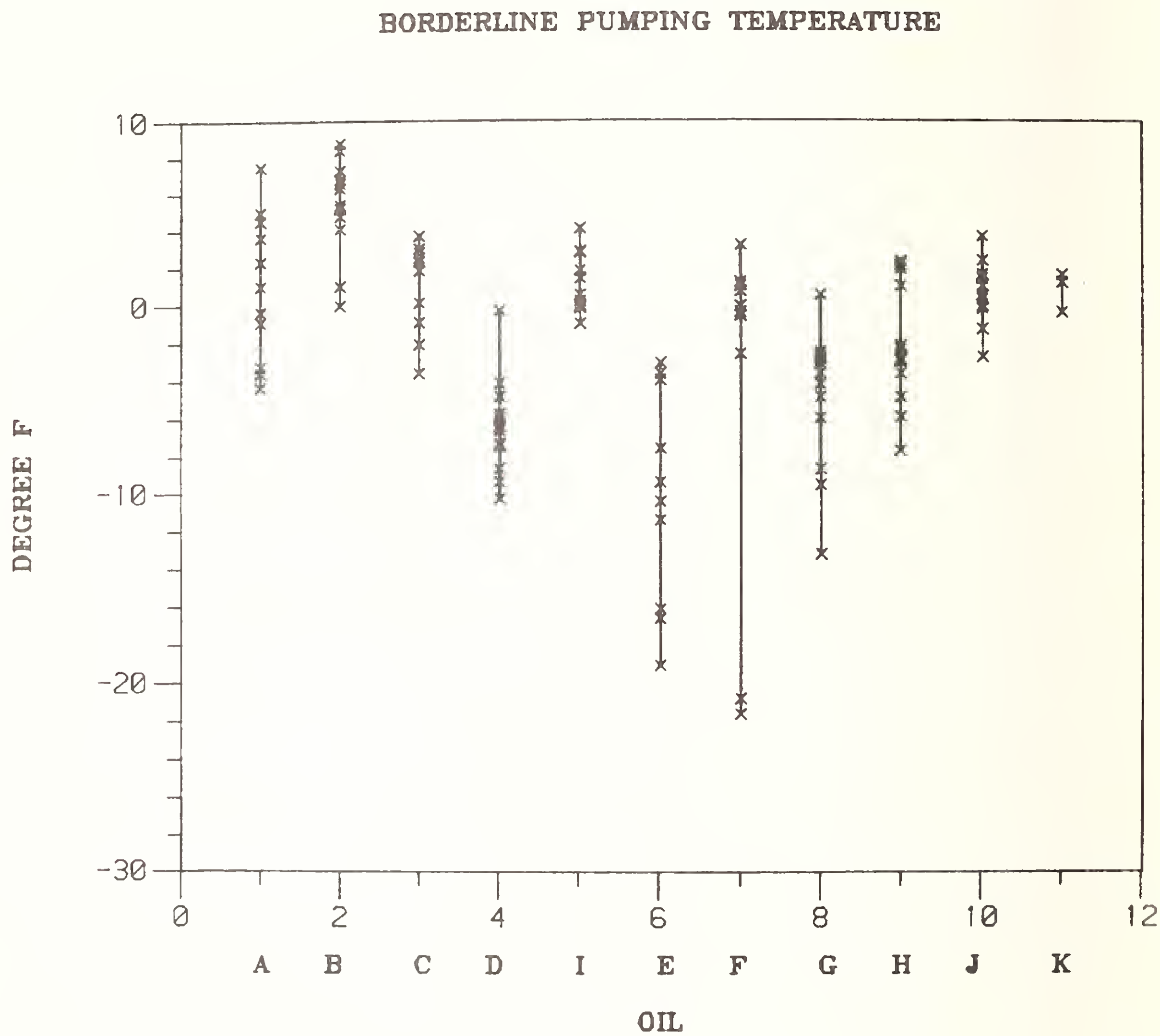
CRITICAL STARTING TEMP



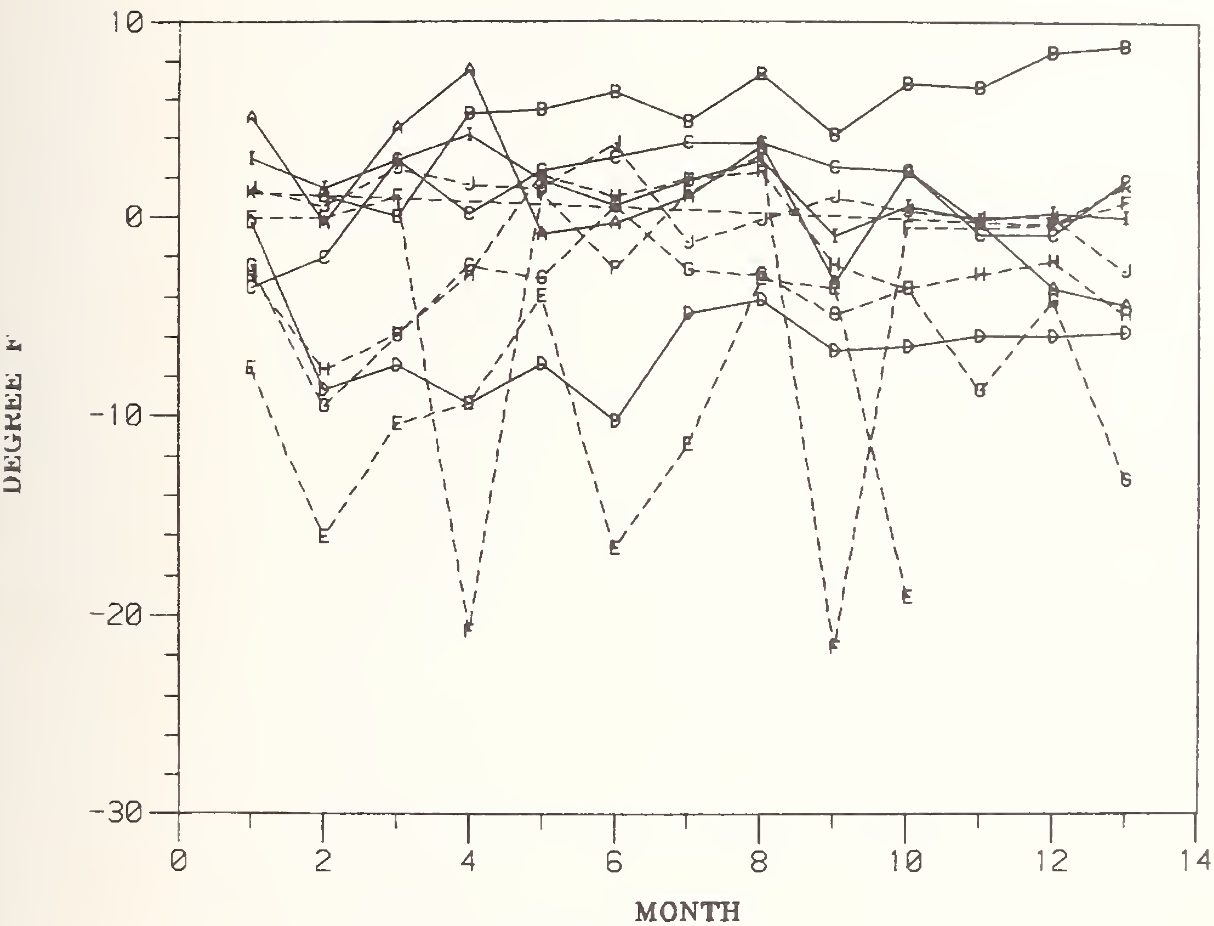
ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: BORDERLINE PUMPING TEMPERATURE BY MRV (DEG F. A=AIR-BINDING, F=FLOW LIMILED) ASTM D3829 LABORATORY: P

		VIRGIN BASESTOCK			REF		RE-REFINED BASESTOCKS				
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	5.0A	-	-3.6A	-.3A	2.9A	-7.6A	-.1F	-2.5A	-3.0F	1.4F	1.2F
APR 80	-.4A	1.0A	-2.1A	-8.7A	1.4A	-16.1A	-.1F	-9.5A	-7.7F	.5F	-
MAY 80	4.5A	.0A	2.8A	-7.5A	2.8A	-10.4A	1.0F	-6.0A	-5.9F	2.4F	-
JUN 80	7.5A	5.2F	.1A	-9.4A	4.1A	-9.4A	-20.8F	-2.5A	-3.0F	1.6F	-
JUL 80	-9.0F	5.4F	2.3A	-7.4F	1.8A	-4.0A	1.2F	-3.1F	2.1F	1.4F	-
AUG 80	-.4A	6.3F	3.0A	-10.3A	.5A	-16.6F	-2.6F	.5F	1.0F	3.7F	-
SEP 80	1.0A	4.8F	3.7A	-4.9F	1.8F	-11.4F	1.2F	-2.7F	1.9F	-1.3F	-
OCT 80	3.6A	7.3F	3.7A	-4.2F	2.8F	-3.1F	3.2F	-2.9F	2.3F	-.2F	-
NOV 80	-3.3F	4.1F	2.5A	-6.7A	-1.0#	-3.6A	-21.6F	-4.9A	-2.4F	1.0F	-
DEC 80	2.3A	6.8F	2.3A	-6.5F	.5#	-19.1F	-.6F	-3.6F	-3.6F	.3F	-
JAN 81	-.4A	6.6F	-.9A	-6.0F	-.2F	-	-.6F	-8.7A	-2.9F	.CF	-
FEB 81	-3.6A	8.4F	-.9A	-6.0F	.2#	-	-.4F	-4.2F	-2.2F	.0F	-.4A
MAR 81	-4.4A	8.8F	1.8A	-5.8F	.0F	-	.7F	-13.2F	-4.9F	-2.7F	1.6F
MEAN	.18	5.39	1.13	-6.44	1.35	-10.13	-3.04	-4.87	-2.18	.62	.80
STD.DEV.	4.52	2.68	2.36	2.53	1.50	5.74	8.17	3.66	3.17	1.61	1.06
MIN	-9.0	.0	-3.6	-10.3	-1.0	-19.1	-21.6	-13.2	-7.7	-2.7	-.4
MAX	7.5	8.8	3.7	-.3	4.1	-3.1	3.2	.5	2.3	3.7	1.6


BORDERLINE PUMPING TEMPERATURE
DEGREE F
10
0
-10
-20
-30
0
2
4
6
8
10
12
A B C D I E F G H J K
OIL

BORDERLINE PUMPING TEMPERATURE



III

PHYSICAL PROPERTIES

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: API GRAVITY (DEG API) ASTM D287

LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	33.0	-	31.2	30.8	29.9	30.5	29.8	29.6	29.1	29.2	30.1
APR 80	32.9	30.2	31.1	30.8	29.9	30.6	29.8	29.2	29.2	28.8	-
MAY 80	33.0	29.9	31.0	30.9	29.8	30.7	29.9	29.4	29.3	29.0	-
JUN 80	33.0	30.2	30.7	30.8	29.9	30.6	29.6	28.4	29.7	29.5	-
JUL 80	29.9	30.0	30.5	30.6	32.9	30.5	29.7	29.6	29.8	29.0	-
AUG 80	30.4	29.8	30.4	30.9	29.8	30.6	29.6	29.3	29.4	29.4	-
SEP 80	32.4	29.7	29.8	30.8	29.7	30.1	29.7	29.4	30.0	29.5	-
OCT 80	32.3	29.9	30.2	31.0	29.9	30.1	30.0	29.5	29.4	29.6	-
NOV 80	32.5	29.7	30.5	31.1	29.9	30.4	29.8	30.1	29.7	29.3	-
DEC 80	32.4	29.9	30.9	31.1	30.0	29.8	29.7	30.0	29.8	29.1	-
JAN 81	32.2	30.0	30.4	31.1	29.9	-	30.0	29.7	29.7	29.6	-
FEB 81	32.1	29.9	30.8	31.4	30.0	-	29.8	29.9	29.8	29.1	29.4
MAR 81	32.2	28.8	30.9	31.2	29.9	-	29.7	29.8	29.4	29.7	29.5
MEAN	32.18	29.83	30.65	30.96	30.12	30.39	29.78	29.53	29.56	29.29	29.67
STD.DEV.	.96	.36	.40	.21	.84	.29	.13	.43	.28	.28	.38
MIN	29.9	28.8	29.8	30.6	29.7	29.8	29.6	28.4	29.1	28.8	29.4
MAX	33.0	30.2	31.2	31.4	32.9	30.7	30.0	30.1	30.0	29.7	30.1

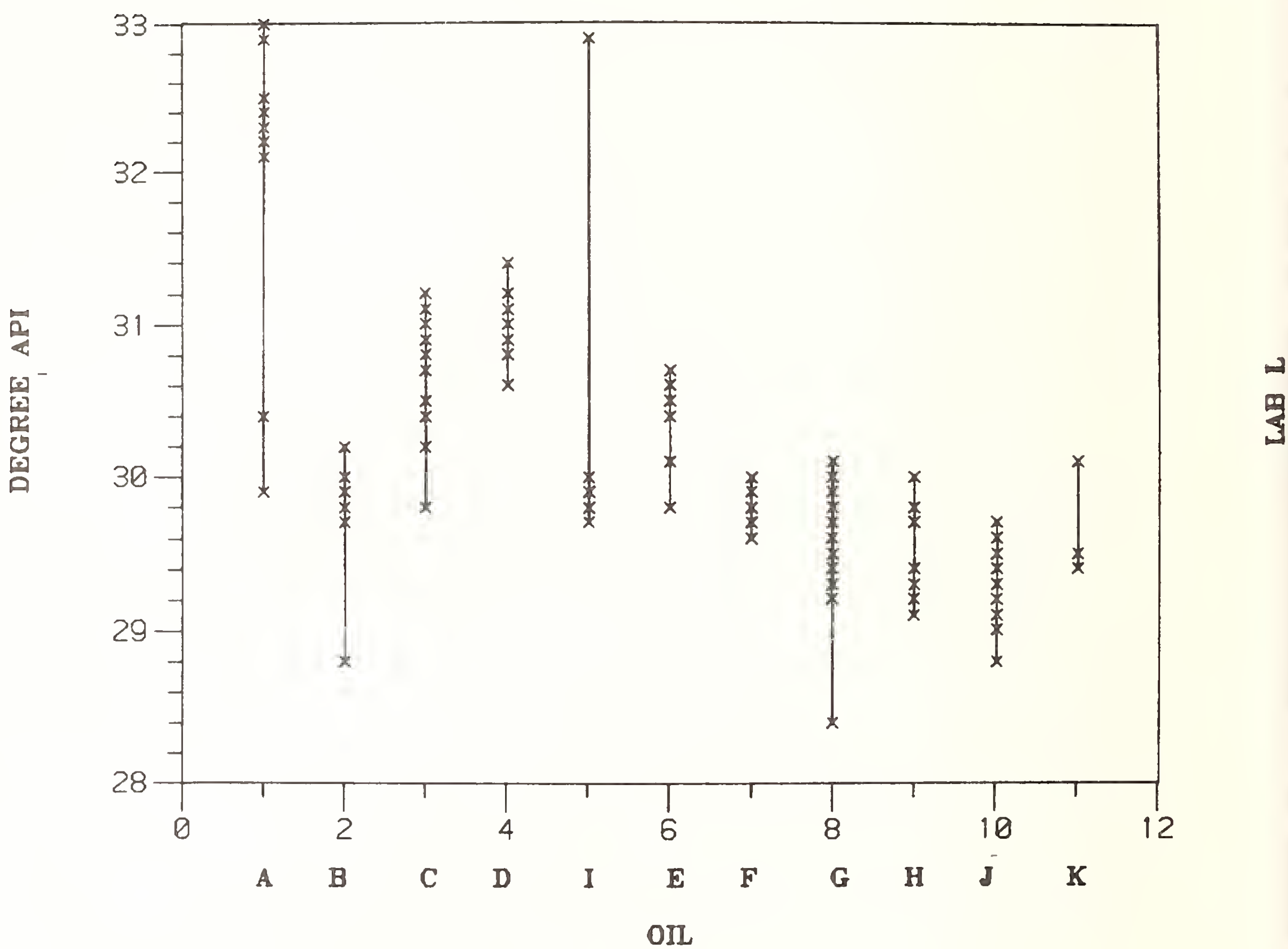
ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: AFI GRAVITY (DEG API) ASTM D287

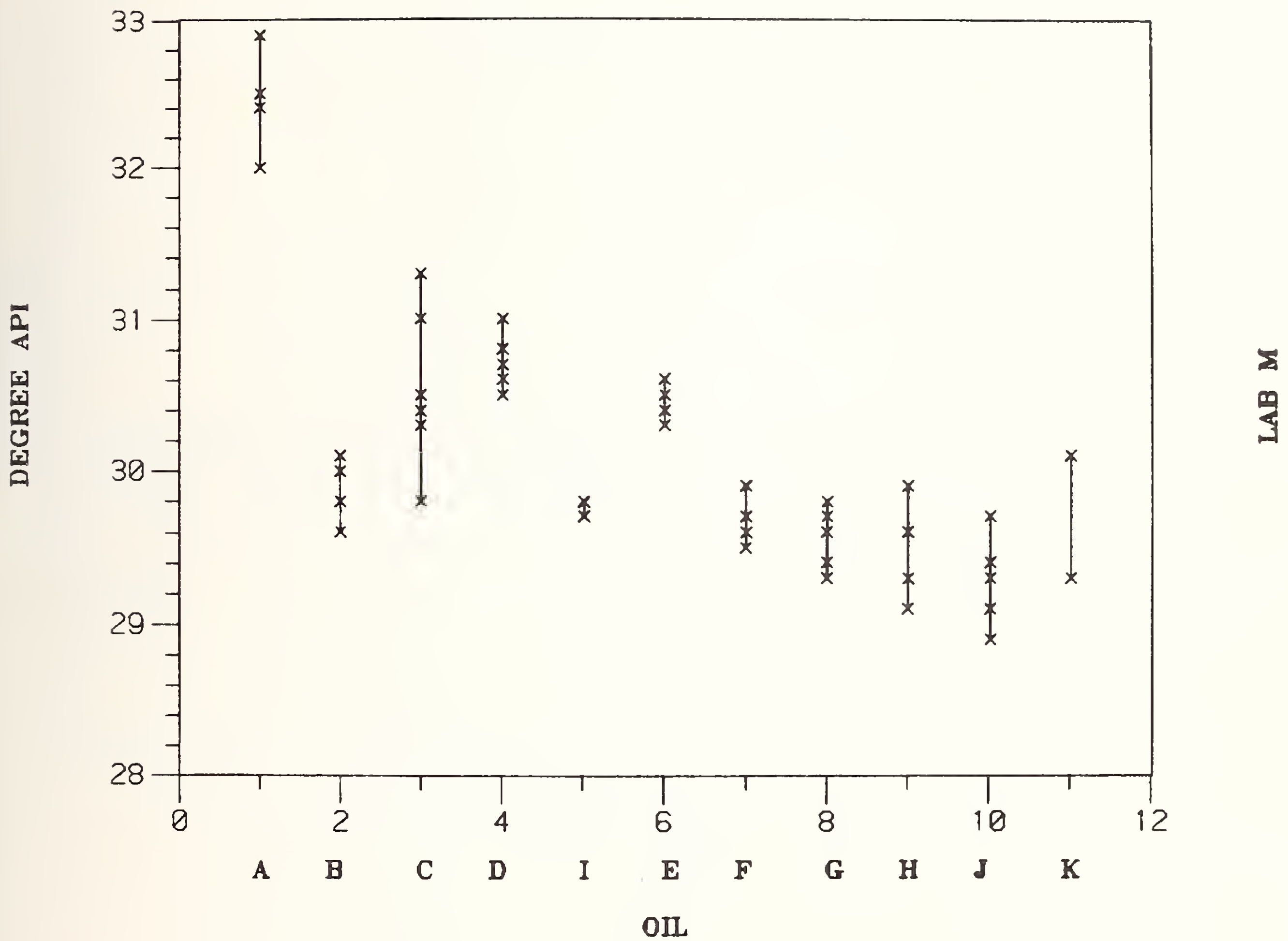
LABORATORY: M

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	32.9	-	31.3	30.7	29.8	30.4	29.7	29.6	29.1	29.1	30.1
APR 80	--	30.1	--	30.6	--	30.6	29.7	--	--	--	-
MAY 80	--	--	31.0	--	29.7	--	--	29.3	--	--	-
JUN 80	32.9	30.0	--	--	--	30.4	--	--	29.6	--	-
JUL 80	--	--	30.4	30.5	--	--	29.6	29.6	--	29.4	-
AUG 80	32.4	29.8	30.4	30.8	29.7	30.5	29.5	29.3	29.3	28.9	-
SEP 80	--	--	29.8	30.8	29.7	--	--	--	29.9	--	-
OCT 80	--	29.8	--	--	--	--	29.9	29.4	--	29.4	-
NOV 80	32.5	--	30.5	31.0	--	30.3	--	--	--	--	-
DEC 80	--	--	--	--	29.8	--	--	29.8	29.6	29.1	-
JAN 81	--	29.8	30.3	31.0	--	-	29.9	--	--	29.3	-
FEB 81	32.0	29.6	30.5	31.0	29.7	-	--	29.7	29.6	--	29.3
MAR 81	--	--	--	--	29.7	-	--	--	--	29.7	-
MEAN	32.54	29.85	30.52	30.80	29.73	30.44	29.72	29.53	29.52	29.27	29.70
STD.DEV.	.38	.18	.45	.19	.05	.11	.16	.20	.28	.26	.57
MIN	32.0	29.6	29.8	30.5	29.7	30.3	29.5	29.3	29.1	28.9	29.3
MAX	32.9	30.1	31.3	31.0	29.8	30.6	29.9	29.8	29.9	29.7	30.1

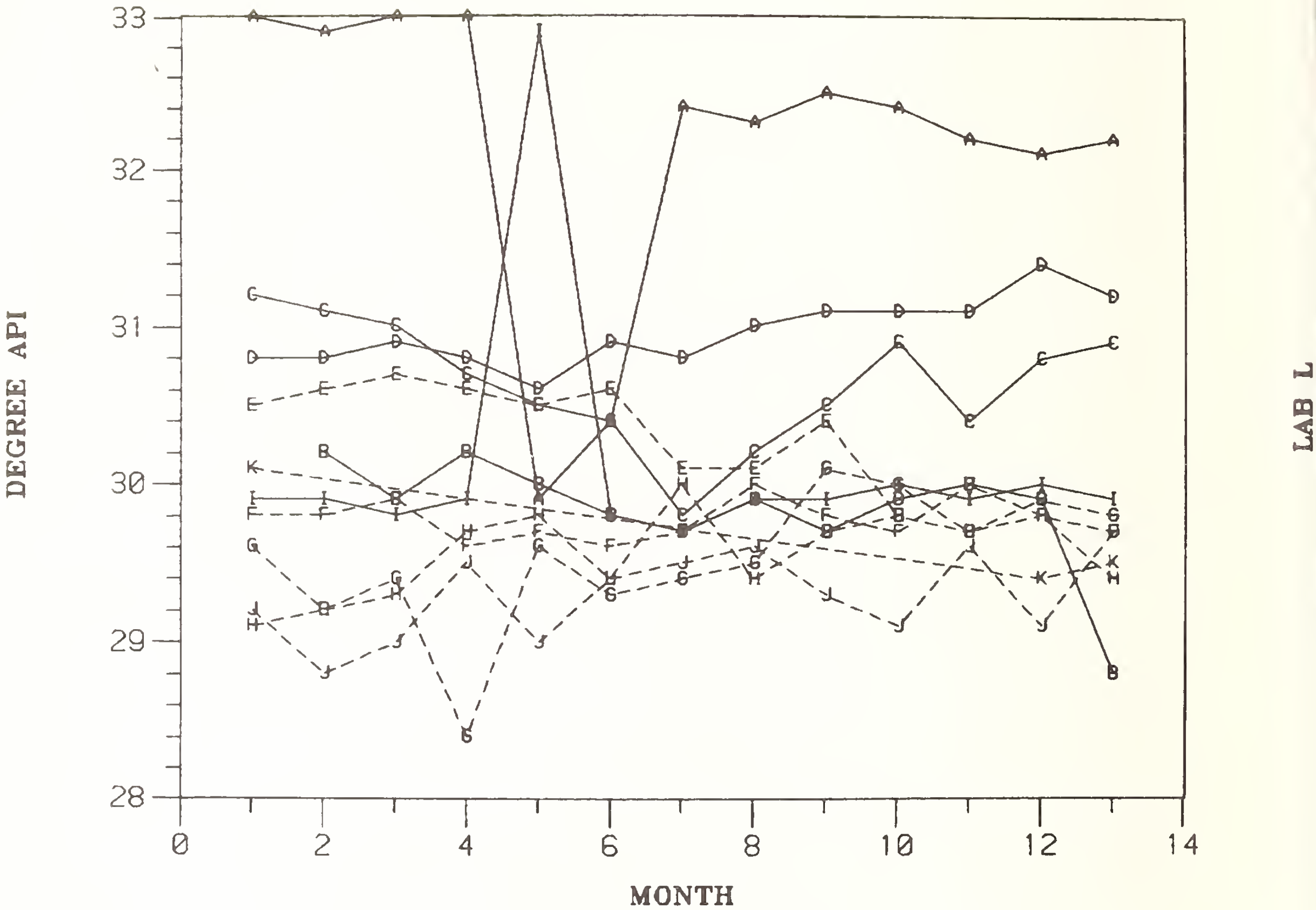
API GRAVITY



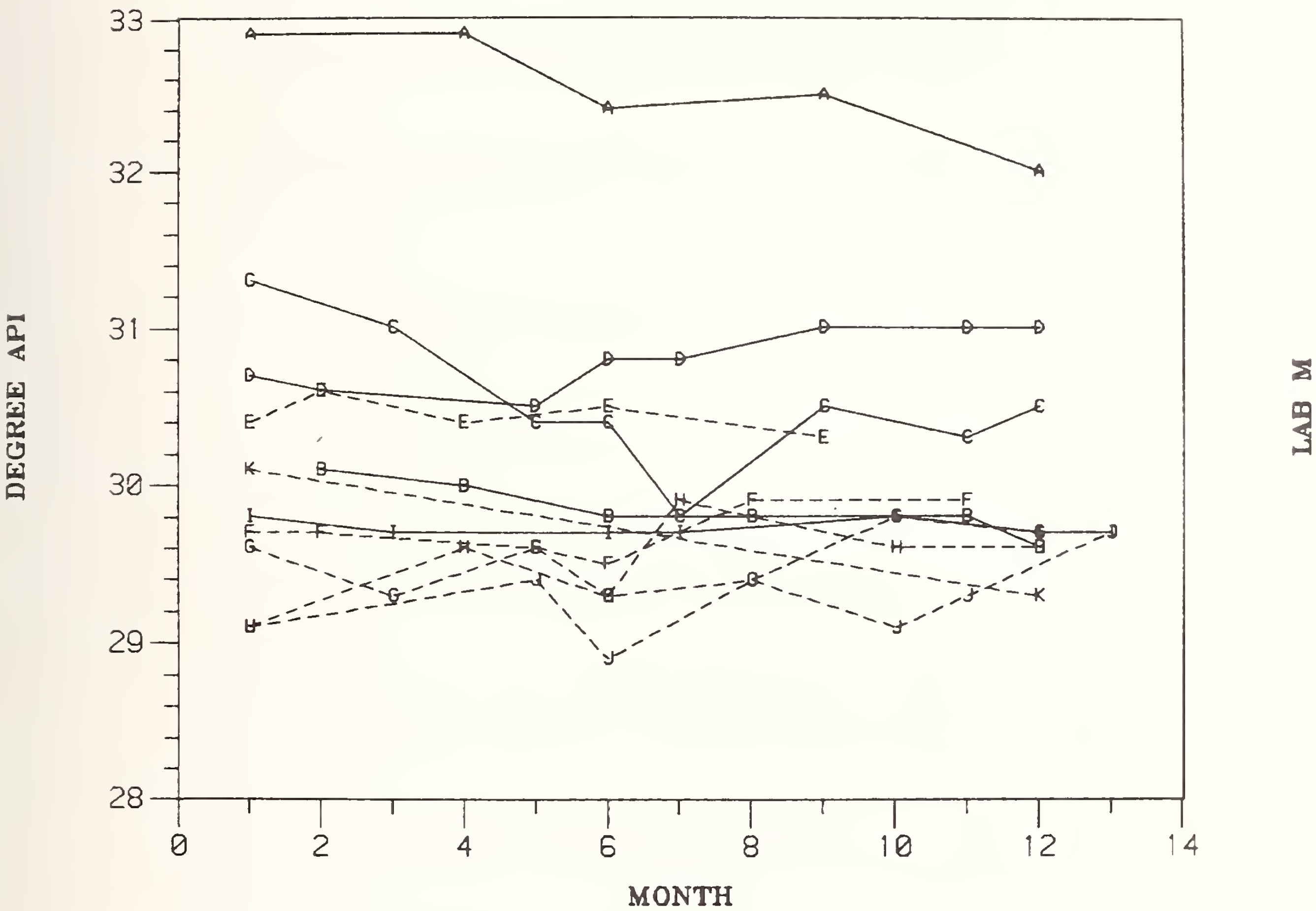
API GRAVITY



API GRAVITY



API GRAVITY



ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: GCEPD 0.5% OFF (DEG C) MODIFIED ASTM D2887 LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	330.	-	290.	360.	351.	282.	281.	261.	305.	302.	266.
APR 80	321.	343.	276.	353.	344.	294.	275.	259.	259.	283.	-
MAY 80	331.	375.	284.	346.	348.	285.	276.	265.	306.	280.	-
JUN 80	331.	364.	295.	344.	353.	296.	270.	261.	316.	287.	-
JUL 80	335.	365.	286.	349.	345.	280.	267.	266.	301.	311.	-
AUG 80	325.	357.	294.	344.	343.	288.	287.	271.	313.	315.	-
SEP 80	336.	336.	280.	339.	338.	278.	274.	267.	305.	318.	-
OCT 80	343.	369.	284.	352.	348.	303.	288.	271.	313.	319.	-
NOV 80	322.	287.	272.	345.	332.	286.	258.	260.	300.	313.	-
DEC 80	334.	363.	276.	323.	341.	282.	268.	257.	296.	327.	-
JAN 81	343.	329.	294.	299.	345.	-	263.	262.	306.	312.	-
FEB 81	334.	384.	280.	341.	343.	-	292.	278.	296.	310.	298.
MAR 81	341.	393.	280.	355.	346.	-	281.	263.	284.	302.	290.
MEAN	332.8	355.4	283.9	342.3	344.4	287.4	275.4	264.5	300.0	306.1	284.7
STD.DEV.	7.2	28.5	7.5	15.9	5.5	8.0	10.2	5.9	15.0	14.6	16.7
MIN	321.	287.	272.	299.	332.	278.	258.	257.	259.	280.	266.
MAX	341.	393.	295.	360.	353.	303.	292.	278.	316.	327.	298.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: GCBPD 1.0% OFF (DEF C) MODIFIED ASTM D2887 LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	337.	-	305.	372.	365.	299.	305.	274.	328.	316.	298.
APR 80	332.	363.	296.	367.	359.	307.	296.	275.	287.	305.	-
MAY 80	339.	391.	301.	362.	365.	301.	299.	279.	322.	302.	-
JUN 80	339.	386.	316.	362.	373.	314.	293.	275.	335.	308.	-
JUL 80	342.	387.	302.	364.	360.	298.	290.	285.	323.	327.	-
AUG 80	342.	381.	309.	362.	361.	306.	311.	286.	332.	334.	-
SEP 80	343.	354.	297.	358.	358.	297.	301.	284.	325.	337.	-
OCT 80	350.	389.	302.	372.	364.	319.	314.	290.	334.	333.	-
NOV 80	340.	308.	291.	366.	356.	306.	289.	280.	319.	337.	-
DEC 80	341.	387.	299.	353.	360.	304.	297.	280.	317.	348.	-
JAN 81	348.	376.	311.	334.	362.	-	294.	276.	326.	336.	-
FEB 81	347.	396.	322.	362.	362.	-	320.	298.	320.	326.	332.
MAR 81	346.	407.	304.	374.	362.	-	309.	282.	298.	319.	316.
MEAN	342.0	377.1	304.2	362.2	362.1	305.1	301.4	281.8	320.5	325.2	315.3
STD.DEV.	4.9	25.9	8.5	10.3	4.2	7.1	9.7	6.9	13.8	14.2	17.0
MIN	332.	308.	291.	334.	356.	297.	289.	274.	287.	302.	298.
MAX	350.	407.	322.	374.	373.	319.	320.	298.	335.	348.	332.

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: GCBPD 5% OFF (DEF C) MODIFIED ASTM D2887 LABORATORY: L

DATE :	A	B	C	D	I	E	F	G	H	J	K
	VIRGIN BASESTOCK				: REF :	RE-REFINED BASESTOCKS					
MAR 80 :	357.	-	355.	397.	393.	343.	369.	322.	367.	355.	375.
APR 80 :	354.	410.	349.	396.	390.	347.	359.	319.	361.	358.	-
MAY 80 :	358.	416.	353.	393.	397.	343.	364.	324.	361.	355.	-
JUN 80 :	359.	417.	371.	392.	406.	359.	358.	317.	370.	359.	-
JUL 80 :	360.	419.	349.	393.	390.	345.	360.	337.	364.	369.	-
AUG 80 :	361.	420.	354.	393.	393.	347.	369.	334.	371.	369.	-
SEP 80 :	356.	410.	348.	393.	393.	345.	368.	338.	364.	371.	-
OCT 80 :	361.	425.	352.	403.	397.	360.	374.	343.	372.	366.	-
NOV 80 :	356.	376.	343.	396.	390.	348.	362.	343.	360.	373.	-
DEC 80 :	354.	421.	354.	397.	391.	349.	366.	346.	360.	378.	-
JAN 81 :	360.	417.	364.	396.	392.	-	366.	326.	367.	369.	-
FEB 81 :	360.	418.	353.	396.	392.	-	377.	350.	362.	366.	379.
MAR 81 :	358.	429.	361.	402.	392.	-	374.	338.	346.	361.	379.
MEAN :	358.0	414.8	354.3	395.9	393.5	348.6	366.6	333.6	363.5	365.3	377.7
STD.DEV. :	2.4	13.4	7.4	3.4	4.4	6.1	6.0	10.9	6.7	7.2	2.3
MIN :	354.	376.	343.	392.	390.	343.	358.	317.	346.	355.	375.
MAX :	361.	429.	371.	403.	406.	360.	377.	350.	372.	378.	379.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: GCBPD 10% OFF (DEG C) MODIFIED ASTM D2887

LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	367.	-	379.	411.	406.	362.	391.	354.	384.	373.	404.
APR 80	366.	426.	377.	410.	404.	365.	383.	347.	380.	380.	-
MAY 80	367.	429.	381.	410.	410.	362.	385.	355.	379.	377.	-
JUN 80	368.	431.	397.	406.	419.	378.	385.	344.	385.	380.	-
JUL 80	370.	431.	375.	406.	402.	365.	384.	361.	380.	388.	-
AUG 80	369.	435.	379.	407.	408.	364.	390.	362.	388.	385.	-
SEP 80	364.	429.	373.	409.	407.	366.	392.	363.	381.	385.	-
OCT 80	369.	440.	378.	417.	410.	377.	395.	368.	389.	381.	-
NOV 80	365.	413.	367.	408.	402.	366.	383.	365.	378.	388.	-
DEC 80	362.	435.	378.	412.	404.	369.	387.	368.	377.	392.	-
JAN 81	368.	430.	388.	411.	405.	-	385.	353.	383.	384.	-
FEB 81	367.	430.	375.	409.	405.	-	396.	367.	377.	382.	405.
MAR 81	366.	440.	386.	412.	404.	-	395.	361.	373.	379.	406.
MEAN	366.8	430.8	379.5	409.8	406.6	367.4	388.5	359.1	381.1	382.6	405.0
STD.DEV.	2.2	7.1	7.5	3.0	4.5	5.7	4.8	7.9	4.6	5.1	1.0
MIN	362.	413.	367.	406.	402.	362.	383.	344.	373.	373.	404.
MAX	370.	440.	397.	417.	419.	378.	396.	368.	389.	392.	406.

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: GCEPD 20% OFF (DEG C) MODIFIED ASTM D2887 LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	382.	-	407.	429.	422.	381.	415.	384.	407.	396.	437.
APR 80	381.	444.	407.	427.	421.	385.	408.	378.	402.	404.	-
MAY 80	382.	443.	409.	428.	427.	381.	409.	384.	401.	402.	-
JUN 80	384.	447.	424.	425.	435.	398.	411.	377.	406.	404.	-
JUL 80	384.	447.	405.	423.	418.	386.	410.	386.	402.	410.	-
AUG 80	384.	452.	407.	426.	425.	383.	413.	389.	410.	404.	-
SEP 80	377.	449.	403.	429.	423.	388.	419.	387.	403.	403.	-
OCT 80	382.	458.	408.	436.	427.	397.	419.	394.	411.	400.	-
NOV 80	380.	440.	395.	425.	417.	385.	406.	387.	379.	408.	-
DEC 80	376.	451.	404.	429.	412.	389.	409.	390.	398.	411.	-
JAN 81	381.	444.	412.	429.	420.	-	406.	379.	404.	401.	-
FEB 81	379.	445.	396.	424.	419.	-	419.	386.	395.	402.	434.
MAR 81	379.	455.	410.	428.	418.	-	419.	385.	399.	400.	435.
MEAN	380.1	447.9	406.7	427.5	421.8	387.3	412.5	385.1	401.3	403.5	435.3
STD.DEV.	2.6	5.3	7.2	3.3	5.8	6.0	5.1	4.9	8.1	4.2	1.5
MIN	376.	440.	395.	423.	412.	381.	406.	377.	379.	396.	434.
MAX	384.	458.	424.	436.	435.	398.	419.	426.	411.	411.	437.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: GCBFD 30% OFF (DEG C) MODIFIED ASTM D2887 LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	395.	-	423.	441.	435.	395.	434.	403.	423.	413.	460.
APR 80	394.	457.	425.	440.	434.	399.	427.	398.	419.	421.	-
MAY 80	395.	453.	427.	440.	439.	395.	426.	403.	418.	421.	-
JUN 80	397.	459.	440.	438.	447.	412.	429.	398.	423.	421.	-
JUL 80	397.	457.	425.	435.	429.	401.	428.	402.	418.	427.	-
AUG 80	397.	463.	426.	440.	437.	397.	432.	407.	428.	419.	-
SEP 80	390.	462.	422.	444.	436.	404.	440.	404.	419.	417.	-
OCT 80	397.	471.	428.	449.	439.	412.	439.	413.	428.	415.	-
NOV 80	393.	455.	414.	437.	429.	398.	424.	403.	416.	426.	-
DEC 80	389.	464.	420.	442.	432.	404.	427.	405.	415.	424.	-
JAN 81	394.	456.	427.	440.	431.	-	422.	396.	421.	415.	-
FEB 81	390.	457.	411.	435.	430.	-	436.	399.	410.	417.	454.
MAR 81	391.	466.	425.	438.	429.	-	438.	401.	417.	415.	454.
MEAN	393.8	460.0	424.1	439.9	434.4	401.7	430.9	402.5	419.6	419.3	456.0
STD.DEV.	2.9	5.3	7.0	3.8	5.3	6.3	6.0	4.4	5.0	4.5	3.5
MIN	389.	453.	411.	435.	429.	395.	422.	396.	410.	413.	454.
MAX	397.	471.	440.	449.	447.	412.	440.	413.	428.	427.	460.

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: GCEFD 40% OFF (DEG C) MODIFIED ASTM D2887 LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE :	A	B	C	D	I	E	F	G	H	J	K
MAR 80 :	408.	-	437.	453.	446.	407.	451.	418.	439.	427.	479.
APR 80 :	407.	468.	439.	451.	446.	410.	444.	413.	435.	437.	-
MAY 80 :	409.	462.	439.	452.	451.	406.	443.	419.	434.	437.	-
JUN 80 :	410.	469.	452.	450.	457.	423.	445.	415.	438.	435.	-
JUL 80 :	409.	467.	439.	446.	439.	413.	446.	416.	433.	443.	-
AUG 80 :	410.	474.	439.	457.	447.	408.	448.	423.	445.	433.	-
SEP 80 :	403.	473.	436.	456.	447.	418.	457.	418.	435.	429.	-
OCT 80 :	410.	482.	443.	461.	451.	426.	456.	429.	445.	428.	-
NOV 80 :	407.	467.	429.	447.	439.	411.	440.	415.	431.	436.	-
DEC 80 :	403.	474.	433.	451.	442.	417.	443.	418.	430.	438.	-
JAN 81 :	406.	464.	438.	450.	442.	-	437.	411.	436.	428.	-
FEB 81 :	402.	467.	422.	445.	440.	-	451.	412.	423.	431.	470.
MAR 81 :	403.	476.	438.	447.	440.	-	454.	415.	432.	428.	469.
MEAN :	406.7	470.3	437.2	451.2	445.2	413.9	447.3	417.1	435.1	433.1	472.7
STD.DEV. :	3.0	5.7	7.0	4.7	5.5	6.9	6.2	4.8	6.0	5.0	5.5
MIN :	402.	462.	422.	445.	439.	406.	437.	411.	423.	427.	469.
MAX :	410.	482.	452.	461.	457.	426.	457.	429.	445.	443.	479.

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: GCBPD 50% OFF (DEG C) MODIFIED ASTM D2887 LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	421.	-	447.	462.	457.	418.	467.	434.	454.	440.	496.
APR 80	420.	477.	451.	461.	457.	422.	459.	427.	450.	452.	-
MAY 80	422.	470.	450.	462.	461.	417.	458.	434.	450.	454.	-
JUN 80	423.	478.	461.	460.	467.	435.	461.	431.	453.	448.	-
JUL 80	421.	475.	451.	456.	449.	425.	462.	430.	448.	458.	-
AUG 80	423.	482.	451.	462.	458.	419.	463.	438.	462.	446.	-
SEP 80	417.	483.	448.	467.	458.	431.	474.	431.	450.	440.	-
OCT 80	424.	492.	455.	471.	462.	439.	473.	444.	461.	440.	-
NOV 80	422.	477.	440.	456.	449.	422.	455.	428.	446.	449.	-
DEC 80	417.	483.	444.	461.	453.	430.	459.	431.	445.	450.	-
JAN 81	420.	473.	448.	460.	453.	-	454.	424.	451.	440.	-
FEB 81	414.	476.	432.	454.	450.	-	466.	424.	437.	444.	485.
MAR 81	416.	486.	449.	455.	450.	-	471.	428.	447.	442.	485.
MEAN	420.0	479.3	448.2	460.5	455.7	425.8	463.2	431.1	450.3	446.4	488.7
STD.DEV.	3.1	6.1	7.0	4.8	5.6	7.6	6.6	5.5	6.5	6.0	6.4
MIN	414.	470.	432.	454.	449.	417.	454.	424.	437.	440.	485.
MAX	424.	492.	461.	471.	467.	439.	474.	444.	462.	458.	496.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: GCEPD 60% OFF (DEG C) MODIFIED ASTM D2887 LABORATORY: L

DATE	VIRGIN BASESTOCK A	B	C	D	REF I	RE-REFINED BASESTOCKS E	F	G	H	J	K
MAR 80	434.	-	457.	472.	467.	430.	484.	447.	470.	454.	512.
APR 80	433.	487.	462.	471.	468.	433.	476.	441.	465.	466.	-
MAY 80	436.	478.	462.	471.	471.	428.	474.	449.	466.	469.	-
JUN 80	437.	487.	471.	471.	477.	445.	477.	447.	469.	463.	-
JUL 80	435.	482.	462.	465.	459.	437.	480.	443.	463.	474.	-
AUG 80	436.	491.	462.	472.	468.	431.	480.	453.	479.	460.	-
SEP 80	431.	492.	458.	478.	468.	445.	491.	445.	466.	452.	-
OCT 80	439.	502.	466.	482.	473.	453.	491.	459.	479.	452.	-
NOV 80	437.	487.	451.	465.	458.	435.	472.	440.	461.	462.	-
DEC 80	431.	492.	453.	470.	463.	442.	476.	443.	461.	463.	-
JAN 81	433.	481.	457.	469.	463.	-	471.	438.	467.	454.	-
FEB 81	427.	486.	441.	463.	460.	-	481.	436.	452.	457.	500.
MAR 81	430.	497.	460.	464.	460.	-	487.	442.	462.	455.	499.
MEAN	433.8	488.5	458.6	470.2	465.8	437.9	480.0	444.8	466.2	460.1	503.7
STD.DEV.	3.4	6.8	7.4	5.4	5.9	8.1	6.6	6.3	7.3	6.9	7.2
MIN	427.	478.	441.	463.	458.	428.	471.	436.	452.	452.	499.
MAX	439.	502.	471.	482.	477.	453.	491.	459.	479.	474.	512.

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: GCBFD 70% OFF (DEG C) MODIFIED ASTM D2887 LABORATORY: L

DATE	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
	A	B	C	D	I	E	F	G	H	J	K
MAR 80	447.	-	467.	483.	478.	442.	504.	462.	487.	468.	529.
APR 80	446.	498.	472.	482.	479.	445.	496.	456.	482.	481.	-
MAY 80	450.	486.	470.	482.	482.	440.	493.	463.	484.	486.	-
JUN 80	450.	496.	479.	481.	487.	458.	496.	463.	489.	476.	-
JUL 80	449.	491.	472.	475.	469.	450.	501.	458.	481.	490.	-
AUG 80	450.	500.	471.	483.	478.	443.	499.	469.	498.	474.	-
SEP 80	445.	502.	469.	489.	478.	459.	510.	459.	483.	465.	-
OCT 80	453.	512.	476.	495.	483.	467.	510.	475.	497.	465.	-
NOV 80	453.	497.	462.	475.	469.	448.	492.	454.	480.	477.	-
DEC 80	447.	502.	462.	479.	474.	456.	497.	456.	479.	477.	-
JAN 81	448.	490.	466.	478.	474.	-	491.	452.	484.	468.	-
FEB 81	441.	496.	451.	473.	470.	-	498.	450.	468.	471.	516.
MAR 81	444.	510.	472.	474.	470.	-	508.	455.	480.	470.	514.
MEAN	447.9	498.3	468.4	480.7	476.2	450.8	499.6	459.4	484.0	474.5	519.7
STD.DEV.	3.5	7.6	7.1	6.2	5.8	8.9	6.6	7.0	7.8	7.8	8.1
MIN	441.	486.	451.	473.	469.	440.	491.	450.	468.	465.	514.
MAX	453.	512.	479.	495.	487.	467.	510.	475.	498.	490.	529.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: GCEPD 80% OFF (DEG C) MODIFIED ASTM D2887 LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	462.	-	478.	495.	490.	456.	531.	478.	508.	484.	551.
APR 80	460.	510.	484.	494.	492.	458.	520.	472.	504.	499.	-
MAY 80	465.	494.	480.	492.	493.	454.	517.	480.	508.	506.	-
JUN 80	464.	507.	488.	494.	498.	471.	521.	481.	513.	494.	-
JUL 80	463.	500.	483.	486.	480.	465.	528.	476.	505.	509.	-
AUG 80	465.	510.	481.	495.	489.	458.	524.	487.	521.	489.	-
SEP 80	460.	514.	479.	502.	489.	475.	533.	475.	505.	481.	-
OCT 80	469.	525.	488.	510.	495.	482.	537.	491.	521.	479.	-
NOV 80	472.	508.	473.	487.	480.	464.	519.	469.	506.	494.	-
DEC 80	462.	512.	472.	490.	485.	472.	526.	470.	503.	494.	-
JAN 81	463.	500.	475.	489.	486.	-	517.	469.	508.	486.	-
FEB 81	457.	508.	462.	485.	482.	-	521.	467.	491.	488.	535.
MAR 81	460.	530.	489.	486.	482.	-	535.	471.	504.	487.	533.
MEAN	463.2	509.8	479.4	492.7	487.8	465.5	525.3	475.8	507.5	491.5	539.7
STD.DEV.	4.0	10.1	7.6	7.1	5.8	9.3	6.9	7.3	7.8	9.1	9.9
MIN	457.	494.	462.	485.	480.	454.	517.	467.	491.	479.	533.
MAX	472.	530.	489.	510.	498.	482.	537.	491.	521.	509.	551.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: GCEPD 90% OFF (DEG C) MODIFIED ASTM D2887

LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	480.	-	493.	513.	506.	474.	572.	500.	542.	504.	575.
APR 80	477.	532.	501.	512.	511.	476.	561.	492.	539.	522.	-
MAY 80	482.	505.	493.	509.	509.	472.	555.	503.	546.	538.	-
JUN 80	482.	522.	500.	510.	513.	489.	563.	504.	551.	518.	-
JUL 80	481.	512.	498.	501.	494.	485.	569.	502.	548.	539.	-
AUG 80	482.	524.	494.	513.	504.	477.	573.	513.	565.	510.	-
SEP 80	478.	531.	493.	519.	504.	497.	574.	497.	544.	502.	-
OCT 80	487.	548.	503.	532.	513.	504.	575.	515.	580.	499.	-
NOV 80	506.	524.	487.	503.	495.	484.	567.	491.	555.	519.	-
DEC 80	481.	528.	485.	505.	501.	494.	575.	490.	546.	520.	-
JAN 81	483.	512.	488.	505.	503.	-	573.	491.	551.	510.	-
FEB 81	477.	526.	475.	503.	498.	-	558.	492.	528.	513.	575.
MAR 81	478.	575.	575.	504.	498.	-	575.	494.	551.	511.	564.
MEAN	482.6	528.3	498.8	509.9	503.8	485.2	568.5	498.8	549.7	515.8	571.3
STD.DEV.	7.6	18.5	24.1	8.4	6.5	10.7	7.0	8.4	12.6	12.3	6.4
MIN	477.	505.	475.	501.	495.	472.	555.	490.	528.	499.	564.
MAX	506.	575.	575.	532.	513.	504.	575.	515.	580.	539.	575.

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: GCEPD 95% OFF (DEG C) MODIFIED ASTM D2887 LABORATORY: L

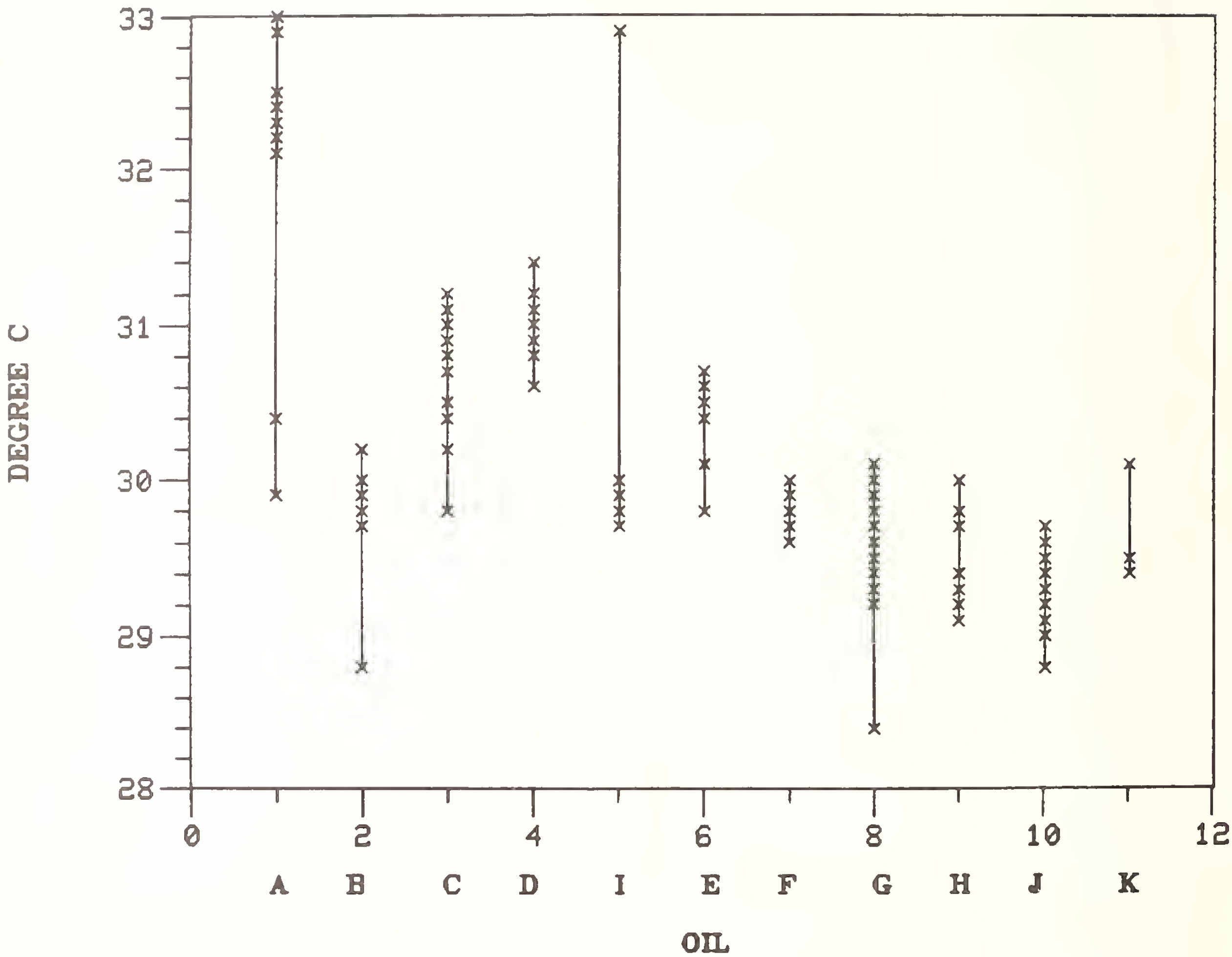
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	492.	-	507.	527.	522.	488.	575.	519.	571.	521.	575.
APR 80	488.	550.	517.	527.	527.	488.	575.	509.	567.	541.	-
MAY 80	493.	513.	503.	520.	520.	485.	575.	527.	574.	576.	-
JUN 80	494.	536.	508.	524.	525.	503.	575.	524.	575.	537.	-
JUL 80	513.	520.	510.	511.	503.	503.	575.	526.	575.	575.	-
AUG 80	494.	535.	504.	526.	515.	492.	575.	538.	575.	526.	-
SEP 80	489.	547.	503.	533.	516.	514.	575.	516.	575.	521.	-
OCT 80	500.	569.	517.	550.	528.	522.	575.	532.	575.	514.	-
NOV 80	575.	539.	498.	517.	506.	501.	575.	508.	575.	541.	-
DEC 80	495.	542.	495.	516.	516.	512.	575.	508.	575.	546.	-
JAN 81	496.	523.	497.	517.	518.	-	575.	510.	575.	532.	-
FEB 81	493.	545.	485.	517.	512.	-	575.	513.	587.	533.	575.
MAR 81	491.	575.	575.	521.	512.	-	575.	515.	575.	532.	575.
MEAN	501.0	541.2	509.2	523.5	516.9	500.8	575.0	518.8	574.9	538.1	575.0
STD.DEV.	23.1	18.3	21.6	9.9	7.6	12.5	-	9.8	4.3	18.9	-
MIN	488.	513.	485.	511.	503.	485.	575.	508.	567.	514.	575.
MAX	575.	575.	575.	550.	528.	522.	575.	538.	587.	576.	575.

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

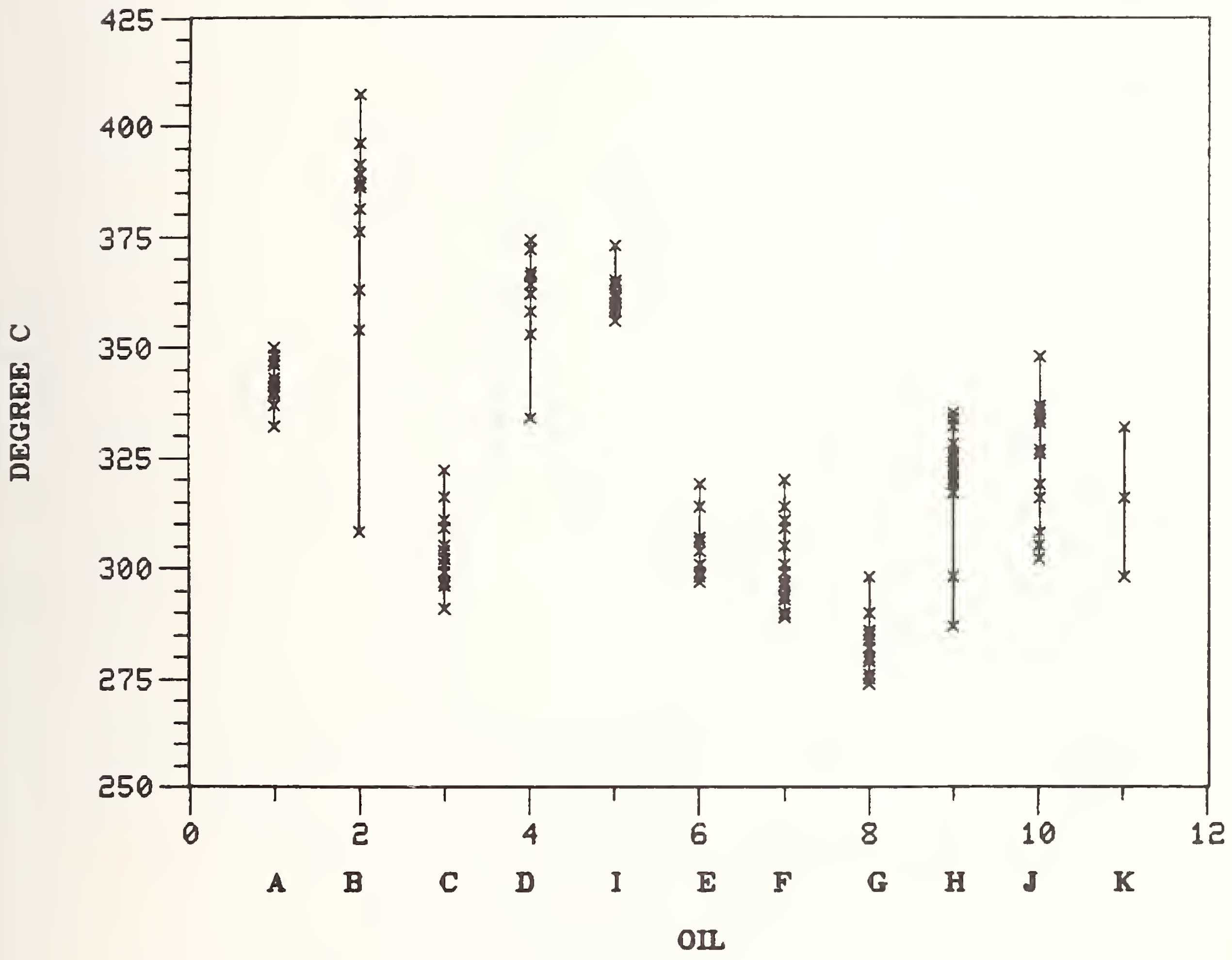
TEST: GCBFD RESIDUE AT 575 C (WT%) MODIFIED ASTM D2887 LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	-1.	-	0.	-1.	1.	-2.	9.	1.	4.	-2.	11.
APR 80	-1.	1.	0.	0.	0.	-2.	8.	-1.	3.	1.	-
MAY 80	-4.	-3.	0.	-2.	-3.	-2.	6.	3.	5.	5.	-
JUN 80	-2.	-1.	-2.	-1.	1.	-1.	9.	0.	6.	0.	-
JUL 80	-2.	-2.	-2.	-3.	-3.	0.	8.	2.	6.	5.	-
AUG 80	-1.	-1.	0.	-1.	-2.	-1.	9.	2.	9.	-2.	-
SEP 80	-2.	0.	-2.	-1.	-2.	0.	9.	0.	6.	0.	-
OCT 80	-2.	3.	-1.	1.	-1.	0.	14.	0.	10.	-1.	-
NOV 80	7.	1.	0.	0.	-1.	-1.	9.	0.	8.	2.	-
DEC 80	-1.	0.	-1.	-2.	0.	0.	10.	1.	7.	3.	-
JAN 81	-1.	0.	-1.	-2.	-1.	-	10.	0.	8.	3.	-
FEB 81	0.	3.	0.	0.	0.	-	8.	1.	3.	-1.	10.
MAR 81	-2.	12.	12.	-1.	-1.	-	12.	1.	8.	0.	9.
MEAN	-.9	1.1	.2	-1.0	-.9	-.9	9.3	.8	6.4	1.0	10.0
STD.DEV.	2.6	3.9	3.6	1.1	1.3	.9	2.0	1.1	2.2	2.4	1.0
MIN	-4.	-3.	-2.	-3.	-3.	-2.	6.	-1.	3.	-2.	9.
MAX	7.	12.	12.	1.	1.	0.	14.	3.	10.	5.	11.

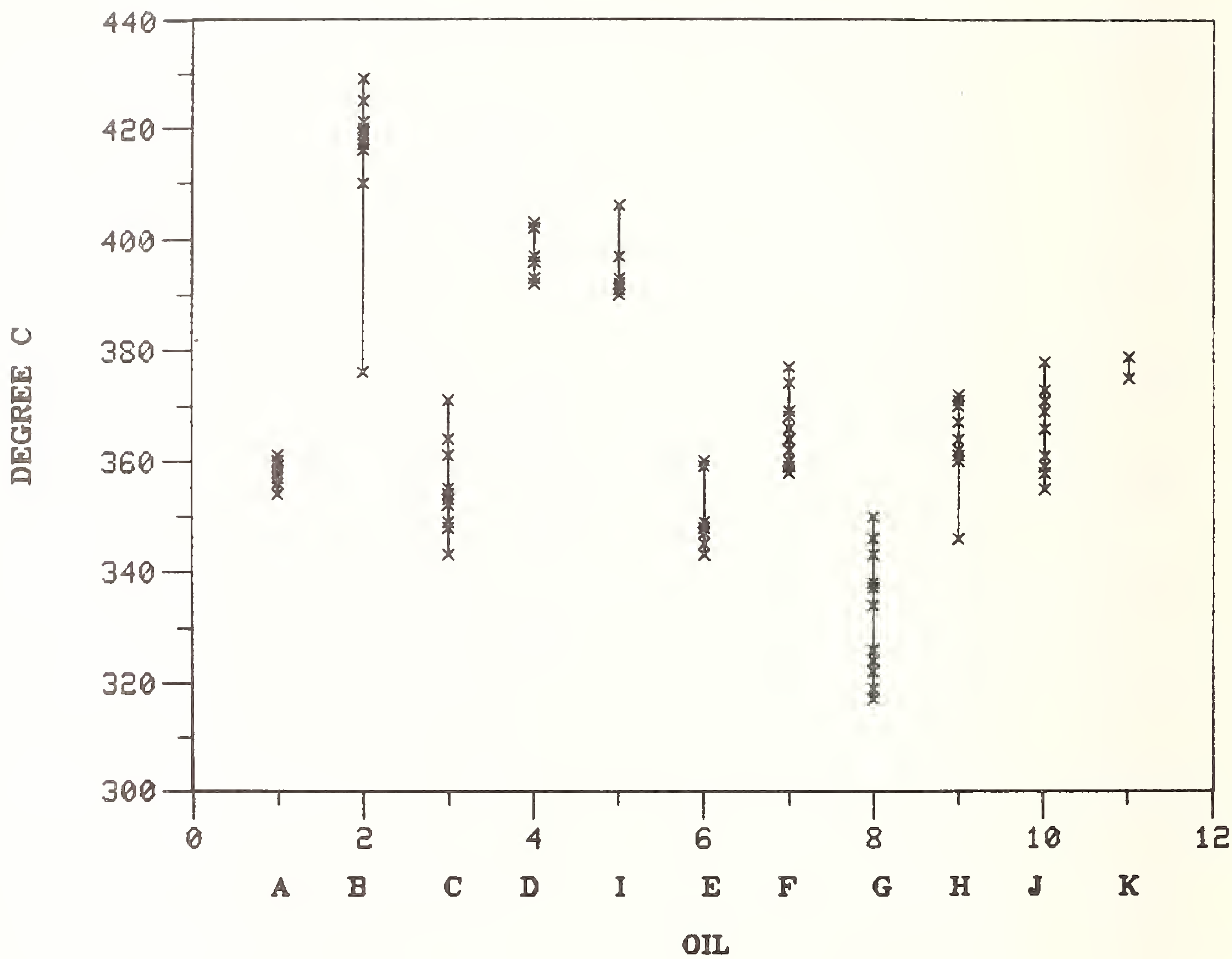
GCBPD 0.5% OFF



GCBPD 1.0% OFF


425
400
375
350
325
300
275
250
DEGREE C
0
2
4
6
8
10
12
A B C D I E F G H J K
OIL

GCBPD 5.0% OFF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400
380
360
340
320
300
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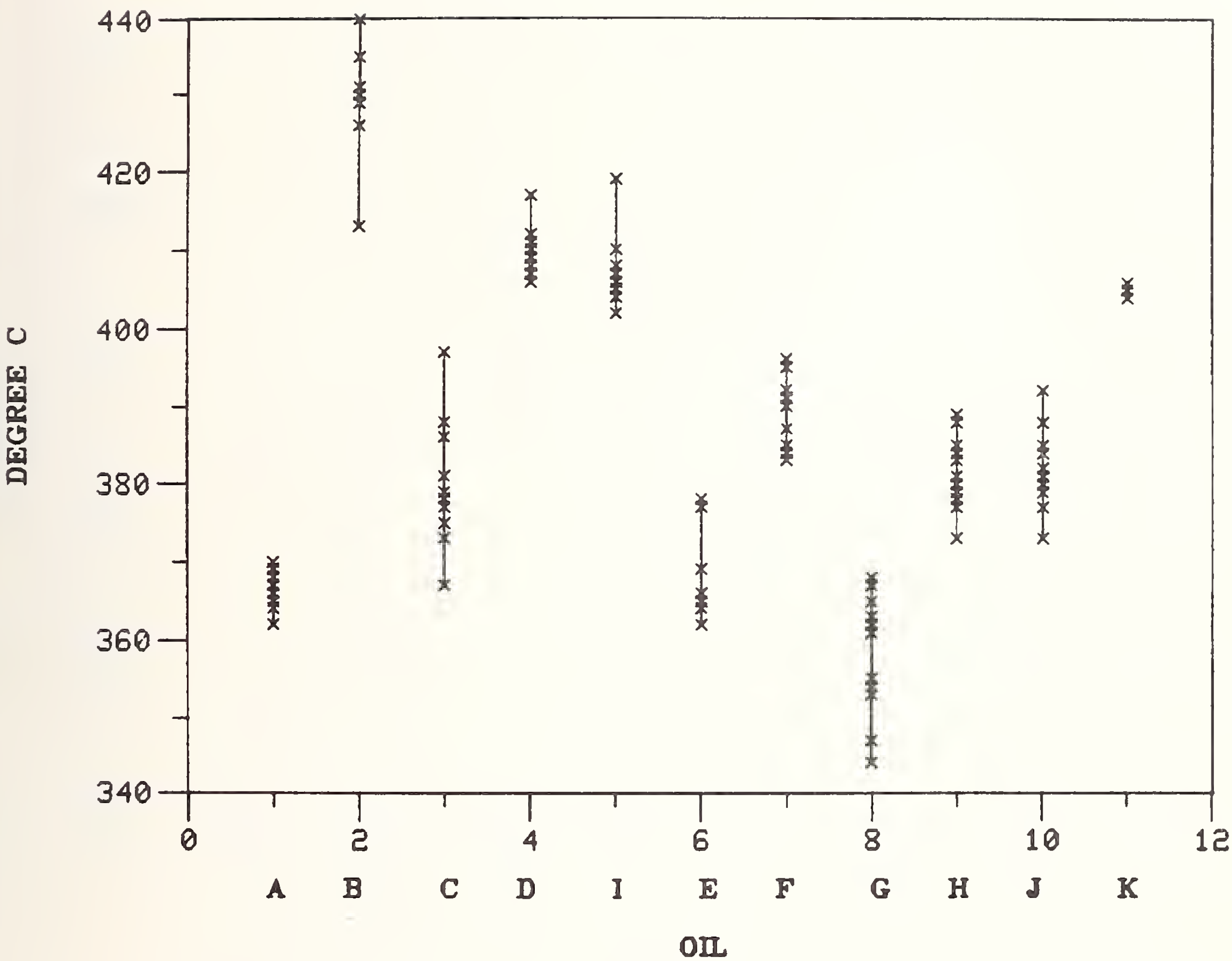
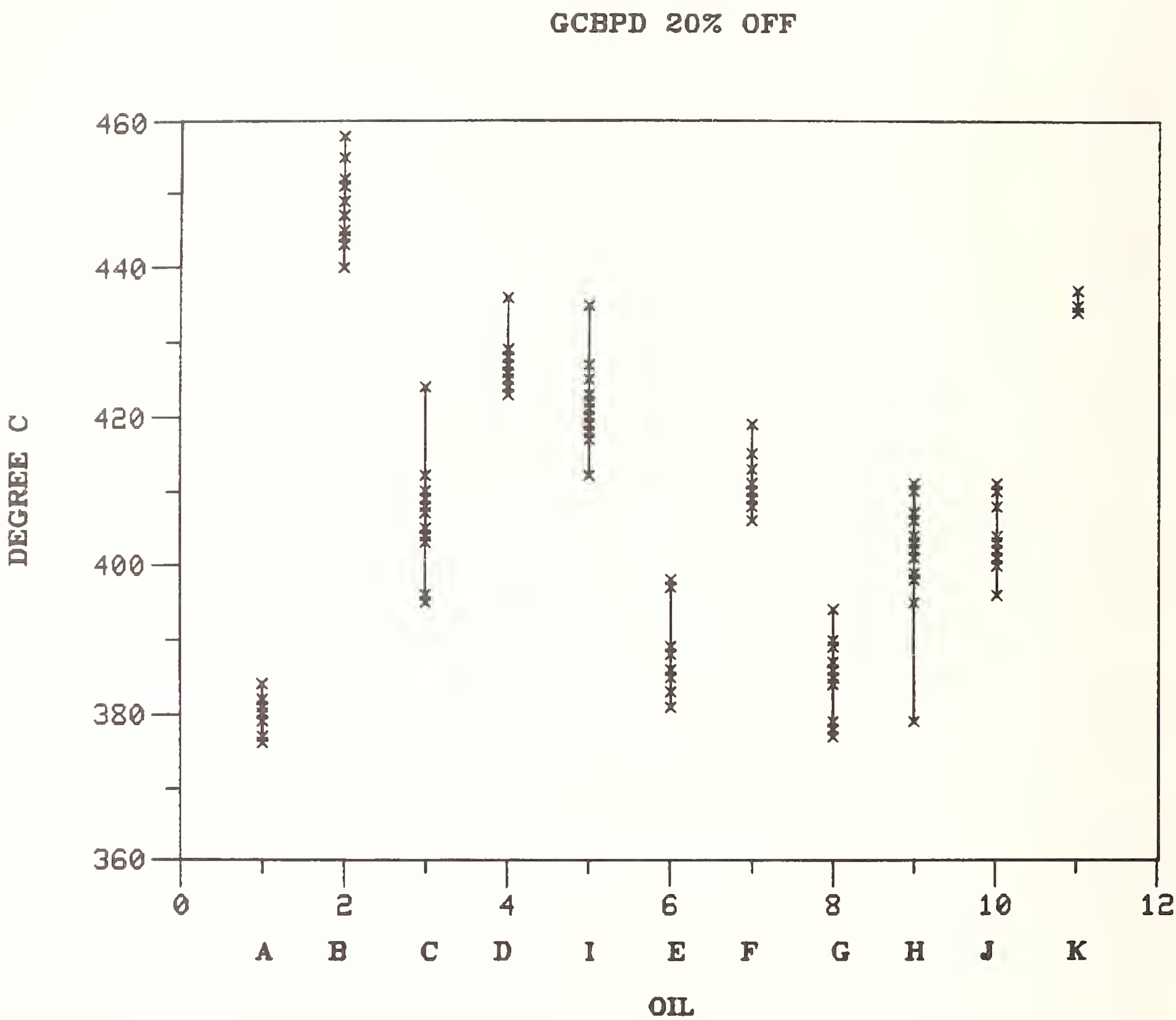
2
4
6
8
10
12
A B C D I E F G H J K
OIL

GCBPD 10% OFF

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360
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A
B
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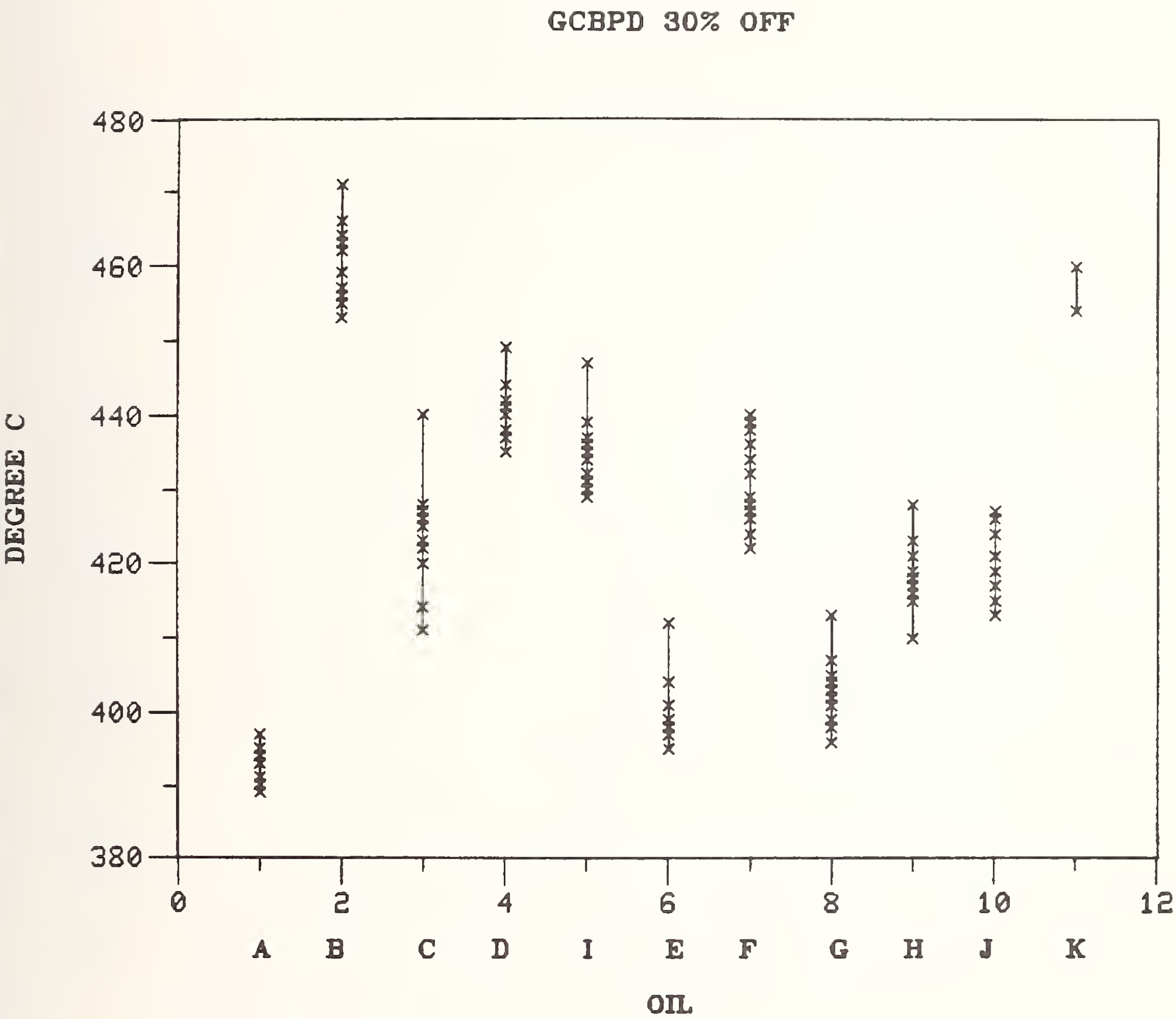
OIL


GCBPD 30% OFF
DEGREE C
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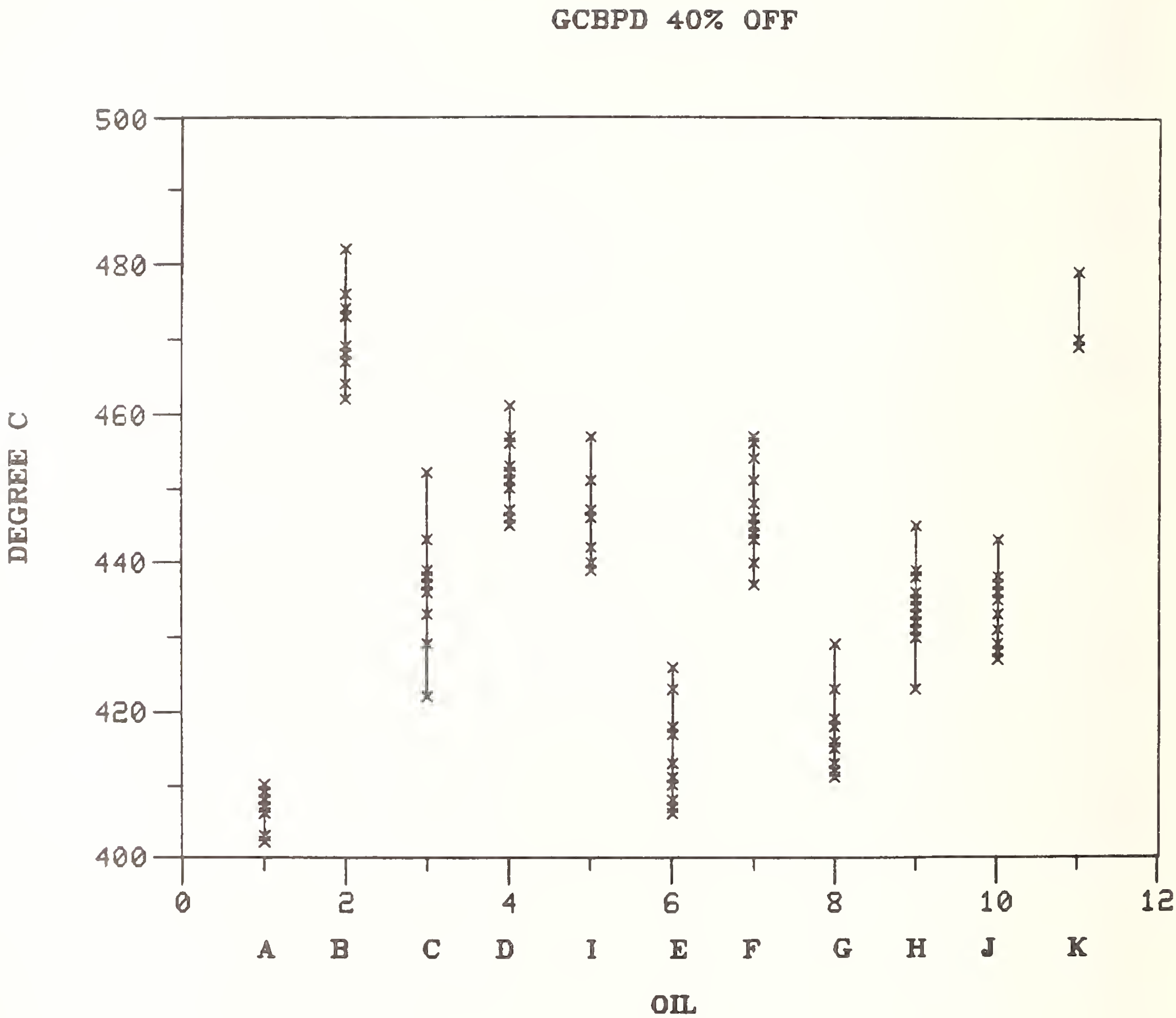
OIL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DEGREE C
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460
440
420
400
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2
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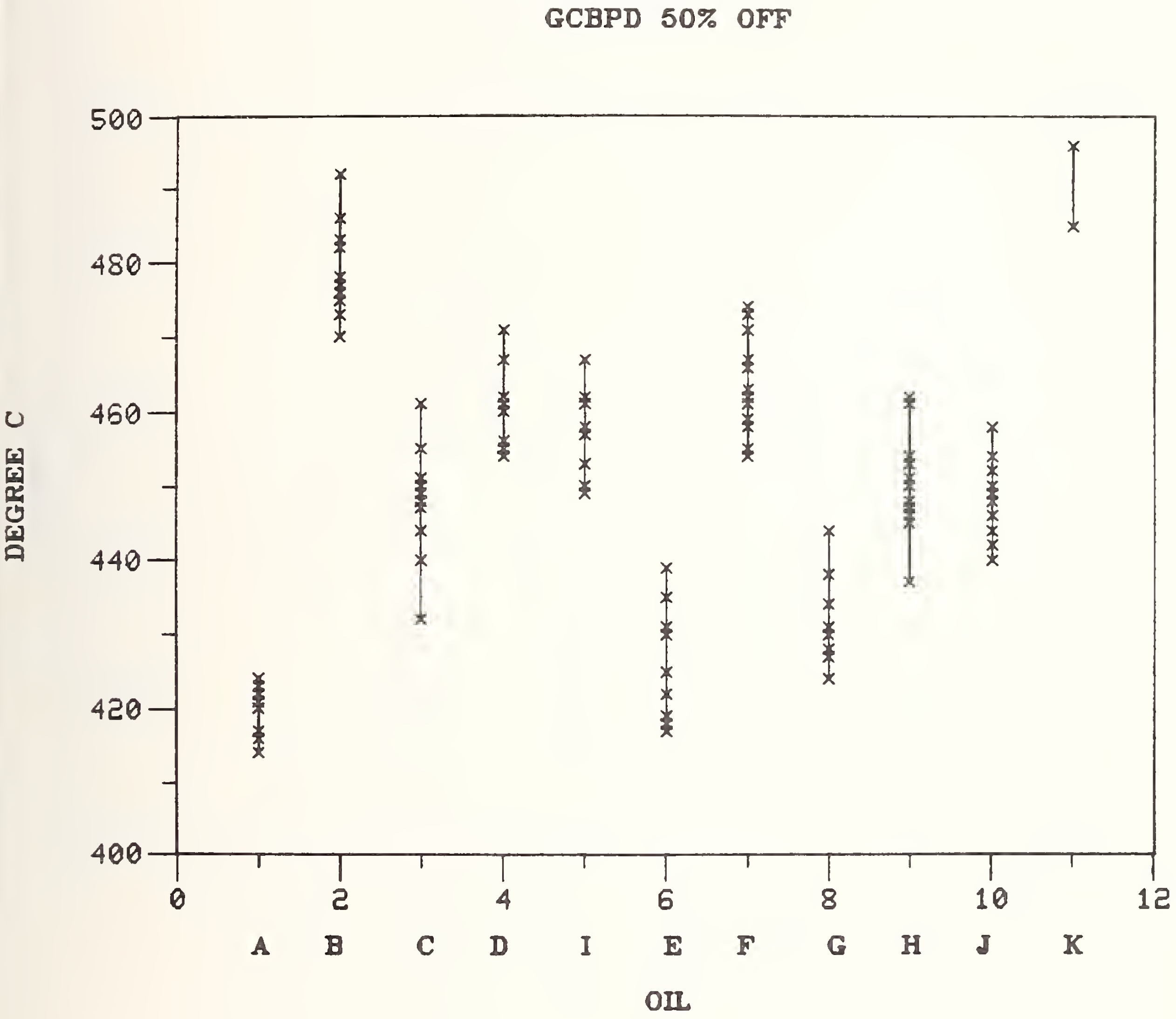
12
A B C D I E F G H J K
OIL


GCBPD 50% OFF
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480
460
440
420
400
DEGREE C
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A
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D
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G
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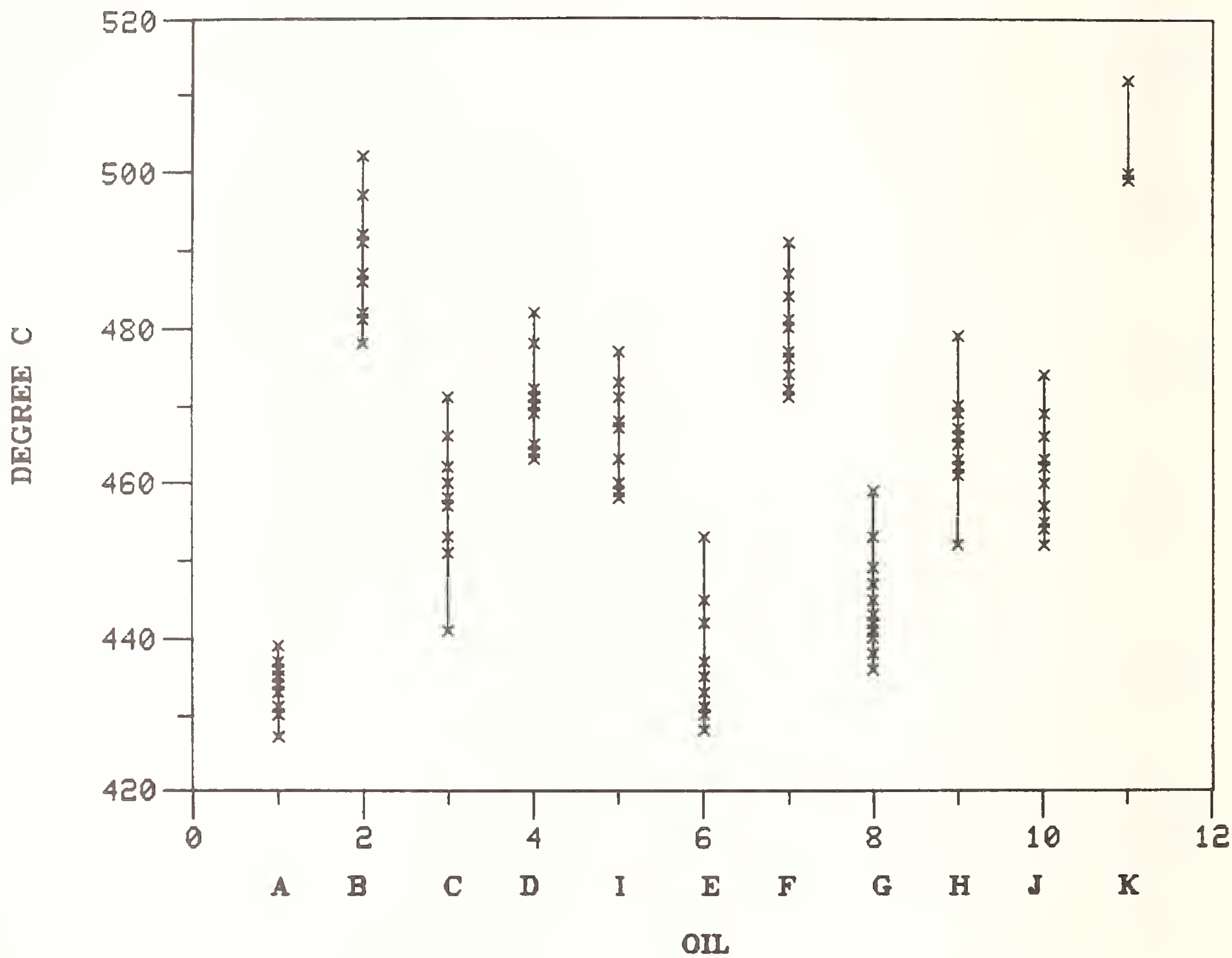
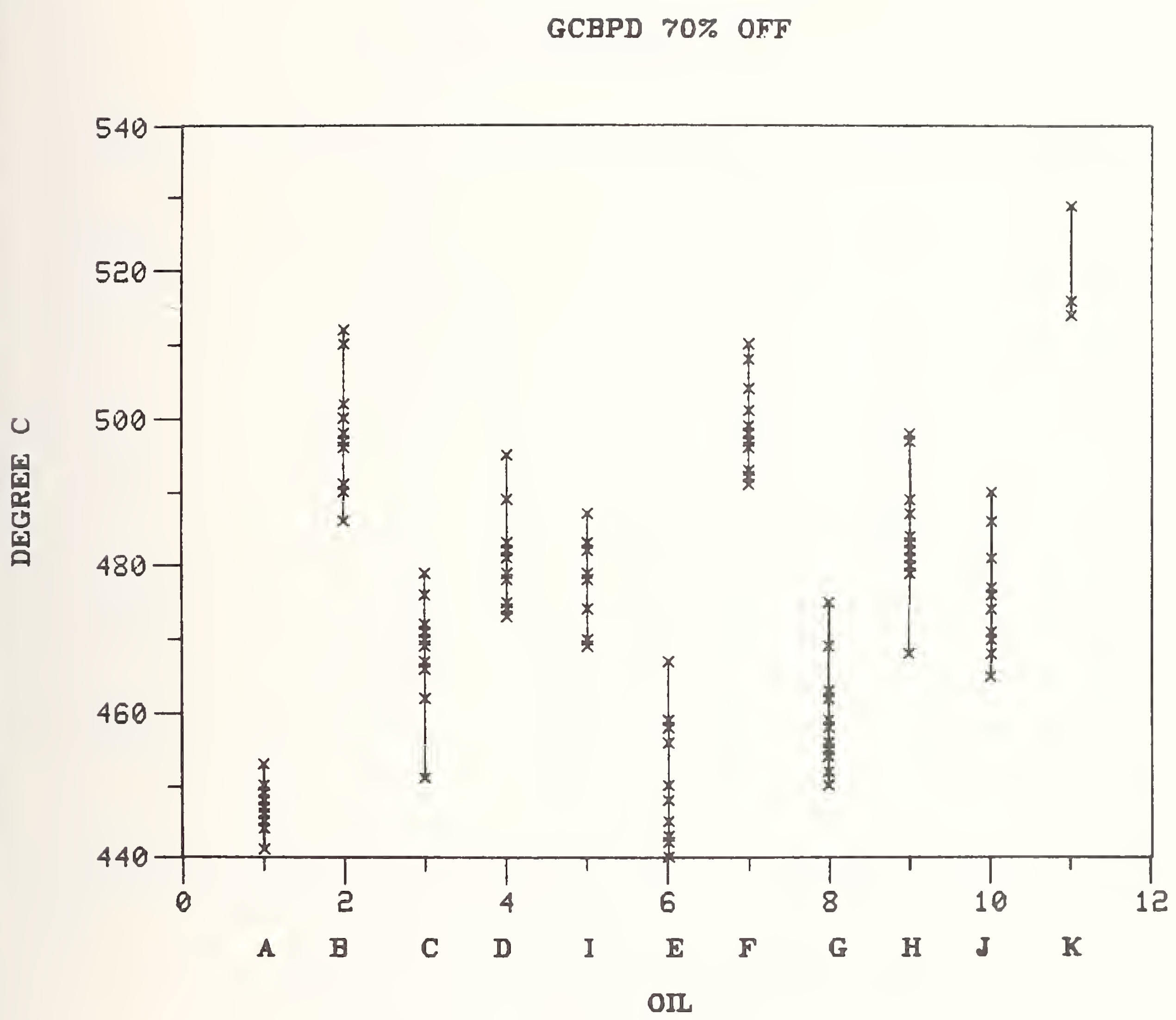
J
K
OIL

GCBPD 60% OFF




GCBPD 70% OFF
540
520
500
480
460
440
DEGREE C
0
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12
A
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D
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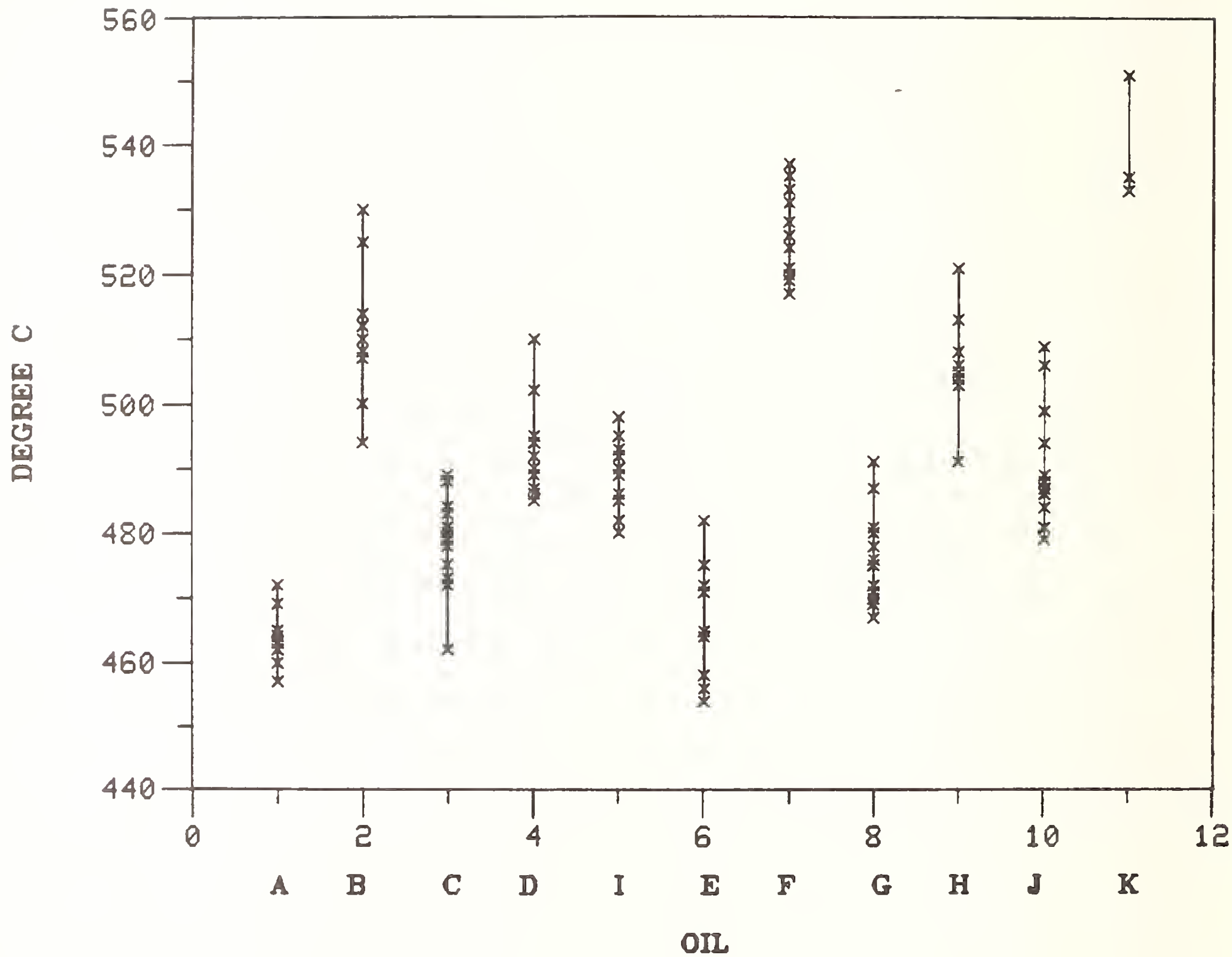
H
J
K
OIL

GCBPD 80% OFF



560
540
520
500
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460
440
DEGREE C
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2
4
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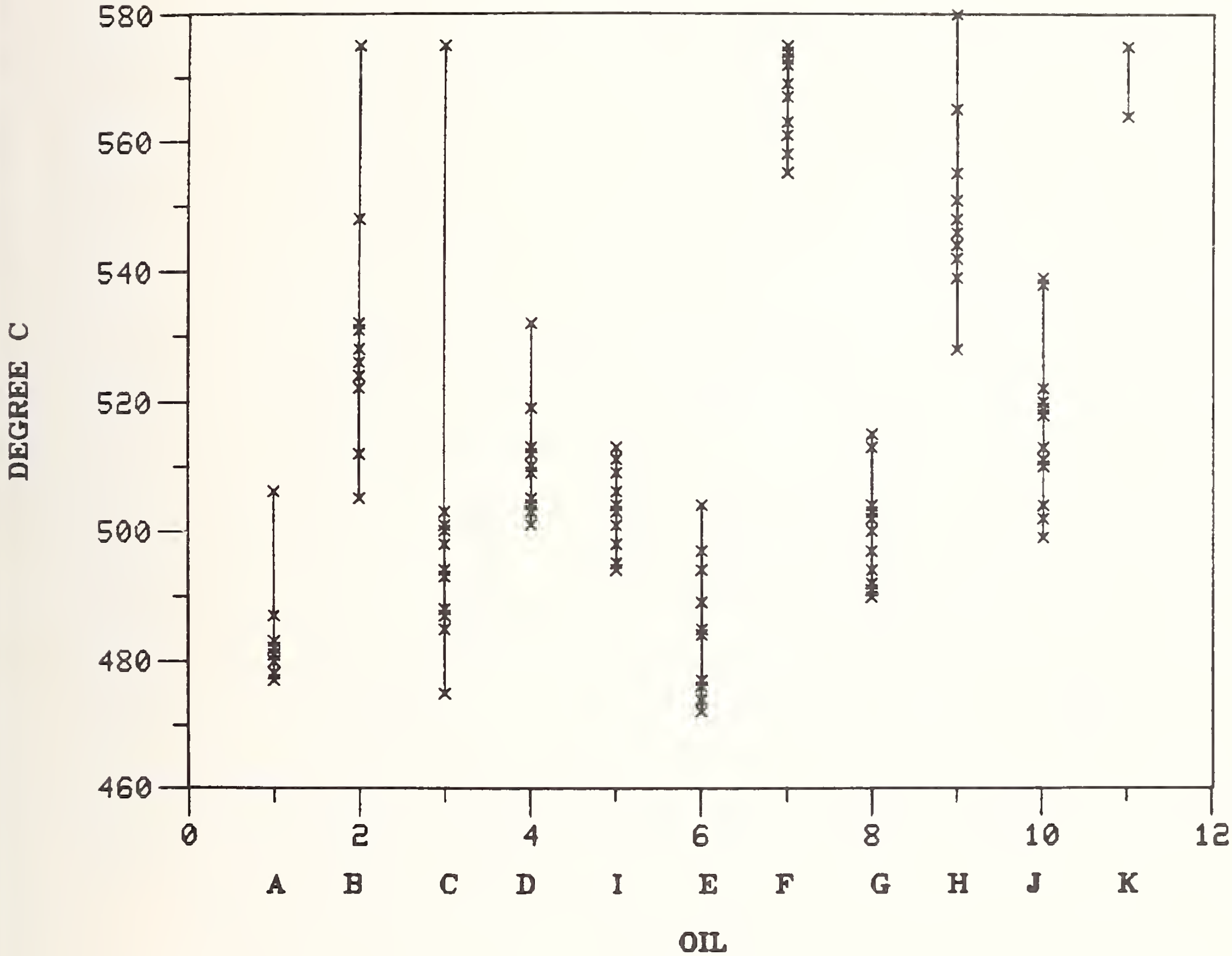
8
10
12
A B C D I E F G H J K
OIL

GCBPD 90% OFF



580
560
540
520
500
480
460
DEGREE C
0
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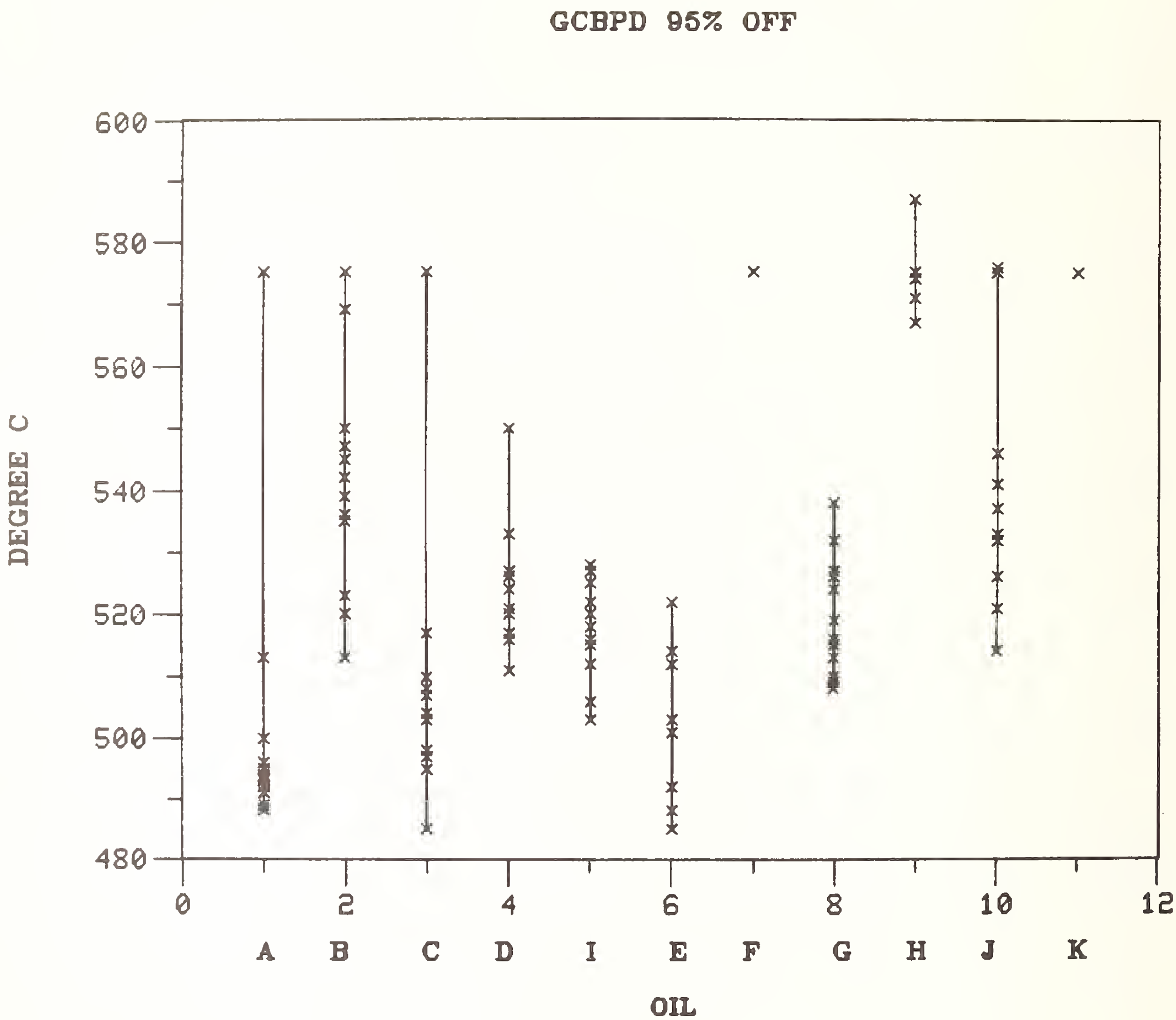
12
A
B
C
D
I
E
F
G
H
J
K
OIL



GCBPD 95% OFF
600
580
560
540
520
500
480
DEGREE C
0
2
4
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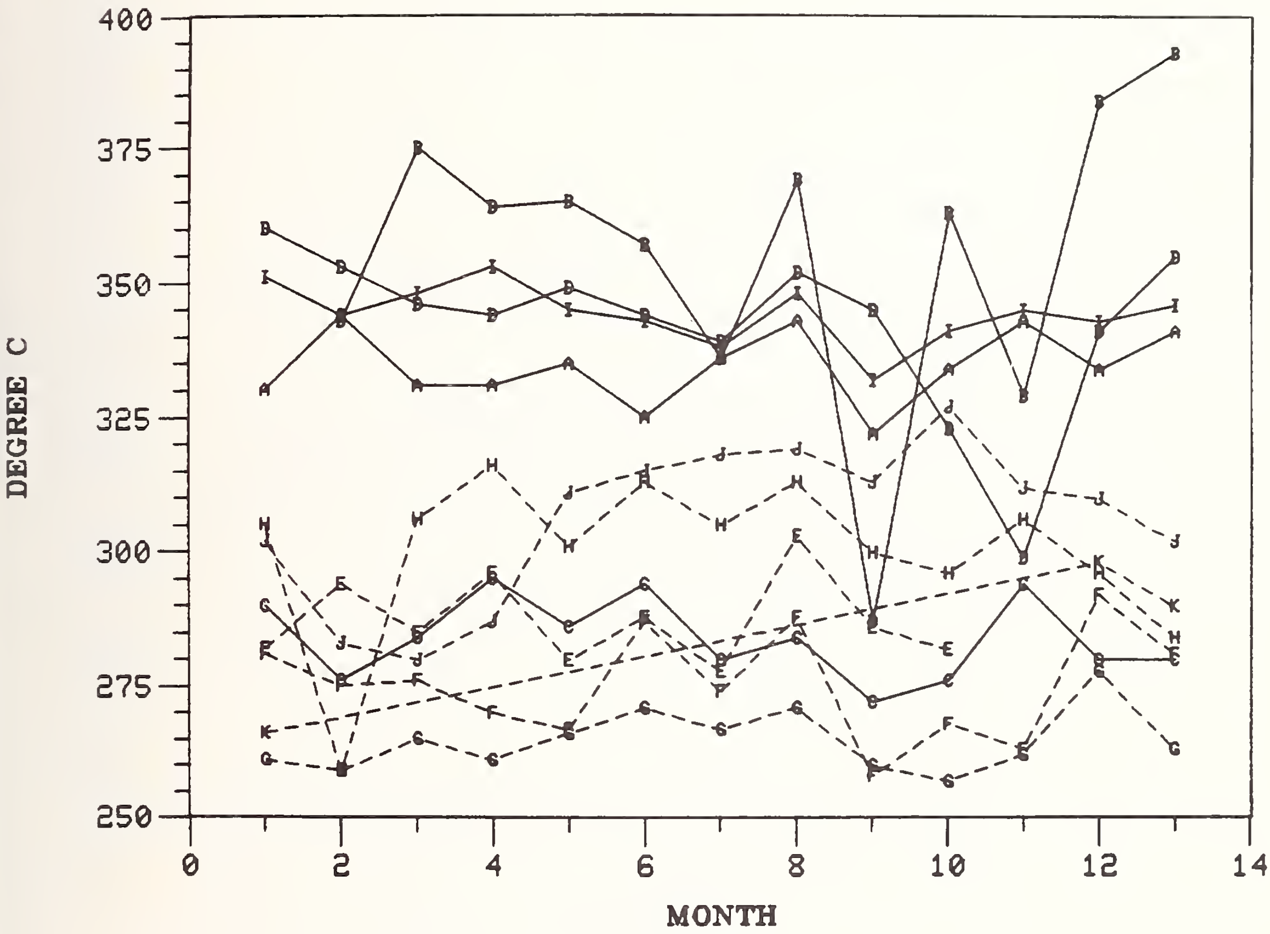
8
10
12
A
B
C
D
I
E
F
G
H
J
K
OIL

GCBPD 0.5% OFF



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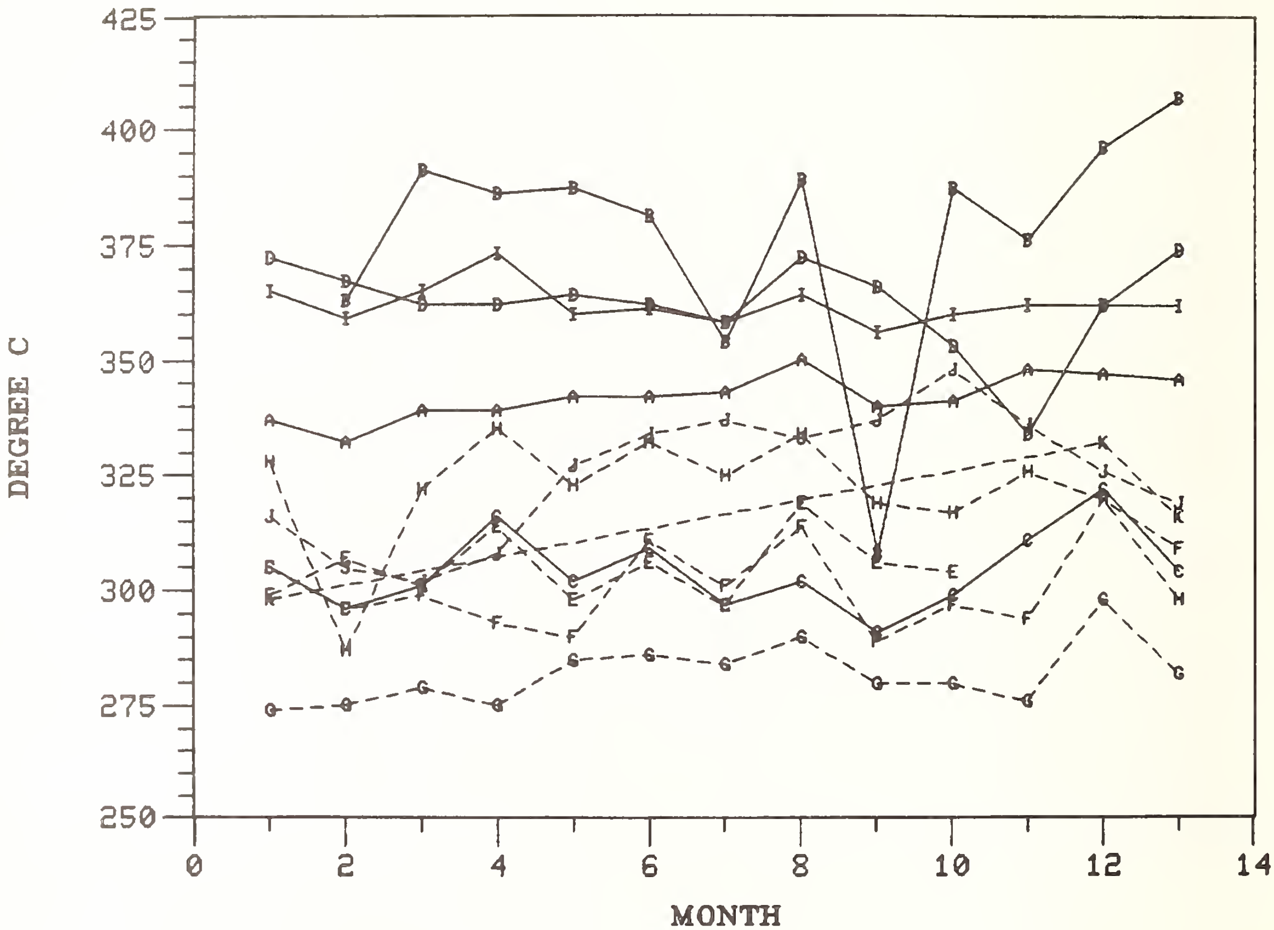
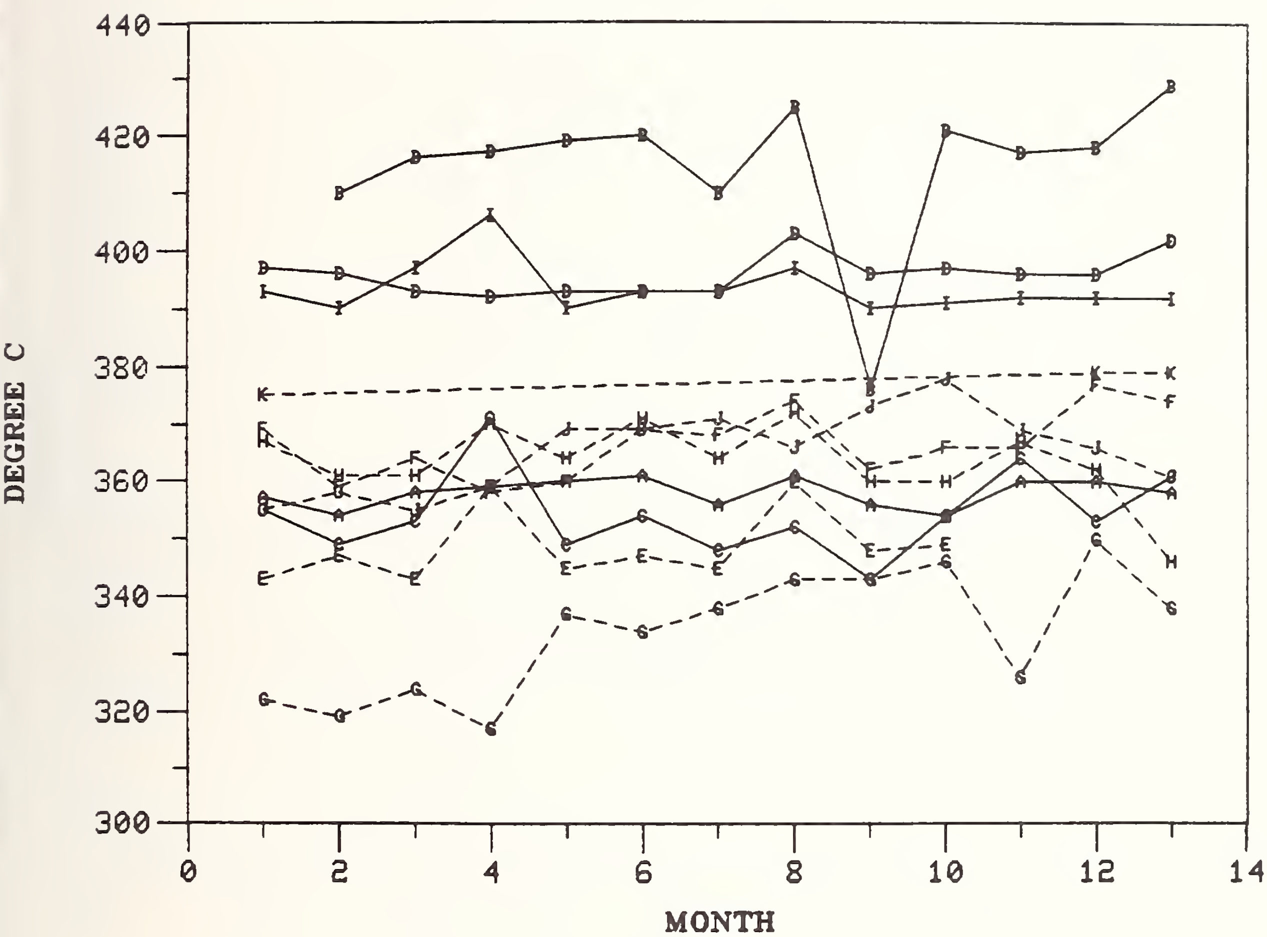


GCBPD 5.0% OFF



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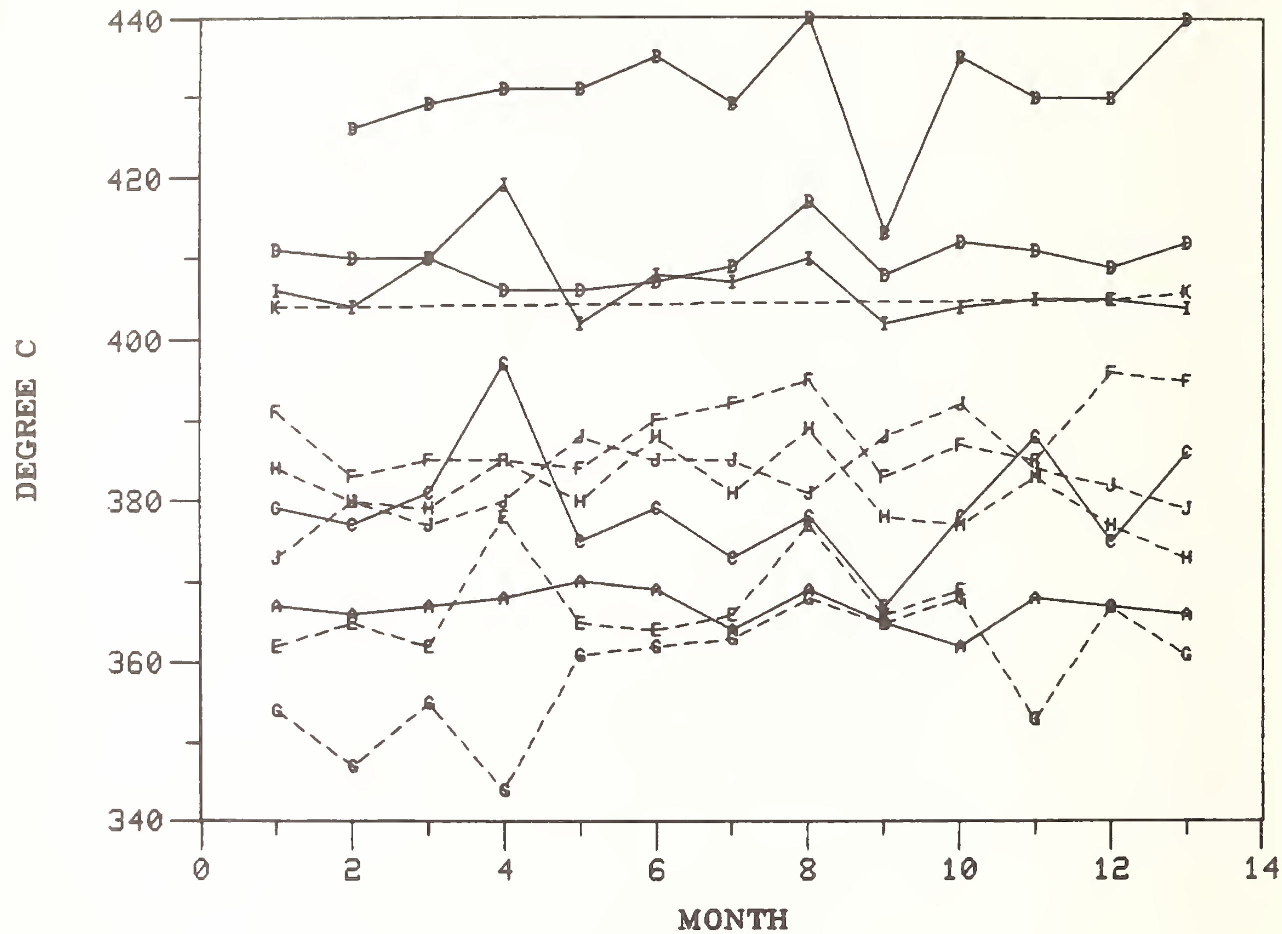

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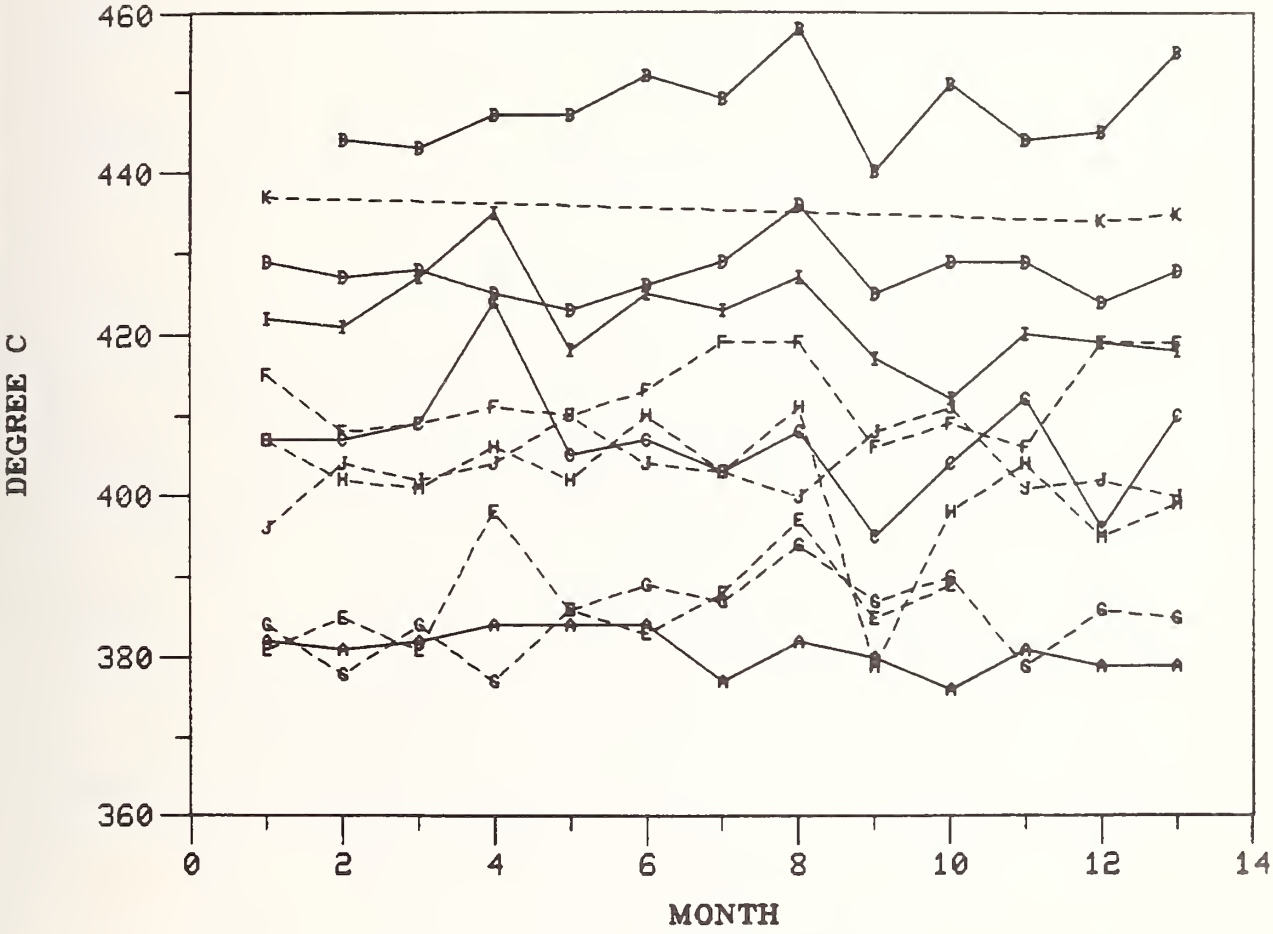
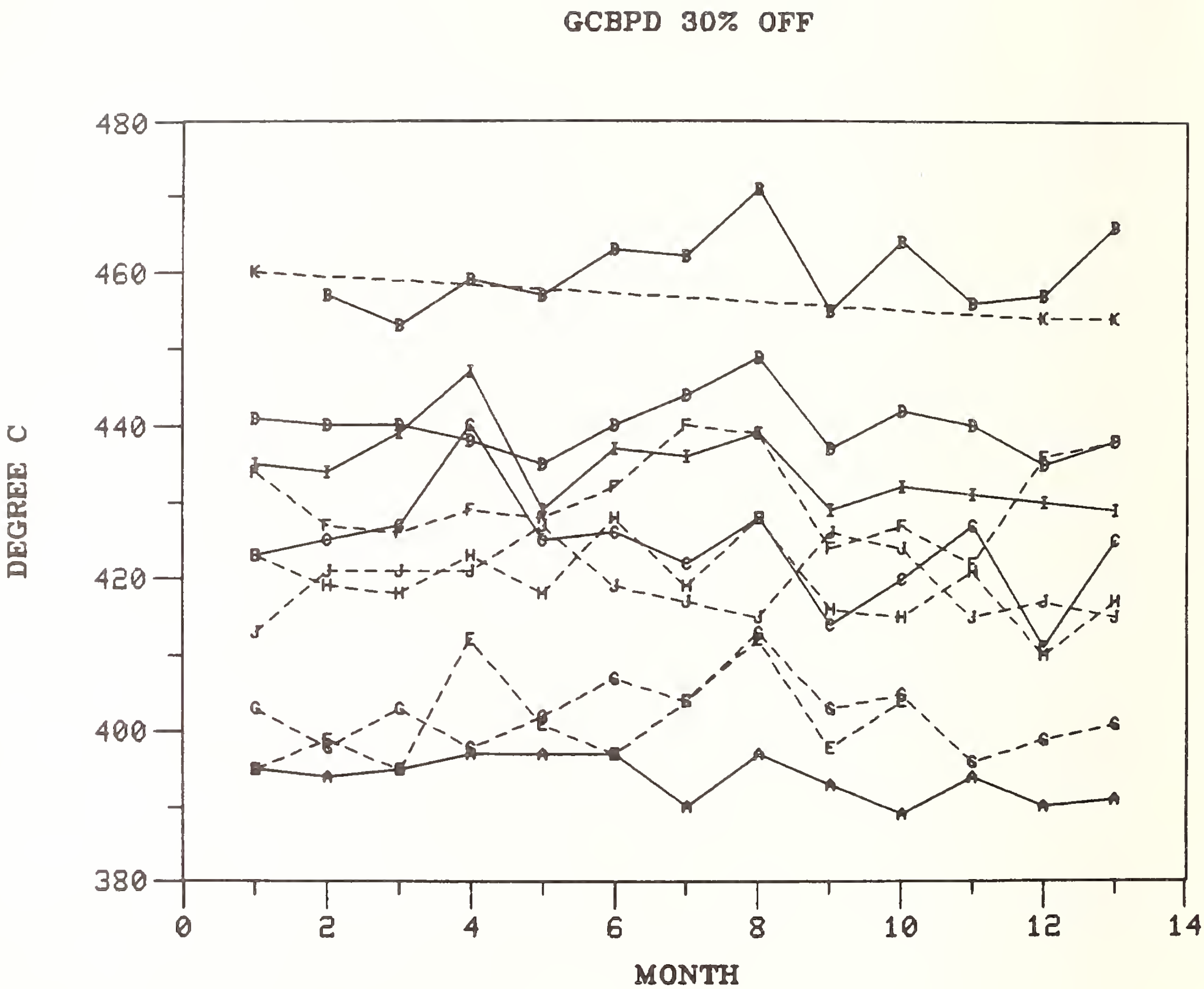
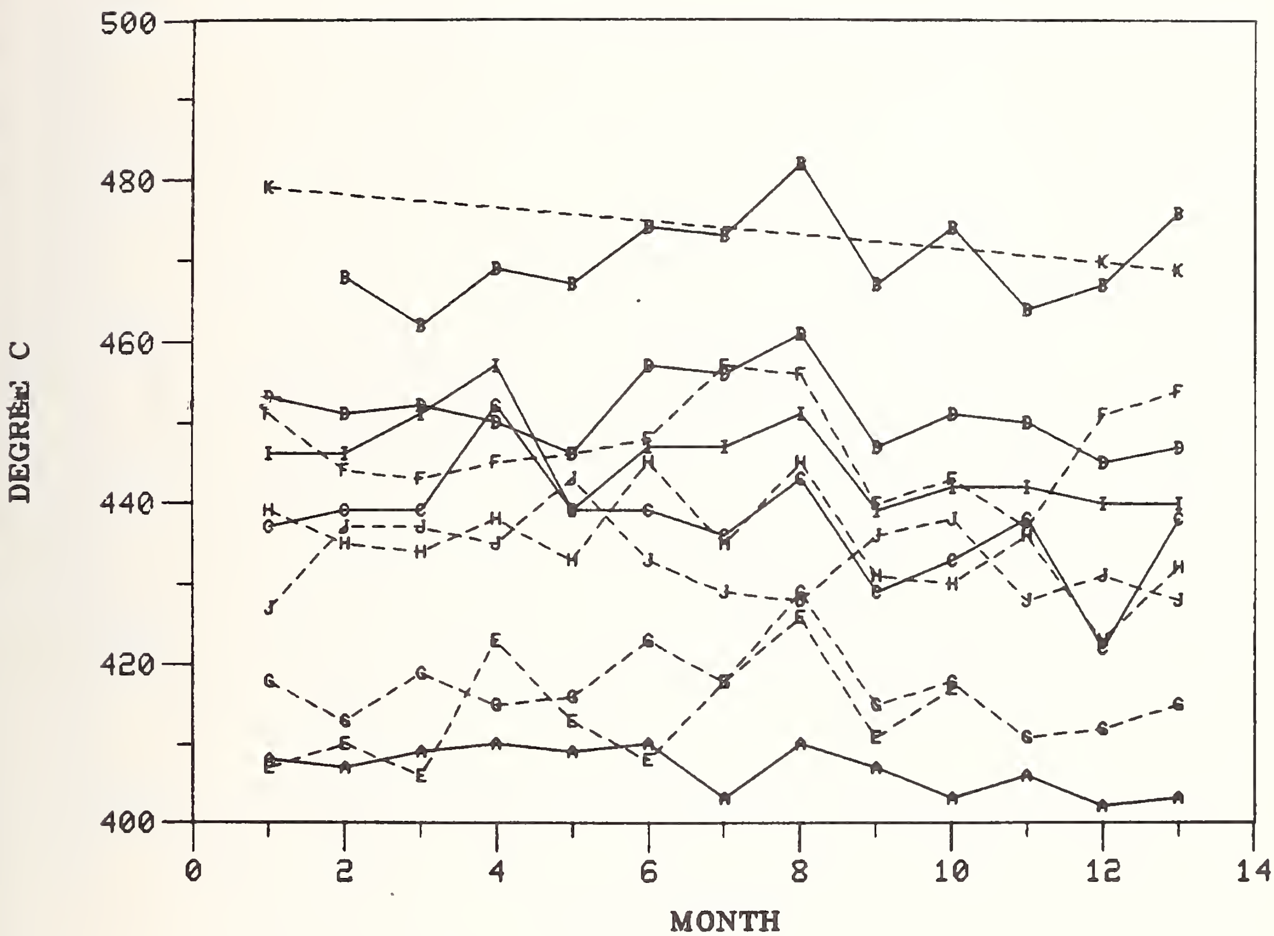
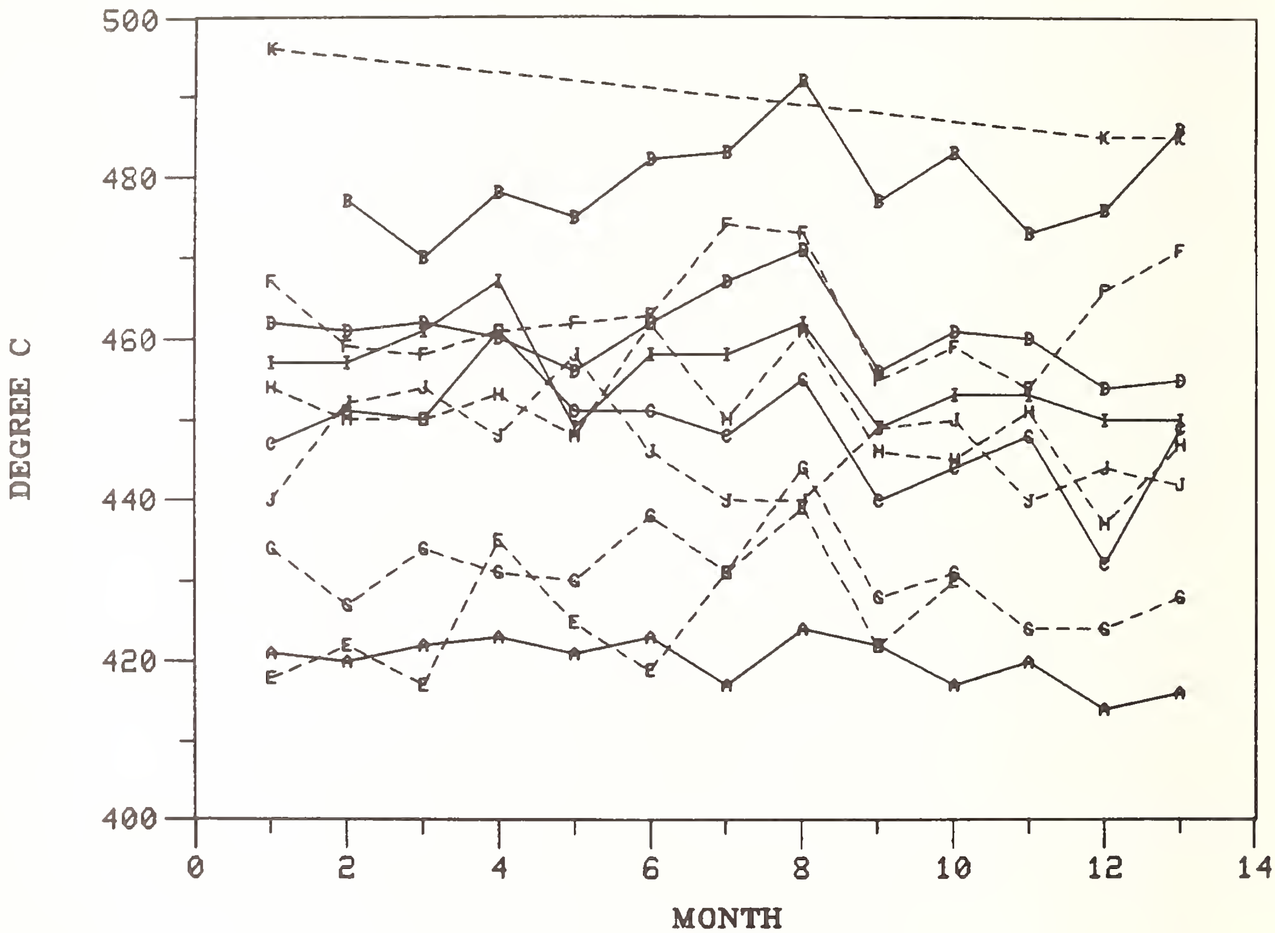



GCBPD 30% OFF
480
460
440
420
400
380
DEGREE C
0
2
4
6
8
10
12
14
MONTH

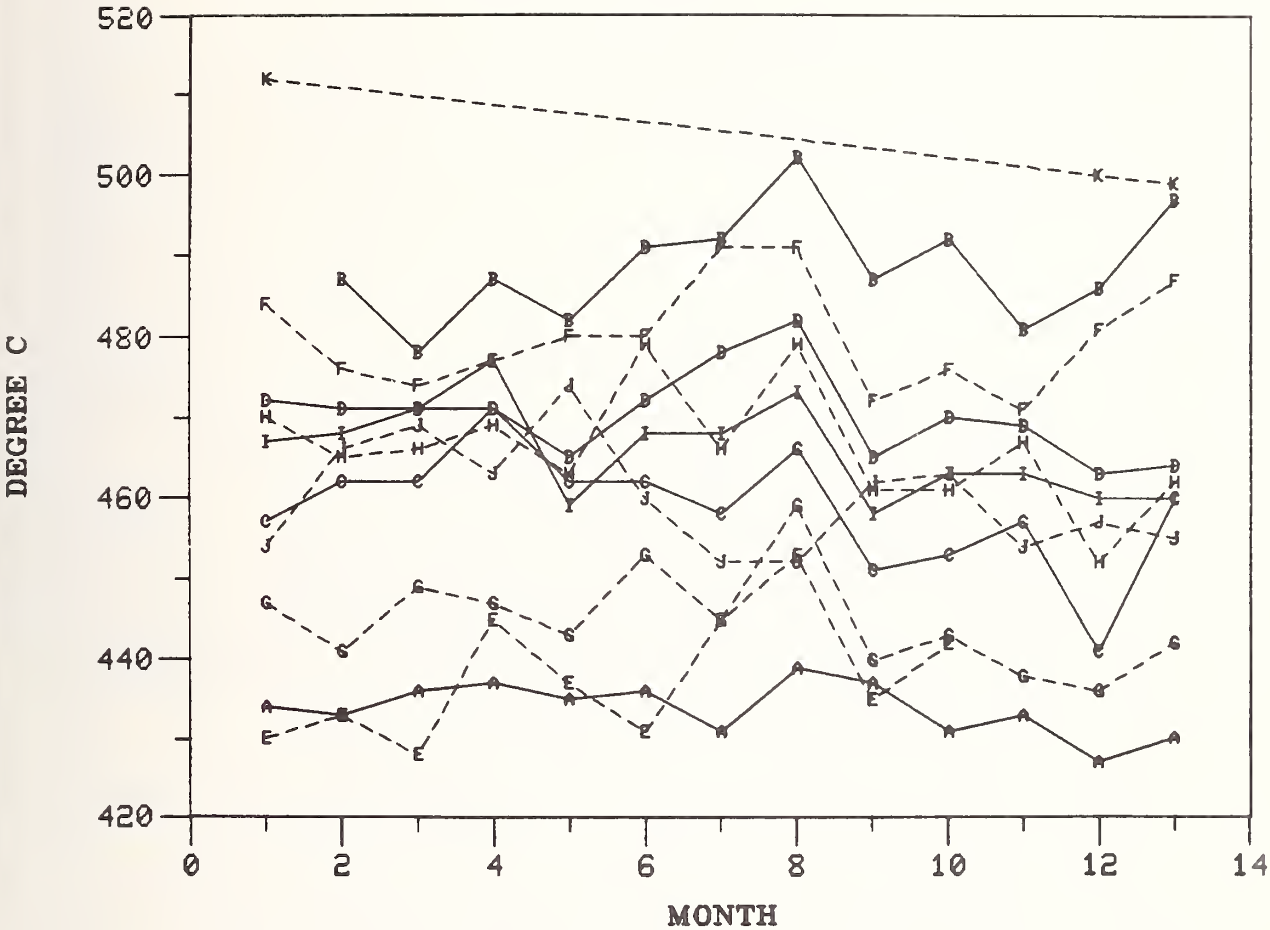
GCBPD 40% OFF

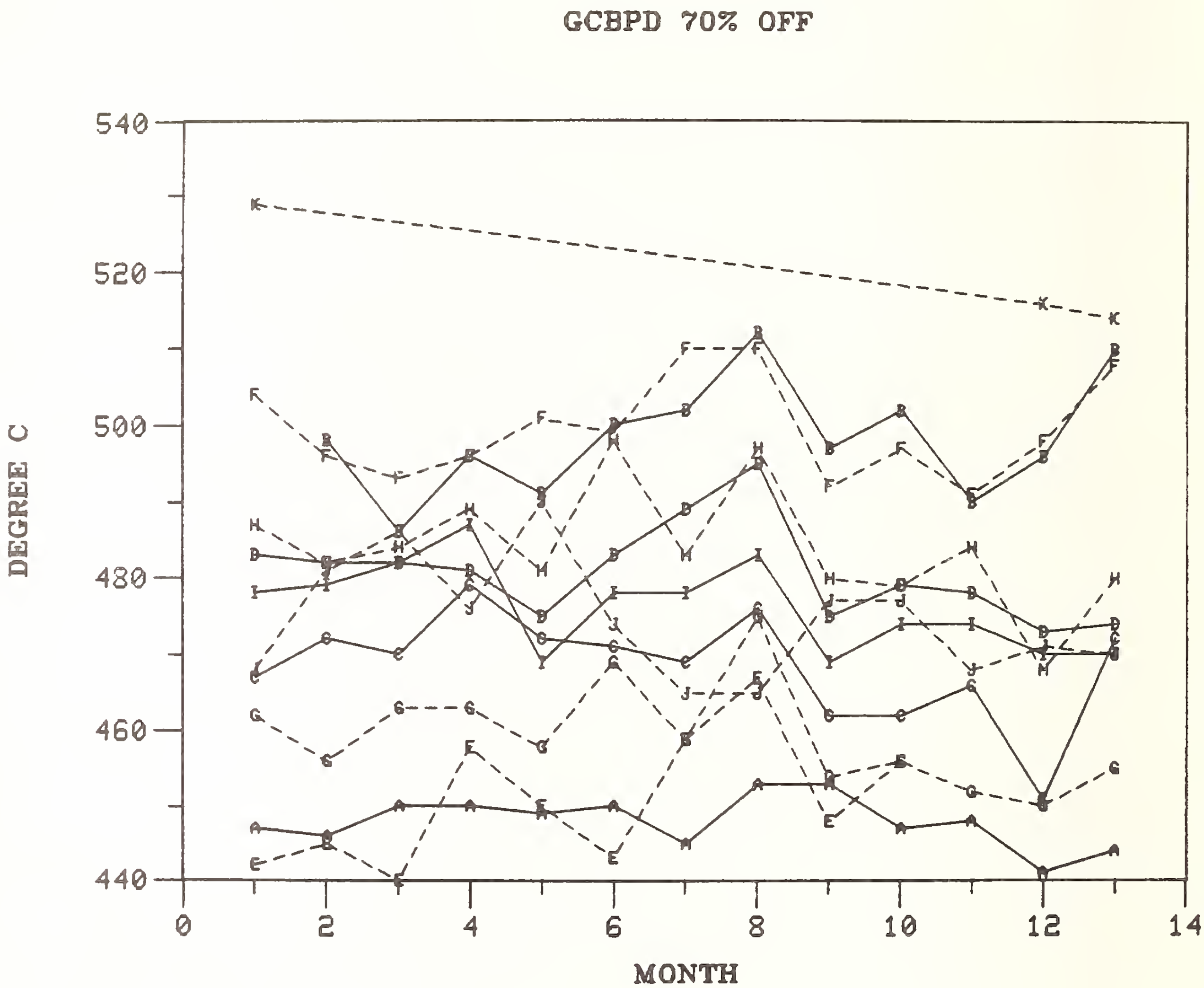


GCBPD 50% OFF



GCBPD 60% OFF




GCBPD 70% OFF
540
520
500
480
460
440
DEGREE C
0
2
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8
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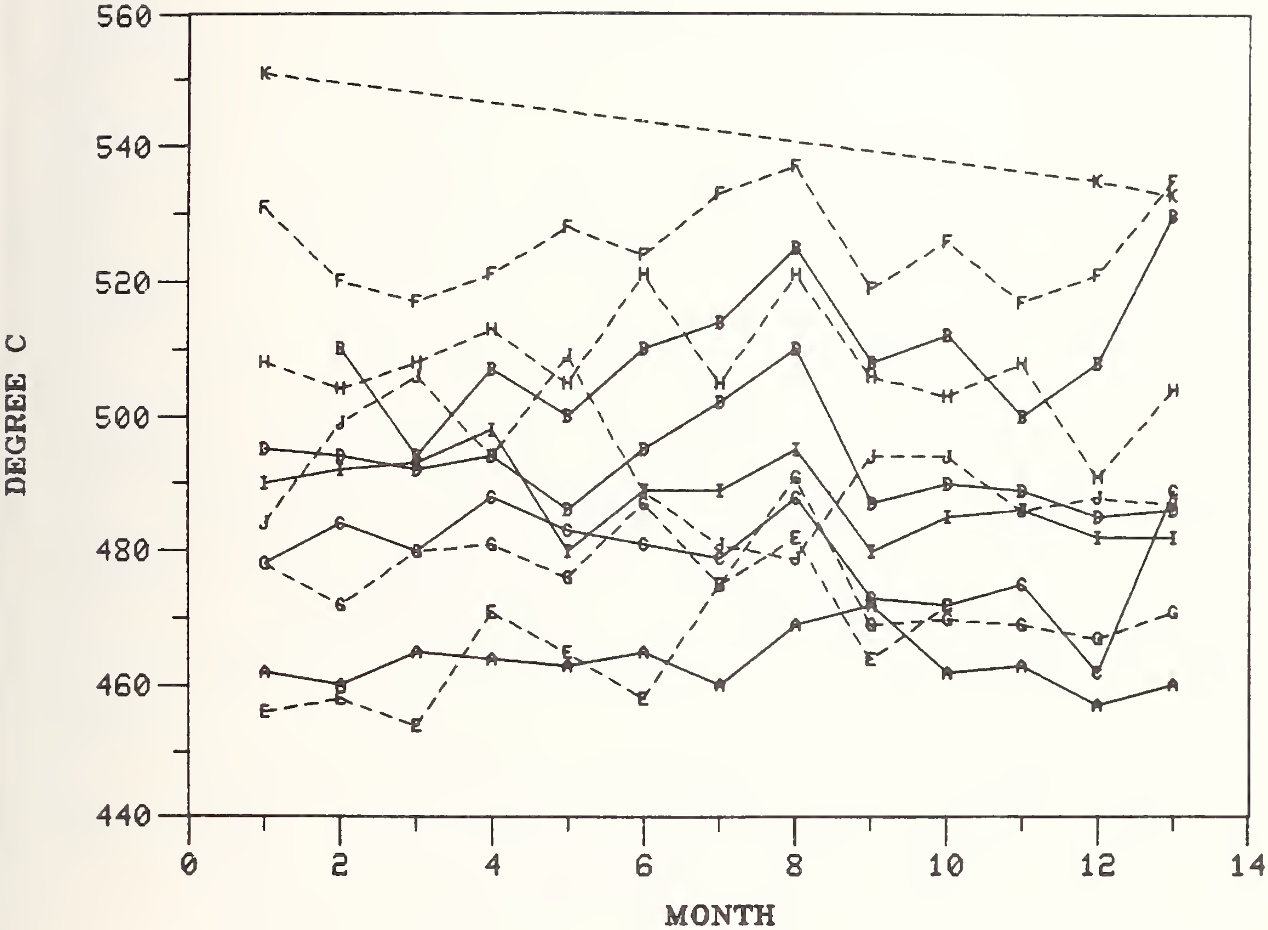
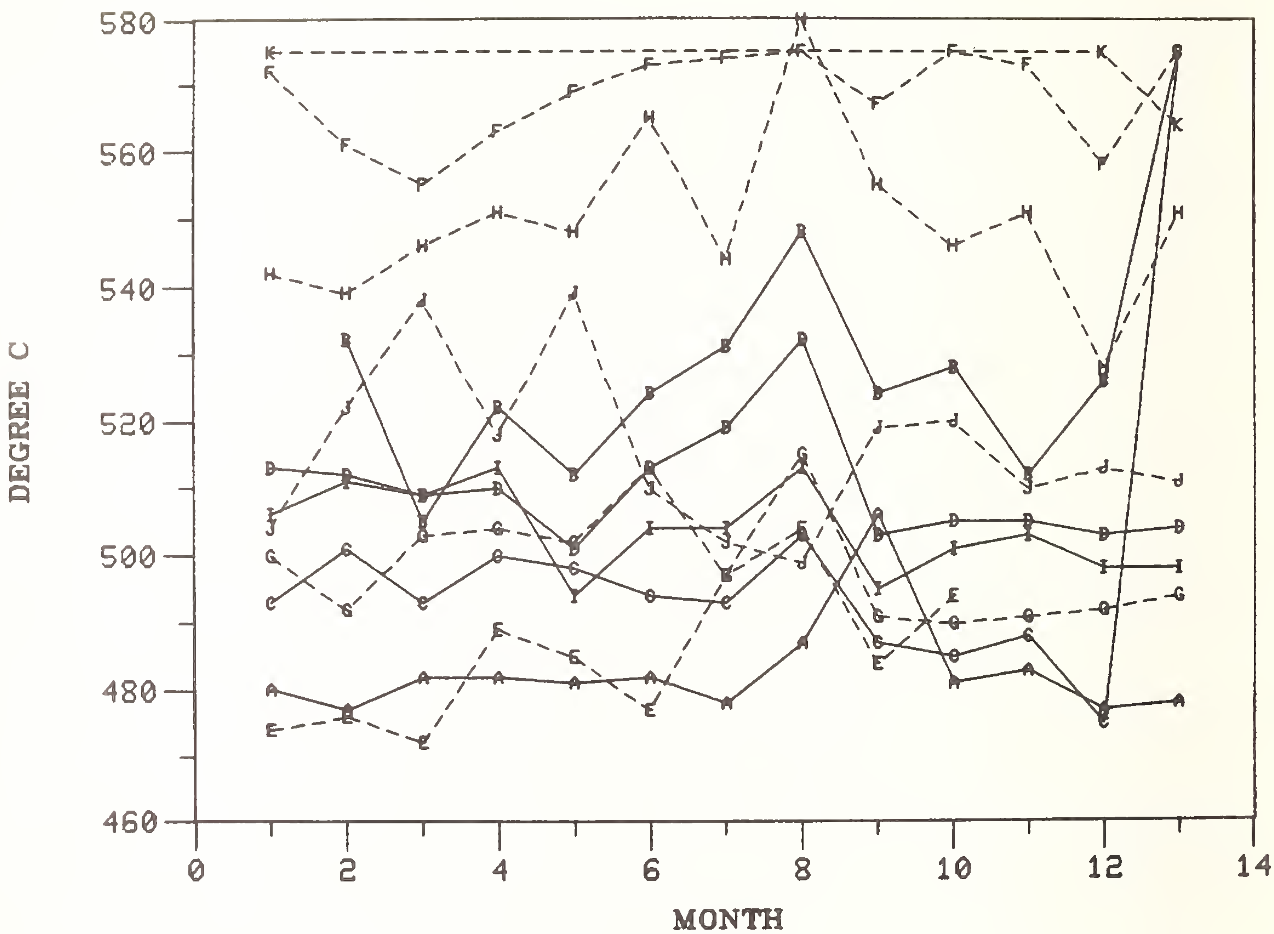
12
14
MONTH

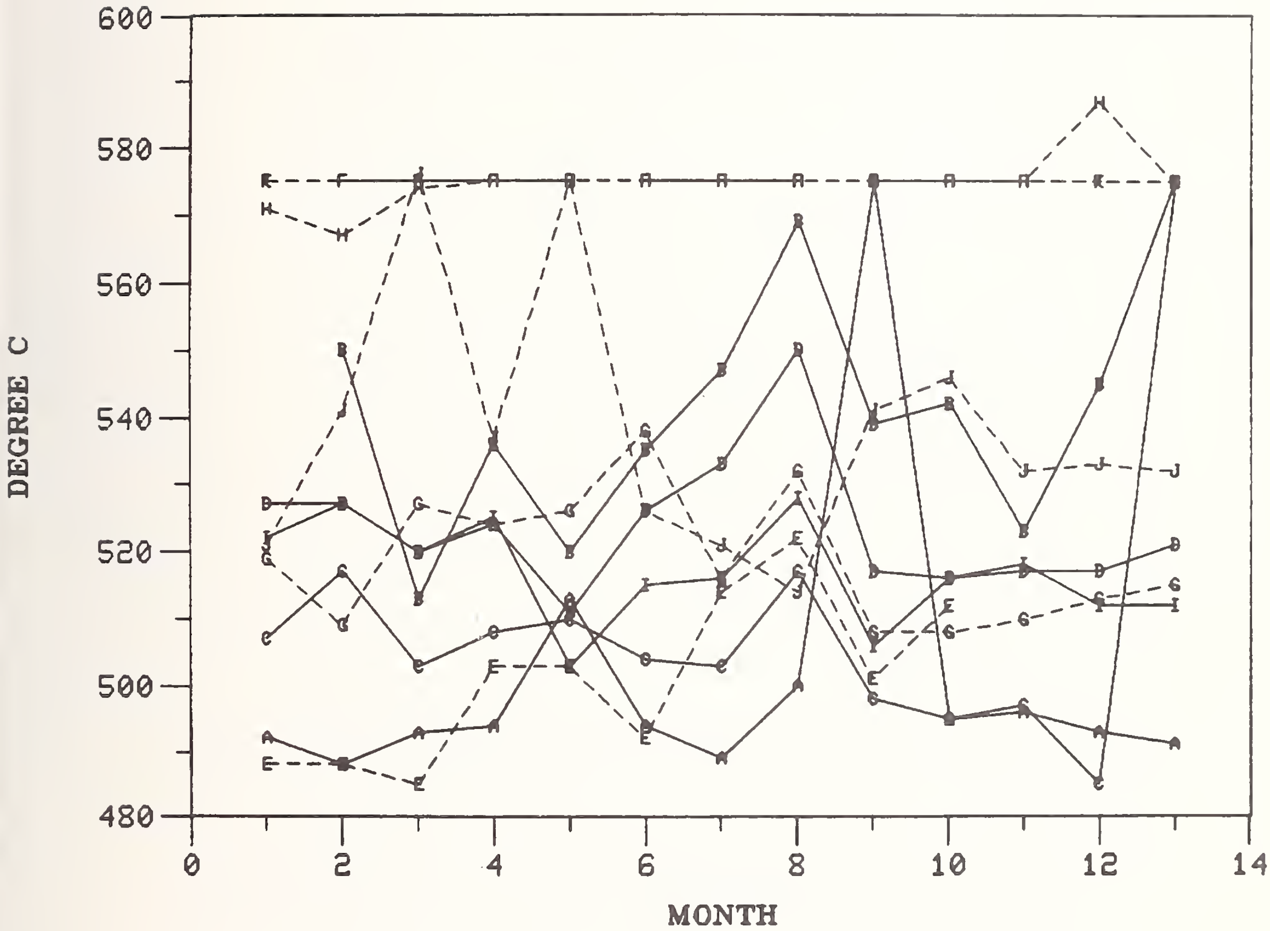
GCBPD 80% OFF



GCBPD 90% OFF



GCBPD 95% OFF

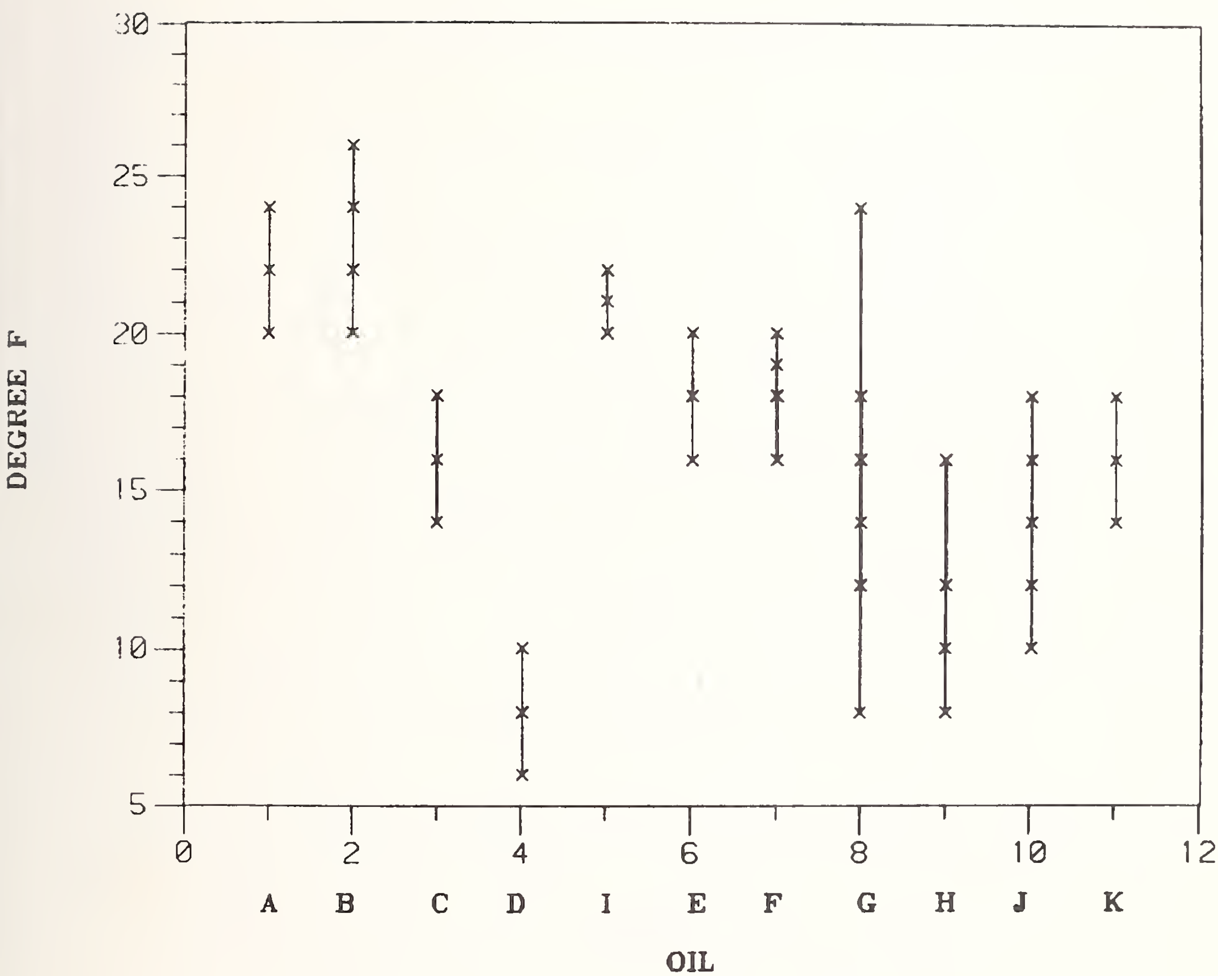


ASTM/NBS BASESTOCK CONSISTENCY STUDY

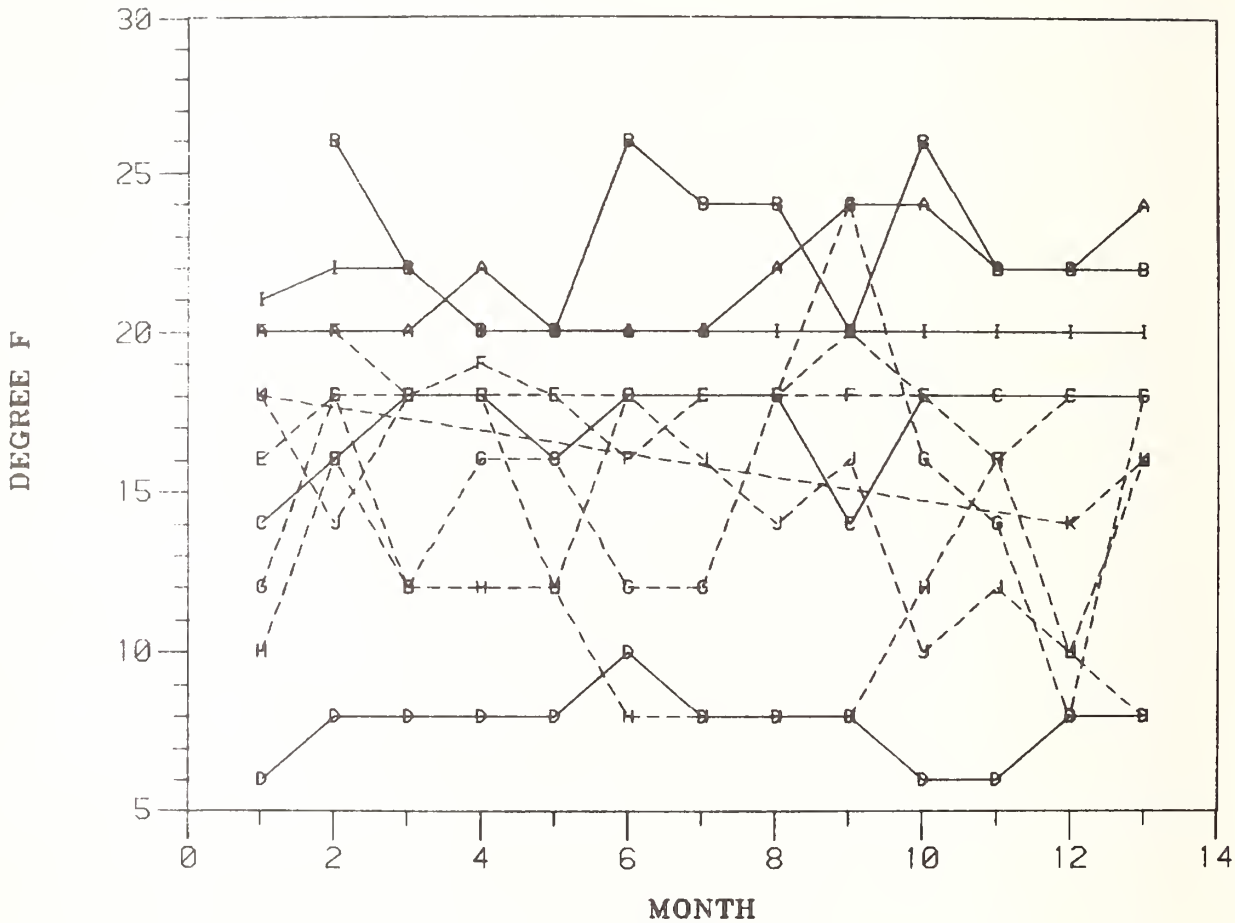
TEST: CLOUD POINT (DEG F) ASTM D2500 LABORATORY: M

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	20.	-	14.	6.	21.	16.	20.	12.	10.	18.	18.
APR 80	20.	26.	16.	8.	22.	18.	20.	18.	16.	14.	-
MAY 80	20.	22.	18.	8.	22.	18.	18.	12.	12.	18.	-
JUN 80	22.	20.	18.	8.	20.	18.	19.	16.	12.	18.	-
JUL 80	20.	20.	16.	8.	20.	18.	18.	16.	12.	12.	-
AUG 80	20.	26.	18.	10.	20.	18.	16.	12.	8.	18.	-
SEP 80	20.	24.	18.	8.	20.	18.	18.	12.	8.	16.	-
OCT 80	22.	24.	18.	8.	20.	18.	18.	18.	8.	14.	-
NOV 80	24.	20.	14.	8.	20.	20.	18.	24.	8.	16.	-
DEC 80	24.	26.	18.	6.	20.	18.	18.	16.	12.	10.	-
JAN 81	22.	22.	18.	6.	20.	-	16.	14.	16.	12.	-
FEB 81	22.	22.	18.	8.	20.	-	18.	8.	10.	10.	14.
MAR 81	24.	22.	18.	8.	20.	-	18.	18.	8.	16.	16.
MEAN	21.5	22.8	17.1	7.7	20.4	18.0	18.1	15.1	10.8	14.8	16.0
STD.DEV.	1.7	2.3	1.6	1.1	.8	.9	1.2	4.1	2.9	3.0	2.0
MIN	20.	20.	14.	6.	20.	16.	16.	8.	8.	10.	14.
MAX	24.	26.	18.	10.	22.	20.	20.	24.	16.	18.	18.

CLOUD POINT



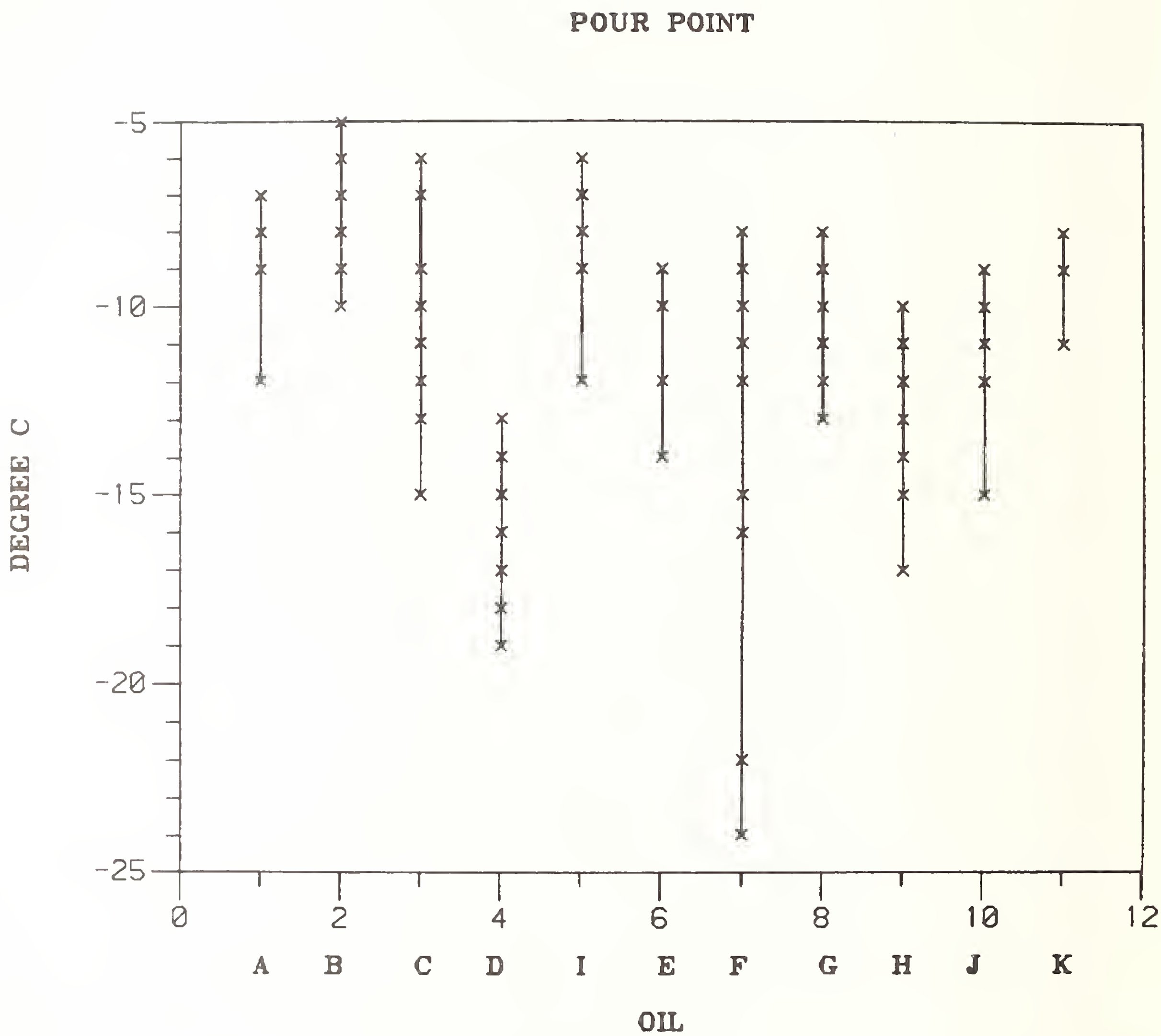
CLOUD POINT



ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: FCUF POINT (DEG C) ASTM D97 LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	-7.	-	-11.	-15.	-8.	-12.	-15.	-11.	-11.	-9.	-9.
APR 80	-7.	-7.	-7.	-14.	-7.	-9.	-8.	-9.	-12.	-9.	-
MAY 80	-7.	-8.	-10.	-17.	-8.	-9.	-11.	-9.	-17.	-9.	-
JUN 80	-12.	-9.	-12.	-18.	-9.	-9.	-24.	-9.	-15.	-12.	-
JUL 80	-7.	-8.	-15.	-13.	-7.	-9.	-12.	-9.	-10.	-12.	-
AUG 80	-9.	-6.	-9.	-15.	-9.	-9.	-12.	-12.	-12.	-12.	-
SEP 80	-8.	-5.	-10.	-15.	-9.	-10.	-11.	-11.	-12.	-9.	-
OCT 80	-8.	-5.	-6.	-18.	-8.	-10.	-9.	-8.	-10.	-12.	-
NOV 80	-9.	-9.	-12.	-18.	-6.	-9.	-22.	-9.	-12.	-10.	-
DEC 80	-8.	-7.	-9.	-16.	-7.	-14.	-16.	-11.	-11.	-15.	-
JAN 81	-12.	-10.	-13.	-19.	-12.	-	-10.	-13.	-14.	-9.	-
FEB 81	-8.	-7.	-9.	-15.	-7.	-	-9.	-9.	-11.	-10.	-8.
MAR 81	-7.	-7.	-11.	-15.	-7.	-	-10.	-10.	-13.	-11.	-11.
MEAN	-8.4	-7.4	-10.3	-16.0	-8.0	-10.0	-13.0	-10.0	-12.3	-10.7	-9.3
STD.DEV.	1.8	1.4	2.4	1.8	1.5	1.7	5.0	1.5	2.0	1.8	1.5
MIN	-12.	-10.	-15.	-19.	-12.	-14.	-24.	-13.	-17.	-15.	-11.
MAX	-7.	-5.	-6.	-13.	-6.	-9.	-8.	-8.	-10.	-9.	-8.


POUR POINT
DEGREE C
-5
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E
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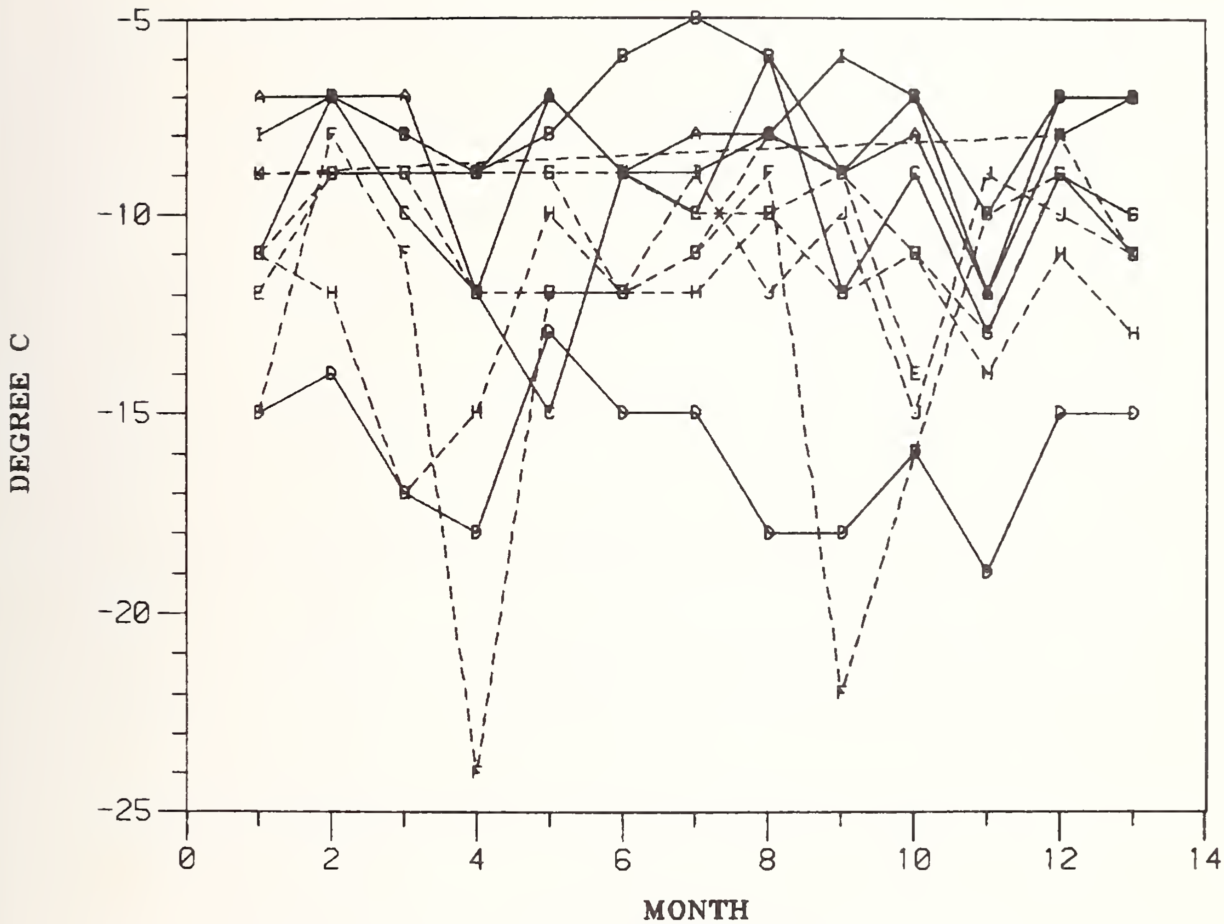
G
H
J
K
OIL

POUR POINT



ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: CCLCR (ASTM COLOR UNITS) ASTM D1500 LABORATORY: L

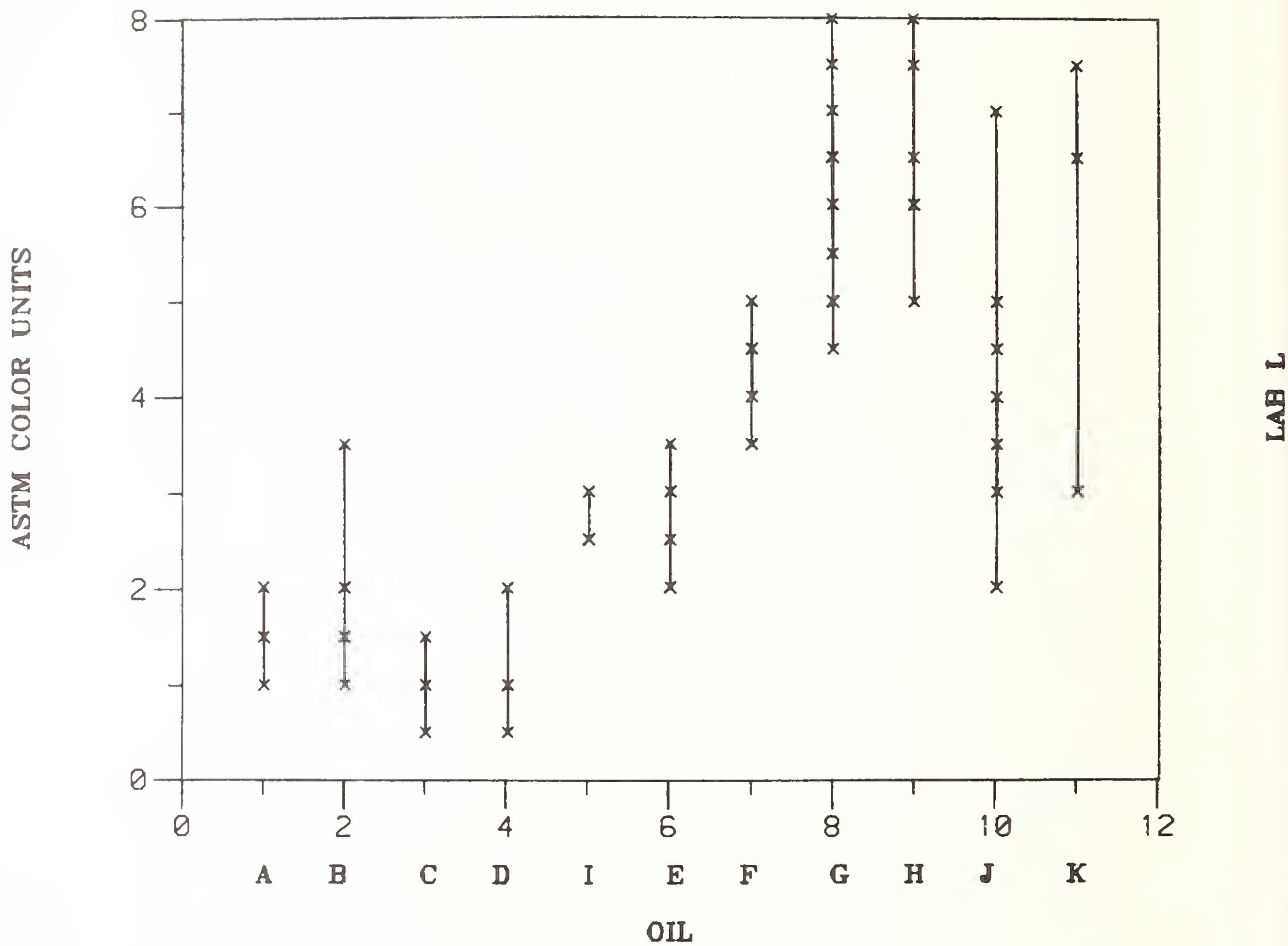
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	1.5	-	1.0	.5	2.5	3.0	4.5	5.0	6.0	4.5	3.0
APR 80	1.5	1.5	.5	.5	2.5	2.5	4.0	5.0	5.0	4.0	-
MAY 80	1.5	1.5	.5	2.0	2.5	2.0	3.5	6.5	6.0	3.0	-
JUN 80	1.5	1.5	.5	.5	2.5	3.0	5.0	7.0	6.0	3.5	-
JUL 80	2.0	1.5	.5	.5	2.5	2.5	3.5	7.5	6.0	2.0	-
AUG 80	1.5	1.5	.5	1.0	2.5	2.0	4.0	8.0	8.0	4.5	-
SEP 80	1.0	1.0	1.0	1.0	3.0	3.0	3.5	6.0	6.0	3.5	-
OCT 80	2.0	2.0	1.5	1.0	2.5	3.5	4.0	6.5	7.5	5.0	-
NOV 80	2.0	2.0	1.0	.5	2.5	2.5	4.5	5.5	6.0	4.5	-
DEC 80	2.0	1.5	.5	1.0	2.5	3.0	4.5	5.5	6.5	5.0	-
JAN 81	2.0	1.5	.5	.5	2.5	-	3.5	4.5	6.0	4.5	-
FEB 81	2.0	2.0	.5	.5	2.5	-	3.5	5.5	6.0	7.0	6.5
MAR 81	2.0	3.5	1.0	1.0	2.5	-	3.5	5.0	6.5	4.0	7.5
MEAN	1.73	1.75	.73	.81	2.54	2.70	3.96	5.96	6.27	4.23	5.67
STD.DEV.	.33	.62	.33	.43	.14	.48	.52	1.07	.75	1.18	2.36
MIN	1.0	1.0	.5	.5	2.5	2.0	3.5	4.5	5.0	2.0	3.0
MAX	2.0	3.5	1.5	2.0	3.0	3.5	5.0	8.0	8.0	7.0	7.5

ASTM/NBS BASESTOCK CONSISTENCY STUDY

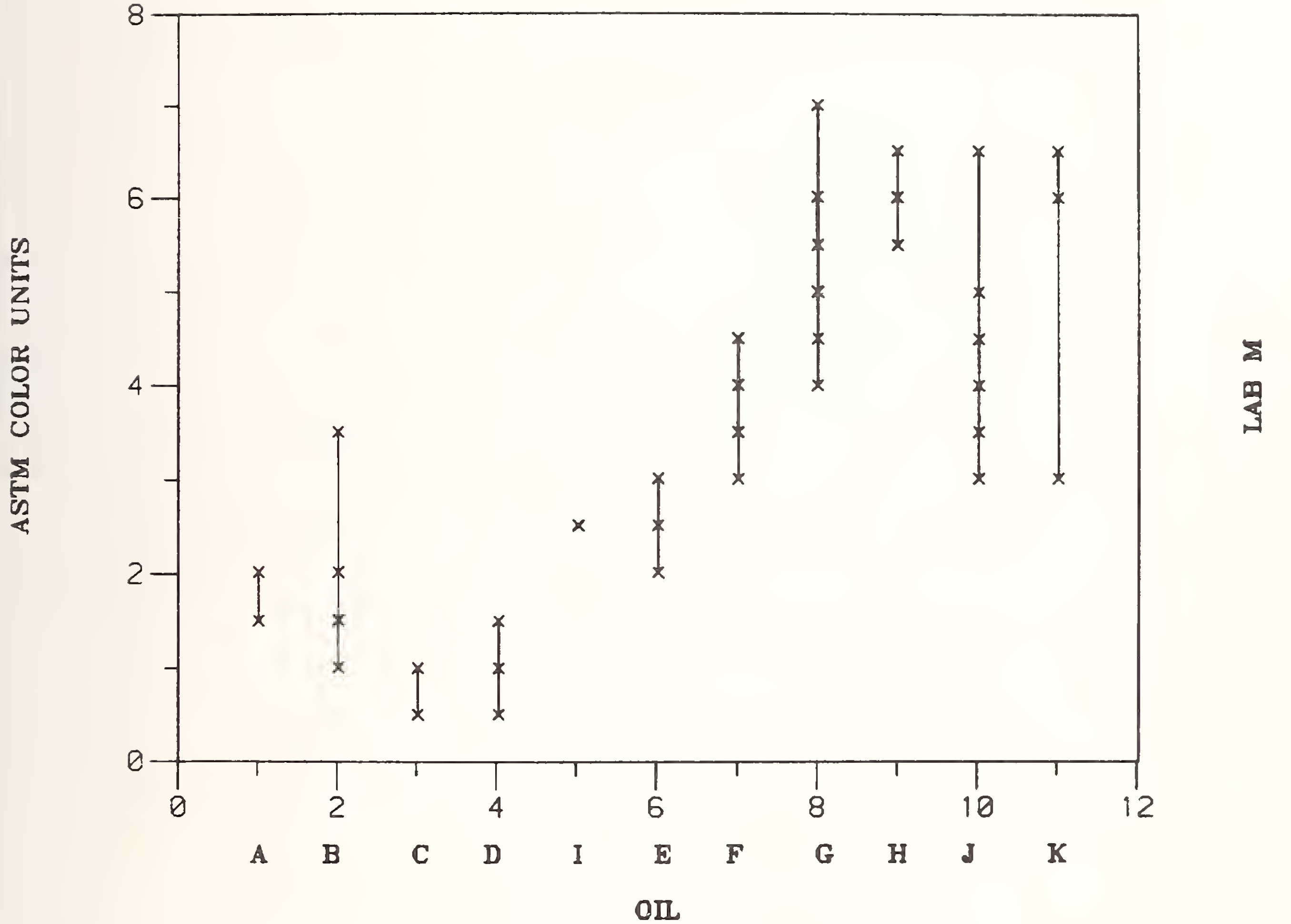
TEST: CCLOR (ASTM COLOR UNITS) ASTM D1500 LABORATORY: M

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	L1.5	-	L1.0	L1.0	L2.5	L3.0	4.5	5.0	6.0	3.5	L3.0
APR 80	1.5	1.0	.5	.5	2.5	2.5	4.0	6.0	6.0	L4.0	-
MAY 80	L1.5	L1.5	.5	L1.5	2.5	2.0	3.5	5.5	5.5	3.0	-
JUN 80	L1.5	L1.5	.5	.5	L2.5	L3.0	4.5	6.0	6.0	L3.5	-
JUL 80	L2.0	L1.5	L1.0	L1.0	L2.5	L3.0	3.5	7.0	5.5	L3.0	-
AUG 80	L1.5	L1.5	.5	L1.0	L2.5	2.5	4.5	7.0	6.5	4.5	-
SEP 80	L2.0	L1.5	L1.0	L1.0	2.5	L3.0	L4.5	5.5	5.5	L3.5	-
OCT 80	L2.0	1.5	L1.0	.5	L2.5	L3.0	3.5	5.5	6.5	4.5	-
NOV 80	L2.0	1.5	L1.0	.5	L2.5	2.5	4.0	5.0	6.0	4.5	-
DEC 80	2.0	1.5	L1.0	L1.0	L2.5	L3.0	4.5	5.0	6.5	L5.0	-
JAN 81	1.5	L1.5	.5	L1.0	2.5	-	3.5	4.0	5.5	4.0	-
FEB 81	L2.0	L2.0	.5	.5	L2.5	-	L3.5	5.0	6.5	6.5	6.0
MAR 81	L2.0	L3.5	L1.0	L1.0	L2.5	-	3.0	4.5	5.5	4.0	6.5
MEAN	1.77	1.67	.77	.85	2.50	2.75	3.92	5.46	5.96	4.12	5.17
STD.DEV.	.26	.62	.26	.32	.00	.35	.53	.88	.43	.94	1.89
MIN	1.5	1.0	.5	.5	2.5	2.0	3.0	4.0	5.5	3.0	3.0
MAX	2.0	3.5	1.0	1.5	2.5	3.0	4.5	7.0	6.5	6.5	6.5

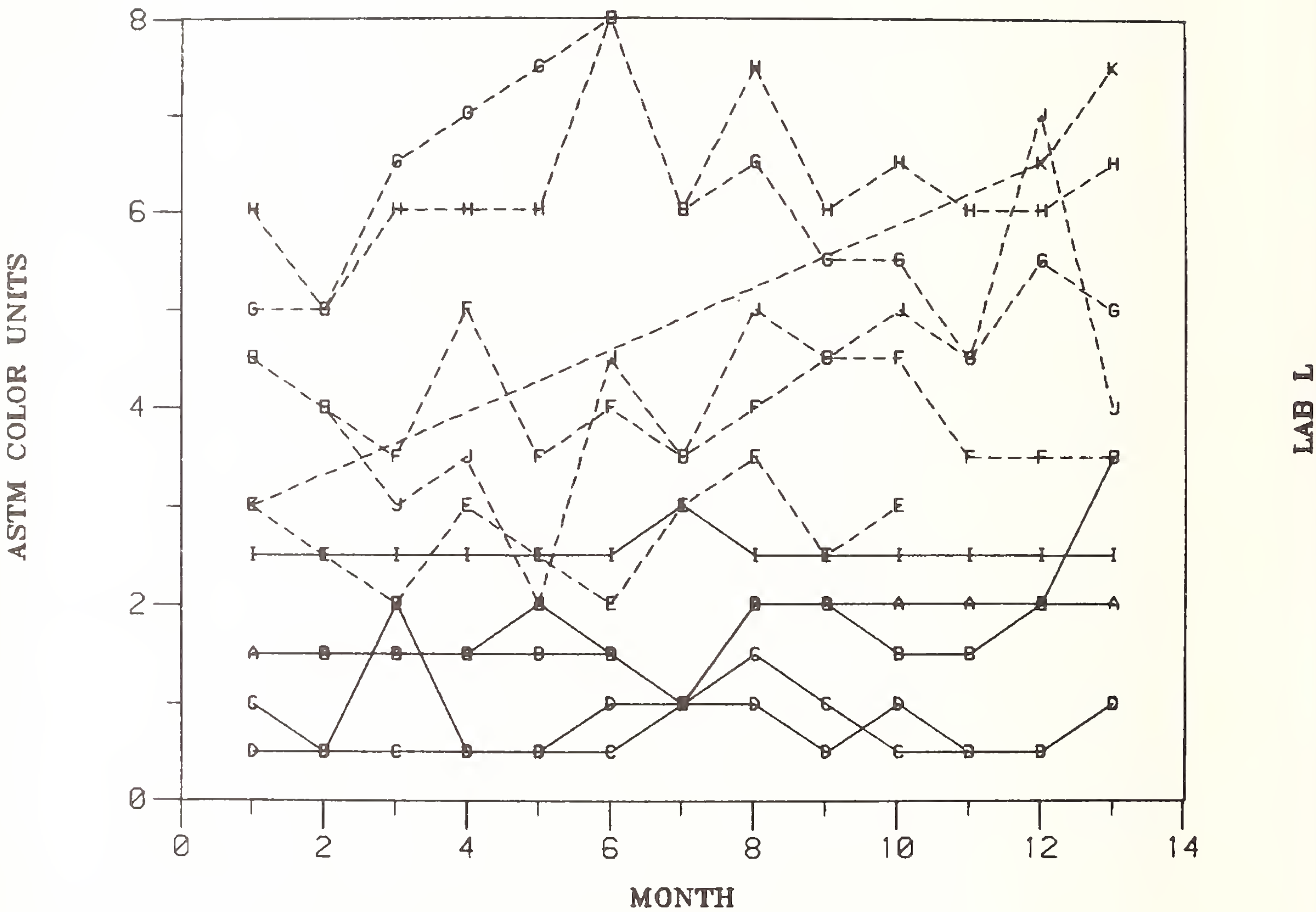
ASTM COLOR

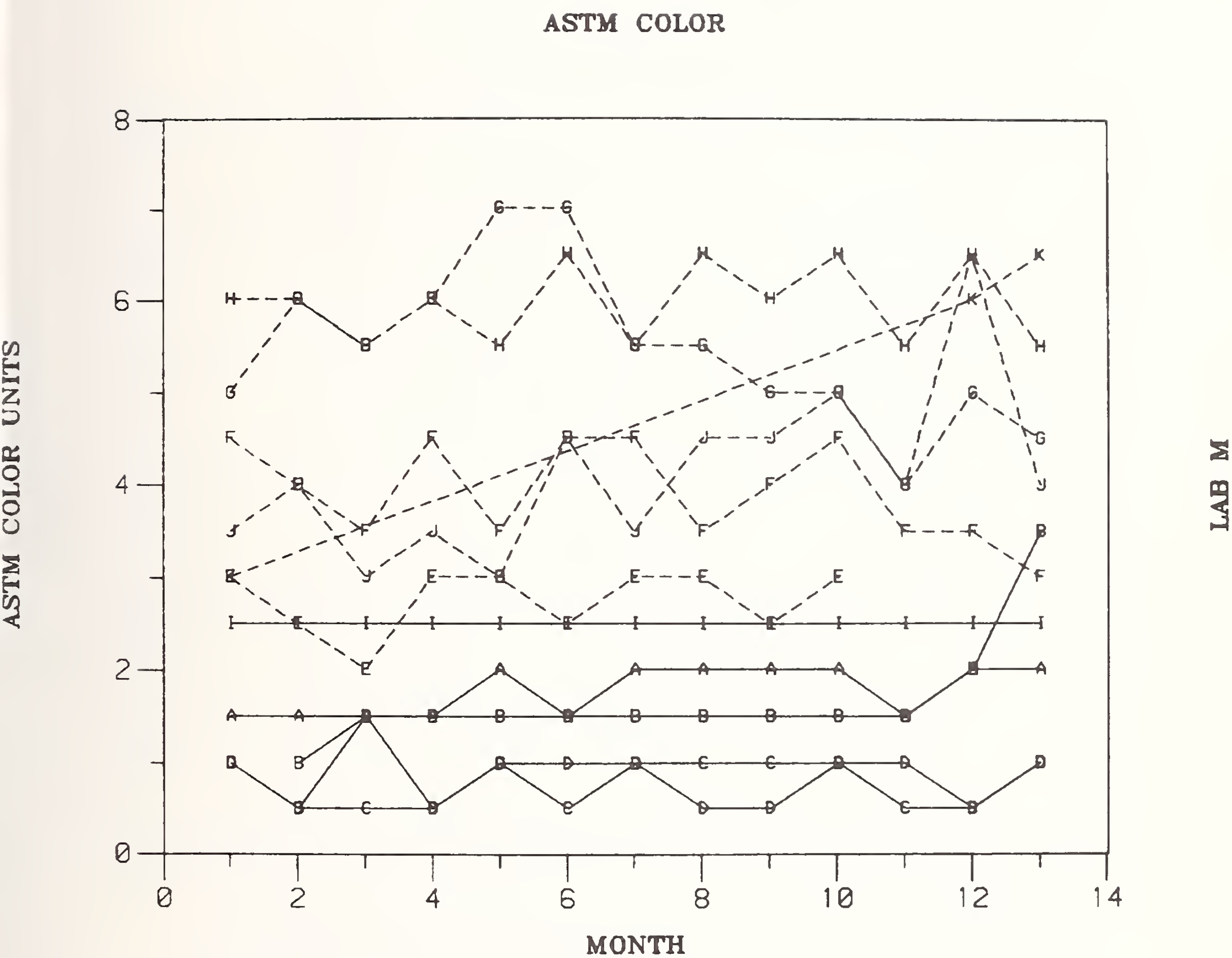


ASTM COLOR



ASTM COLOR




ASTM COLOR
ASTM COLOR UNITS
MONTH
LAB M
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14

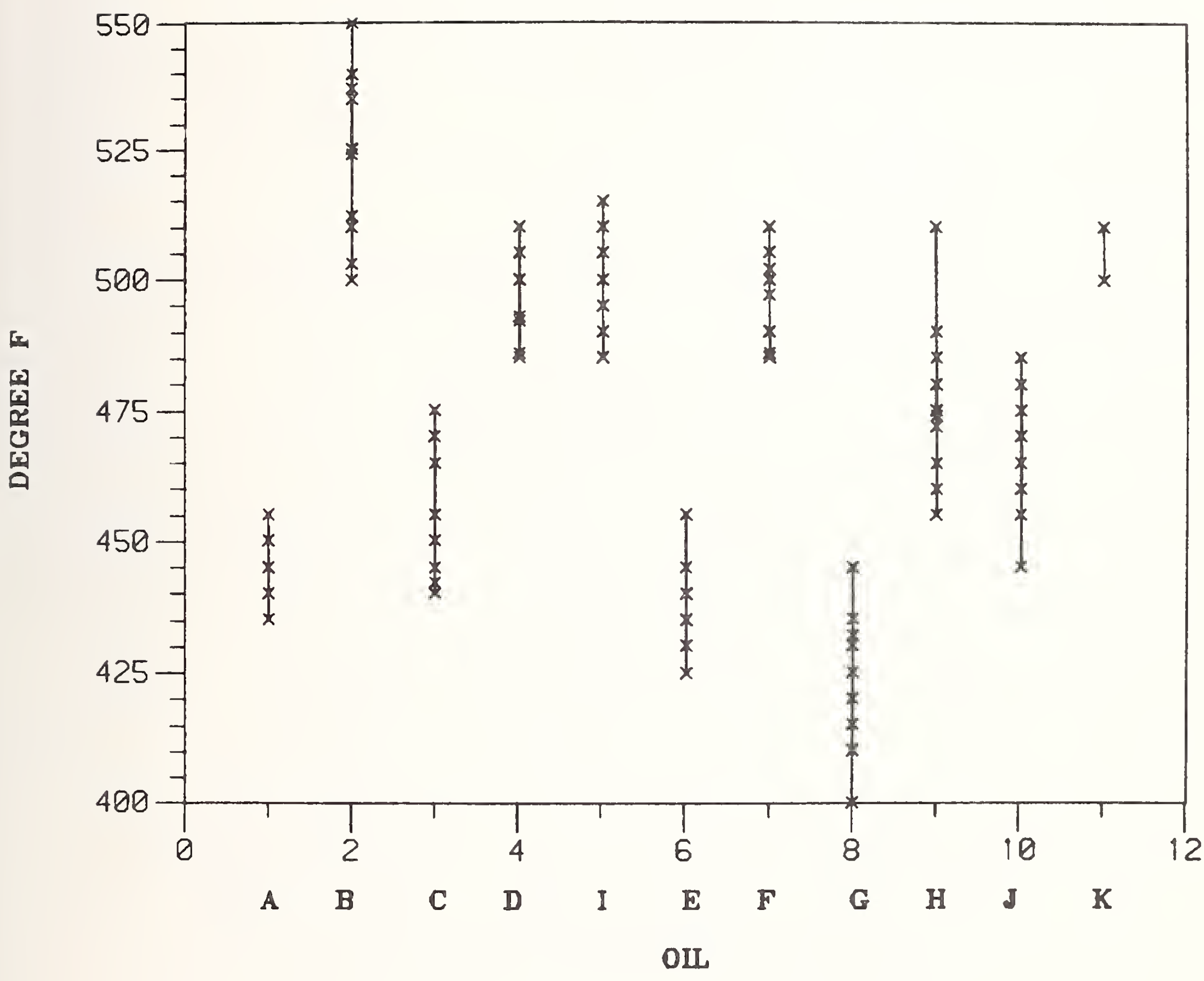
ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: FIRE POINT (DEG F) ASTM D92

LABORATORY: L2

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	445.	-	470.	500.	495.	440.	505.	410.	480.	465.	500.
APR 80	450.	525.	450.	505.	495.	435.	500.	430.	475.	470.	-
MAY 80	445.	537.	475.	500.	505.	440.	502.	400.	475.	455.	-
JUN 80	455.	500.	470.	500.	495.	435.	497.	410.	485.	460.	-
JUL 80	445.	510.	465.	485.	500.	430.	490.	425.	455.	445.	-
AUG 80	435.	512.	440.	486.	485.	425.	485.	410.	474.	470.	-
SEP 80	440.	503.	440.	492.	490.	430.	485.	420.	472.	480.	-
OCT 80	440.	524.	442.	493.	485.	440.	486.	432.	465.	470.	-
NOV 80	445.	525.	445.	510.	510.	445.	490.	435.	480.	485.	-
DEC 80	450.	540.	475.	510.	515.	455.	500.	445.	510.	485.	-
JAN 81	450.	540.	470.	510.	500.	-	500.	415.	490.	475.	-
FEB 81	455.	535.	455.	505.	510.	-	510.	445.	475.	485.	510.
MAR 81	450.	550.	465.	505.	510.	-	510.	432.	460.	470.	500.
MEAN	446.5	525.1	458.6	500.1	499.6	437.5	496.9	423.8	476.6	470.4	503.3
STD.DEV.	5.9	16.0	13.7	8.7	9.9	8.6	8.9	14.2	13.8	12.2	5.8
MIN	435.	500.	440.	485.	485.	425.	485.	400.	455.	445.	500.
MAX	455.	550.	475.	510.	515.	455.	510.	445.	510.	485.	510.

FIRE POINT



550
525
500
475
450
425
400
DEGREE F
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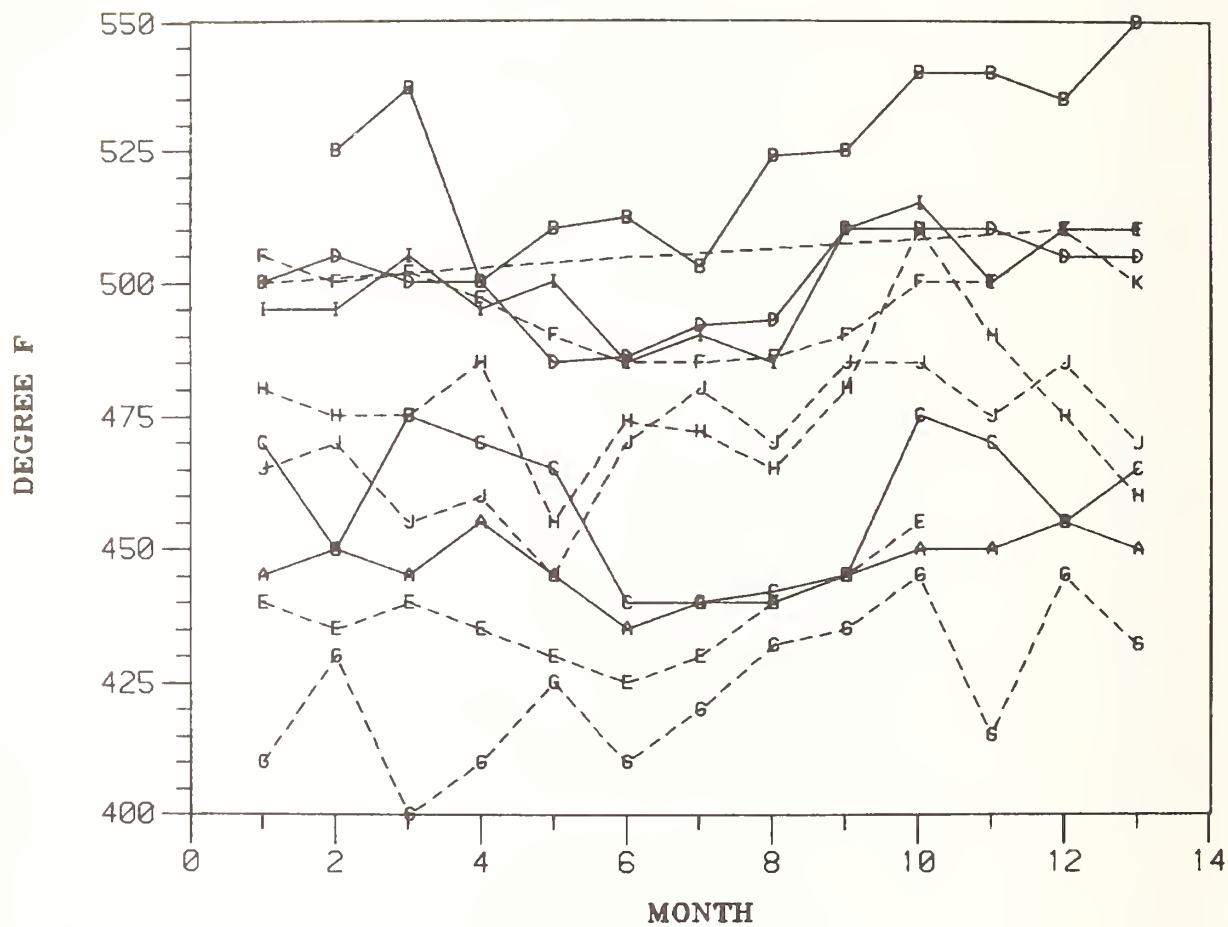
6
8
10
12
A B C D I E F G H J K
OIL

FIRE POINT

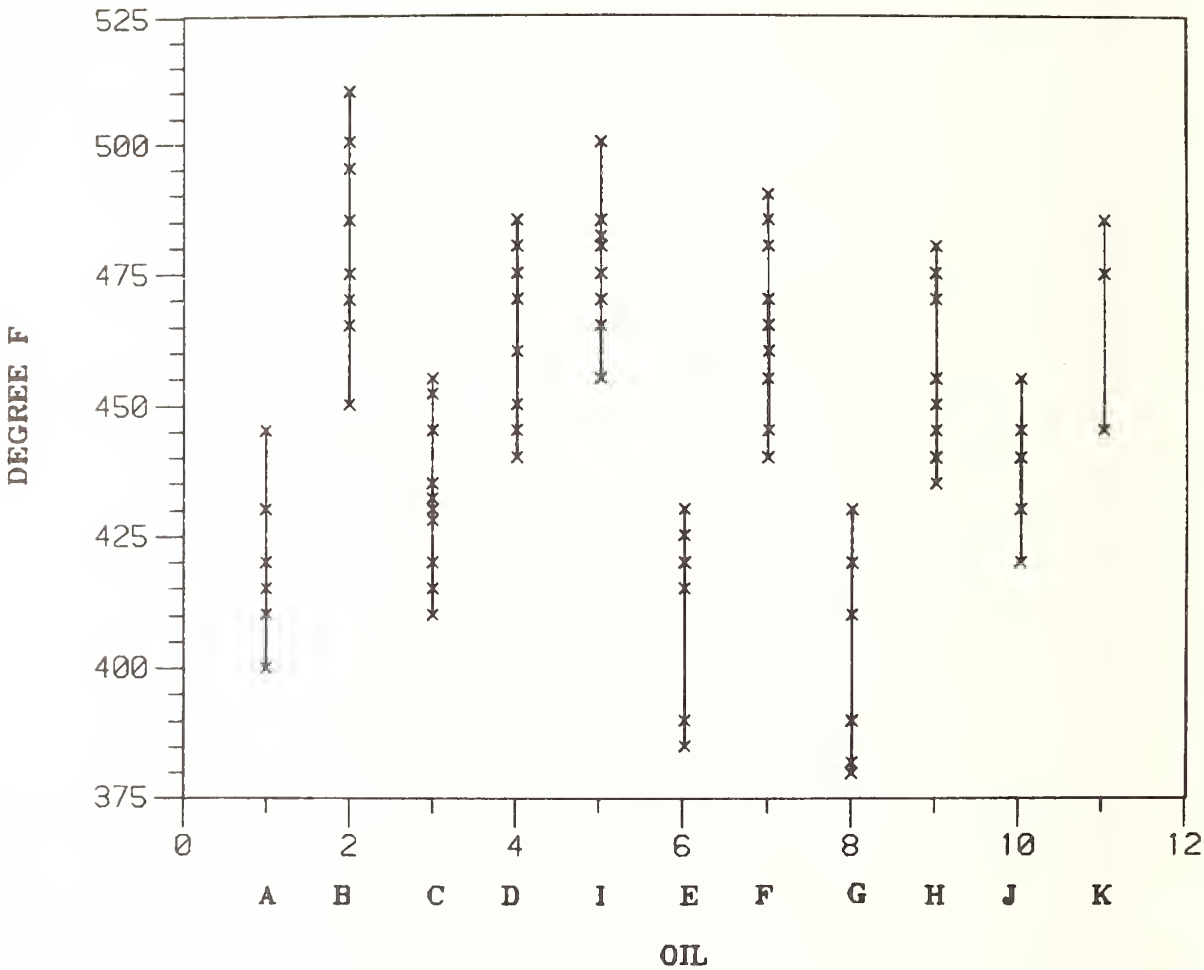


ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: FLASH POINT (DEG F) ASTM D92 LABORATORY: L2

DATE	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
	A	B	C	D	I	E	F	G	H	J	K
MAR 80	430.	-	452.	470.	470.	420.	485.	390.	475.	430.	485.
APR 80	430.	465.	410.	475.	470.	425.	465.	380.	440.	440.	-
MAY 80	445.	485.	435.	475.	482.	420.	470.	390.	440.	430.	-
JUN 80	445.	485.	432.	485.	475.	430.	460.	390.	470.	430.	-
JUL 80	430.	475.	455.	450.	465.	420.	455.	382.	435.	420.	-
AUG 80	400.	470.	415.	445.	455.	385.	445.	380.	440.	440.	-
SEP 80	410.	470.	420.	440.	475.	390.	440.	390.	440.	-	-
OCT 80	420.	485.	410.	470.	455.	420.	470.	420.	450.	430.	-
NOV 80	430.	450.	420.	485.	485.	415.	465.	410.	455.	455.	-
DEC 80	430.	500.	445.	485.	485.	415.	455.	430.	470.	455.	-
JAN 81	420.	510.	430.	480.	480.	-	470.	380.	480.	440.	-
FEB 81	415.	495.	428.	475.	500.	-	490.	420.	455.	455.	475.
MAR 81	430.	510.	435.	460.	500.	-	480.	410.	445.	445.	445.
MEAN	425.8	483.3	429.8	468.8	476.7	414.0	465.4	397.8	453.5	439.2	468.3
STD.DEV.	12.7	18.4	14.8	15.4	14.3	14.7	14.6	17.7	15.5	11.6	20.8
MIN	400.	450.	410.	440.	455.	385.	440.	380.	435.	420.	445.
MAX	445.	510.	455.	485.	500.	430.	490.	430.	480.	455.	485.

FLASH POINT


DEGREE F
525
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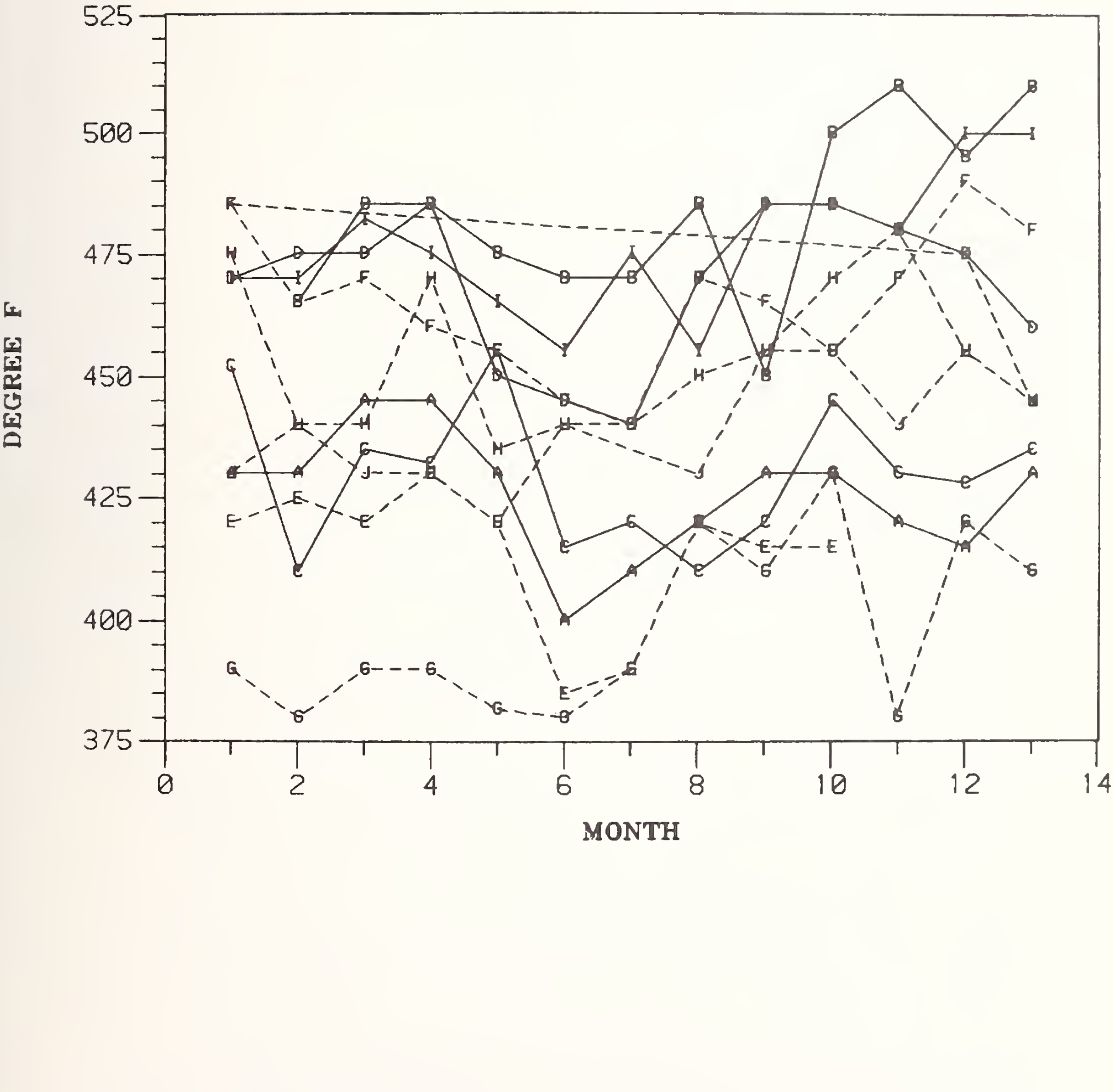
10
12
A B C D I E F G H J K
OIL

FLASH POINT



ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: ODCR COMPARISON TO 100 PALE (MI=MILD,SI=SIMILAR,ST=STRONG,M=MUCH,F=FAIL) LABORATORY: Y

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	--	--	MI	SI
APR 80	MI	MI	MI	MI	SI	SI	SI	ST-F	MI	MST-F	-
MAY 80	MI	MI	MI	MI	MI	MI	ST-F	ST-F	ST	SI	-
JUN 80	MI	MI	MI	MI	MI	MI	SI	SI	SI	ST-F	-
JUL 80	SI	SI	SI	SI	SI	ST-F	ST-F	ST-F	SI	SI	-
AUG 80	SI	SI	SI	SI	SI	ST-F	SI	SI	SI	SI	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	-
MAR 81	--	--	--	--	--	-	--	--	--	--	-
MEAN	-	-	-	-	-	-	-	-	-	-	SI
STD.DEV.	-	-	-	-	-	-	-	-	-	-	.0
MIN	MI	MI	MI	MI	MI	MI	SI	SI	MI	MI	SI
MAX	SI	SI	SI	SI	SI	ST-F	ST-F	ST-F	ST	MST-F	SI

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: ODCR COMPARISON TO 100 NEUT (MI=MILD,SI=SIMILAR,ST=STRONG,M=MUCH,F=FAIL) LABORATORY: Y

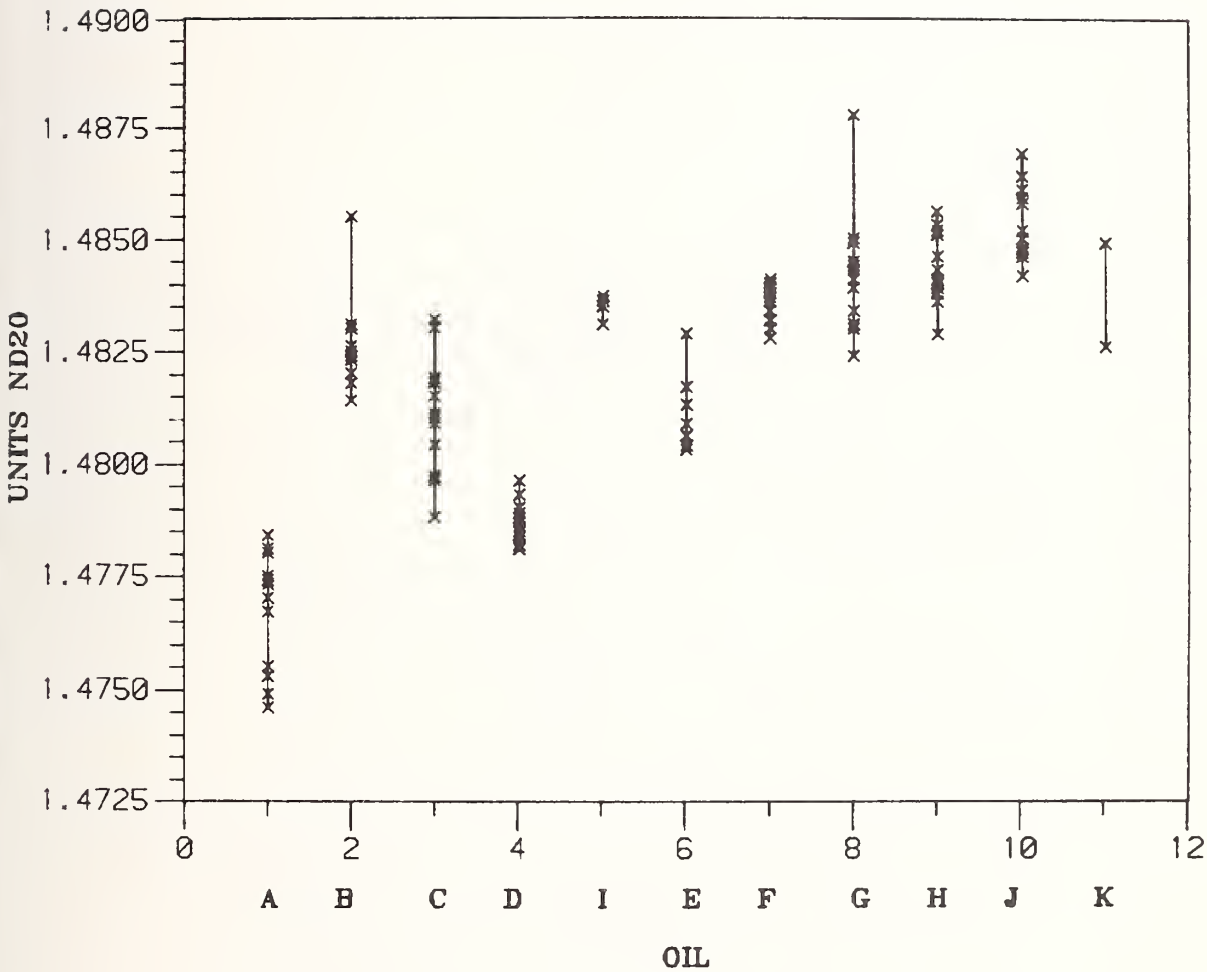
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	--	--	SI	SI
APR 80	SI	ST	MI	SI	MI	ST	ST	MST-F	ST	MST-F	-
MAY 80	SI	SI	SI	SI	MI	ST	MST-F	MST-F	MST	ST	-
JUN 80	SI	MI	SI	SI	SI	MST	ST	SI	ST	ST-F	-
JUL 80	ST	ST	SI	SI	SI	ST-F	ST-F	ST-F	ST	ST	-
AUG 80	ST	SI	SI	SI	SI	ST-F	SI	ST	SI	SI	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	-
MAR 81	--	--	--	--	--	-	--	--	--	--	-
MEAN	-	-	-	SI	-	-	-	-	-	-	SI
STD.DEV.	-	-	-	.0	-	-	-	-	-	-	.0
MIN	SI	MI	MI	SI	MI	ST	SI	SI	SI	SI	SI
MAX	ST	ST	SI	SI	SI	ST-F	MST-F	MST-F	MST	MST-F	SI

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: REFRACTIVE INDEX (UNITS) ASTM D1218 LABORATORY: N

		VIRGIN BASESTOCK			: REF :	RE-REFINED BASESTOCKS					
DATE	:	A	B	C	D	I	E	F	G	H	J	K
MAR 80	:	1.4749	-	1.4788	1.4793	1.4837	1.4809	1.4838	1.4839	1.4856	1.4864	1.4826
APR 80	:	1.4753	1.4814	1.4796	1.4790	1.4835	1.4803	1.4837	1.4849	1.4853	1.4869	-
MAY 80	:	1.4749	1.4820	1.4797	1.4787	1.4836	1.4804	1.4832	1.4845	1.4852	1.4861	-
JUN 80	:	1.4746	1.4818	1.4804	1.4786	1.4836	1.4806	1.4840	1.4878	1.4839	1.4846	-
JUL 80	:	1.4755	1.4823	1.4819	1.4796	1.4836	1.4806	1.4839	1.4843	1.4838	1.4859	-
AUG 80	:	1.4770	1.4825	1.4818	1.4788	1.4836	1.4806	1.4840	1.4850	1.4846	1.4848	-
SEP 80	:	1.4773	1.4831	1.4832	1.4789	1.4836	1.4817	1.4838	1.4841	1.4829	1.4847	-
OCT 80	:	1.4775	1.4826	1.4830	1.4785	1.4831	1.4817	1.4830	1.4844	1.4851	1.4842	-
NOV 80	:	1.4767	1.4830	1.4815	1.4782	1.4836	1.4813	1.4832	1.4824	1.4840	1.4850	-
DEC 80	:	1.4774	1.4826	1.4810	1.4784	1.4836	1.4829	1.4836	1.4830	1.4836	1.4852	-
JAN 81	:	1.4780	1.4824	1.4819	1.4781	1.4835	-	1.4828	1.4834	1.4841	1.4847	-
FEB 81	:	1.4781	1.4831	1.4811	1.4781	1.4835	-	1.4834	1.4831	1.4836	1.4858	1.4849
MAR 81	:	1.4784	1.4855	1.4809	1.4782	1.4836	-	1.4841	1.4831	1.4843	1.4842	1.4849
MEAN	:	1.47658	1.48269	1.48114	1.47865	1.48355	1.48110	1.48358	1.48415	1.48431	1.48527	1.48413
STD.DEV.	:	.00136	.00102	.00129	.00047	.00015	.00081	.00042	.00136	.00080	.00087	.00133
MIN	:	1.4746	1.4814	1.4788	1.4781	1.4831	1.4803	1.4828	1.4824	1.4829	1.4842	1.4826
MAX	:	1.4784	1.4855	1.4832	1.4796	1.4837	1.4829	1.4841	1.4878	1.4856	1.4869	1.4849

REFRACTIVE INDEX



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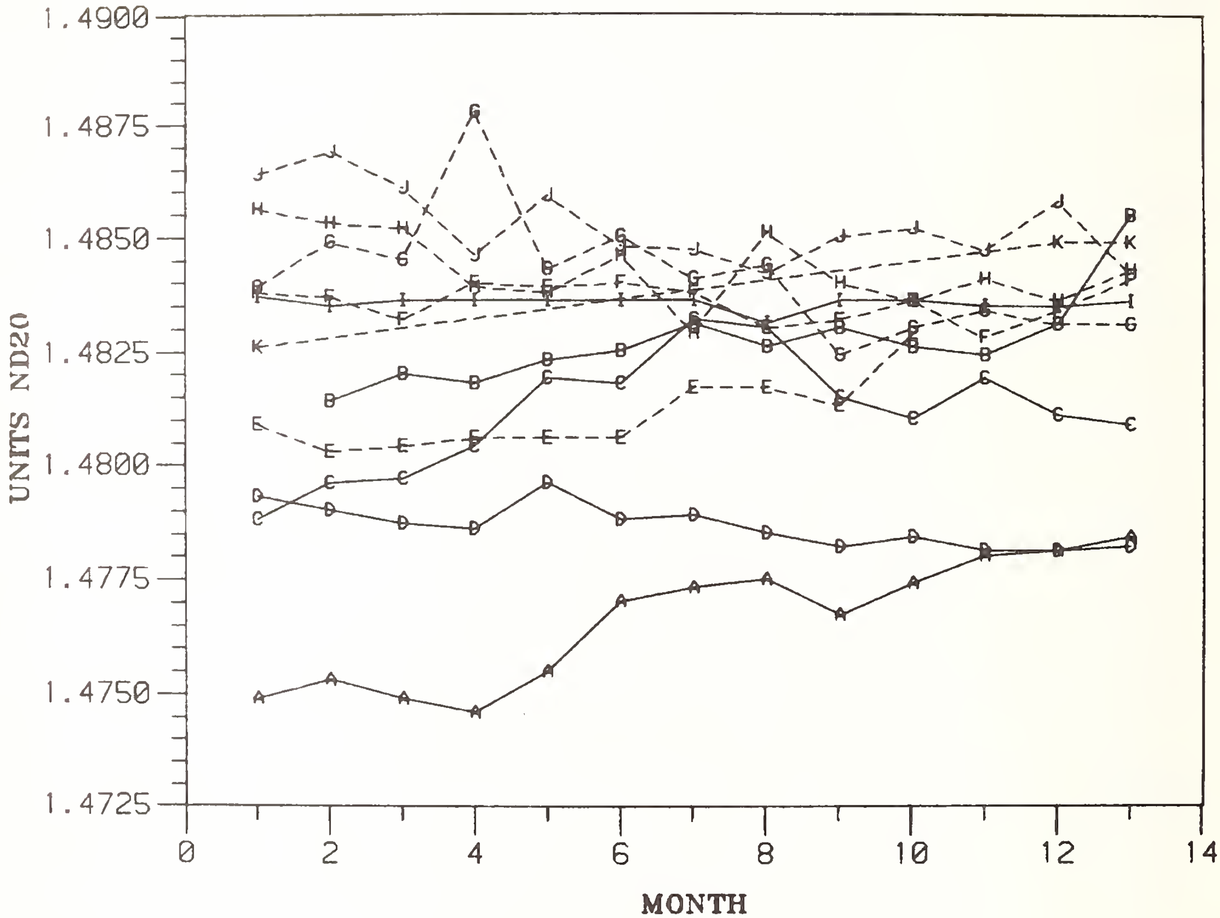


IV

CHEMICAL PROPERTIES

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: CARBONYL ABSORPTION (ABS/CM AT 5.8 MICROMETER) IR SPECTROMETRY LABORATORY: W

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.10	-	.00	.00	.00	2.97	.00	7.66	1.25	.29	-.10
APR 80	.45	.00	.00	.00	.00	2.30	.00	7.95	1.05	2.59	-
MAY 80	.19	.00	-.10	.00	.00	2.30	.00	7.85	.29	.67	-
JUN 80	.00	.00	.00	.00	.00	2.49	.00	12.60	.48	1.72	-
JUL 80	.00	.00	.00	.00	.00	2.85	.00	9.67	.76	.00	-
AUG 80	.00	.00	.00	.00	.00	3.32	.00	11.10	1.42	3.61	-
SEP 80	.00	-.09	.00	-.38	.00	5.03	.00	10.60	1.33	.00	-
OCT 80	.00	.00	-.47	.00	.00	3.32	-.66	9.77	1.23	3.05	-
NOV 80	.00	-.20	-.31	-.41	-.31	3.05	3.56	9.78	.81	1.32	-
DEC 80	.20	-.51	-.31	.81	-.31	3.05	.00	7.64	1.43	2.14	-
JAN 81	.00	-.81	-.81	-1.00	-.71	-	-.31	7.64	.20	1.52	-
FEB 81	.00	-.31	-.51	-.71	-.51	-	-.08	9.67	1.02	.80	-.02
MAR 81	.00	-.05	-.10	-.10	-.08	-	-.07	11.00	1.00	.30	-.07
MEAN	.072	-.164	-.201	-.138	-.148	3.068	.188	9.456	.956	1.385	-.063
STD.DEV.	.136	.259	.262	.432	.238	.785	1.031	1.614	.431	1.188	.040
MIN	.00	-.81	-.81	-1.00	-.71	2.30	-.66	7.64	.20	.00	-.10
MAX	.45	.00	.00	.81	.00	5.03	3.56	12.60	1.43	3.61	-.02

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: NITRATES ABSORPTION (ABS/CM AT 6.2 MICROMETER) IR SPECTROMETRY LABORATORY: W

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.96	-	.00	.00	.00	1.63	2.11	3.64	1.05	2.30	.00
APR 80	.77	.00	.00	-1.70	.00	.48	.76	3.83	1.44	2.59	-
MAY 80	-.48	-1.60	.00	-1.30	.00	.96	.48	3.26	.77	2.59	-
JUN 80	-1.00	-.96	.00	-1.50	.00	.86	.02	4.69	.10	1.72	-
JUL 80	.00	-.19	.77	-2.50	.00	.77	.48	3.07	.19	2.28	-
AUG 80	.57	.00	.85	-1.90	.00	1.23	.95	4.36	1.04	1.52	-
SEP 80	.95	.00	1.14	-.95	.00	1.23	1.23	4.08	.66	1.73	-
OCT 80	.38	-.57	1.61	-1.70	.00	.85	.00	3.89	1.23	2.04	-
NOV 80	.81	-.51	1.22	-3.10	.00	.20	1.32	3.05	1.02	1.73	-
DEC 80	1.73	-1.00	1.22	-1.70	.20	2.04	1.22	3.05	1.22	1.22	-
JAN 81	1.22	-1.50	.61	-3.40	.00	-	.30	4.07	.92	1.52	-
FEB 81	.00	-.81	1.02	-3.10	.00	-	.00	3.56	1.63	1.80	1.80
MAR 81	1.30	-.06	.03	-.20	.00	-	.00	2.34	1.53	1.75	1.60
MEAN	.555	-.600	.652	-1.773	.015	1.025	.682	3.607	.985	1.907	1.133
STD.DEV.	.761	.579	.583	1.054	.055	.536	.657	.642	.467	.423	.987
MIN	-1.00	-1.60	.00	-3.40	.00	.20	.00	2.34	.10	1.22	.00
MAX	1.73	.00	1.61	.00	.20	2.04	2.11	4.69	1.63	2.59	1.80

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: TERMINAL TERTIARY CARBON ABSORPTION (ABS/CM AT 8.15 MICROMETER) IR SPECTROMETRY LABORATORY: W

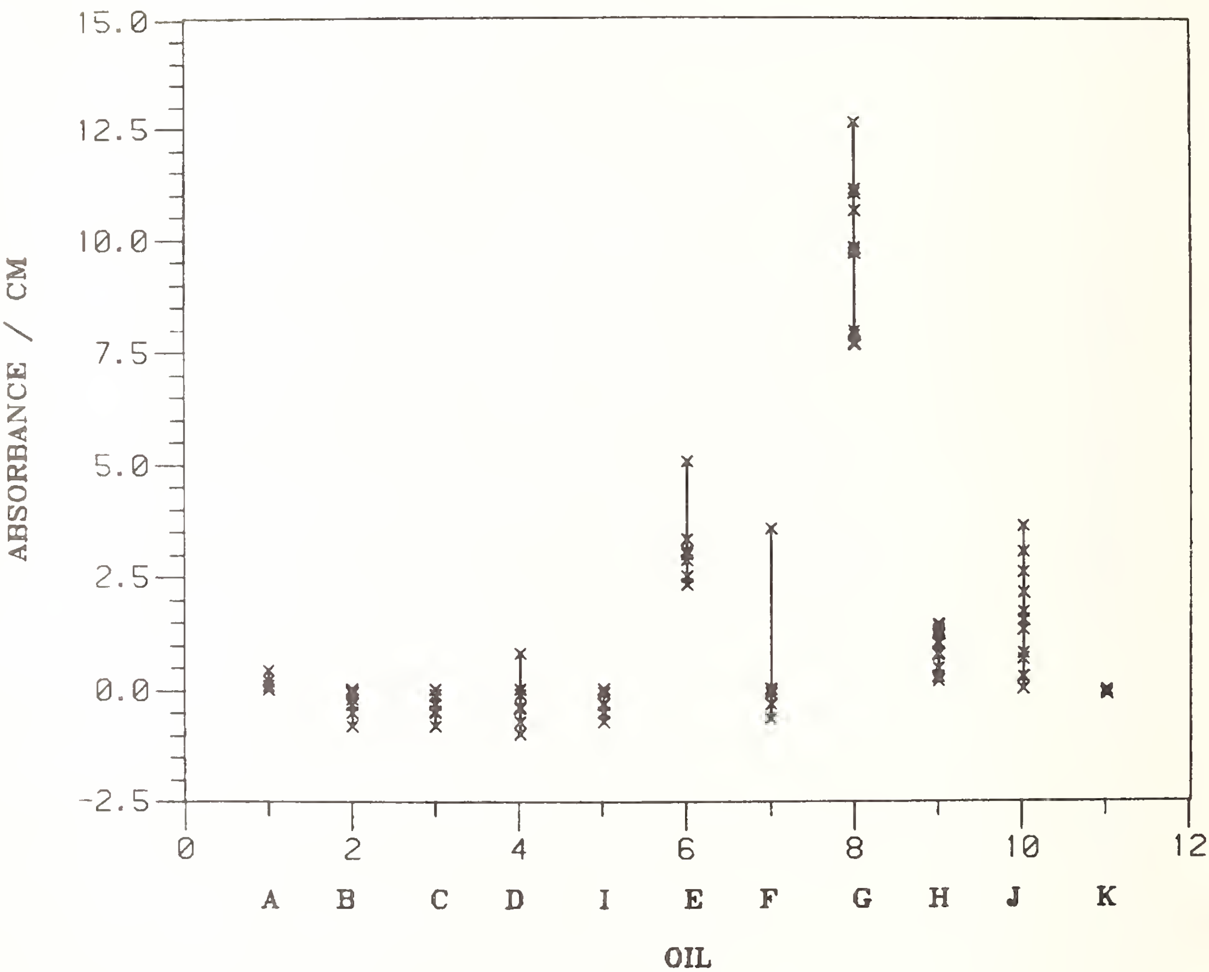
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	-.49	-	.00	.00	.00	.00	.00	.00	2.97	.00	.19
APR 80	-.67	.00	.00	.00	.00	.10	.00	.57	2.30	.00	-
MAY 80	-.67	.19	.00	.00	.00	.00	.00	.00	2.49	.00	-
JUN 80	-.77	.10	.29	.00	.00	.00	.02	.00	2.30	.00	-
JUL 80	-.90	.00	.00	.00	.00	.00	.00	.00	2.68	.00	-
AUG 80	.00	.00	.00	.00	.00	.09	.00	.00	2.66	.00	-
SEP 80	.00	.00	.00	.00	.00	.00	.00	2.94	3.04	.00	-
OCT 80	-1.50	.00	.00	.00	.00	.19	.66	1.89	2.94	-.41	-
NOV 80	-.20	.00	.00	.00	.00	-.31	.31	2.55	3.26	.00	-
DEC 80	.00	.00	.00	.00	.00	.00	.20	1.02	3.05	.00	-
JAN 81	.00	.00	.00	.00	.00	-	.00	.61	2.04	.00	-
FEB 81	-.20	.00	.00	.00	.00	-	.00	.00	2.34	.00	1.00
MAR 81	.00	.00	.00	.02	.00	-	.00	.00	2.55	.00	1.60
MEAN	-.415	.024	.022	.002	.000	.007	.092	.737	2.663	-.032	.930
STD.DEV.	.468	.060	.080	.006	.000	.129	.196	1.057	.367	.114	.708
MIN	-1.50	.00	.00	.00	.00	-.31	.00	.00	2.04	-.41	.19
MAX	.00	.19	.29	.02	.00	.19	.66	2.94	3.26	.00	1.60

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

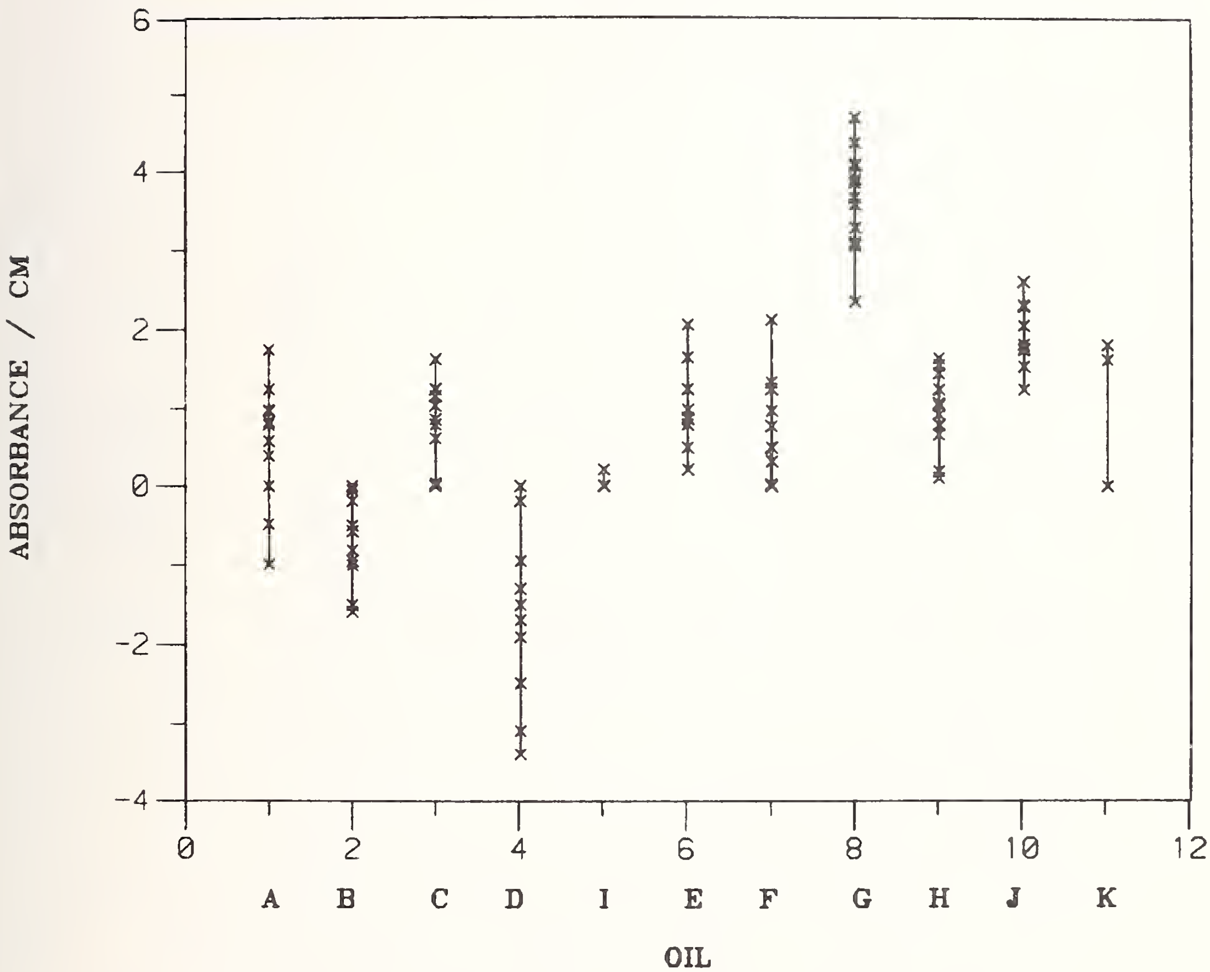
TEST: P-O-C ABSORPTICN (ABS/CM AT 10.3 MICROMETER) IR SPECTROMETRY LABORATORY: W

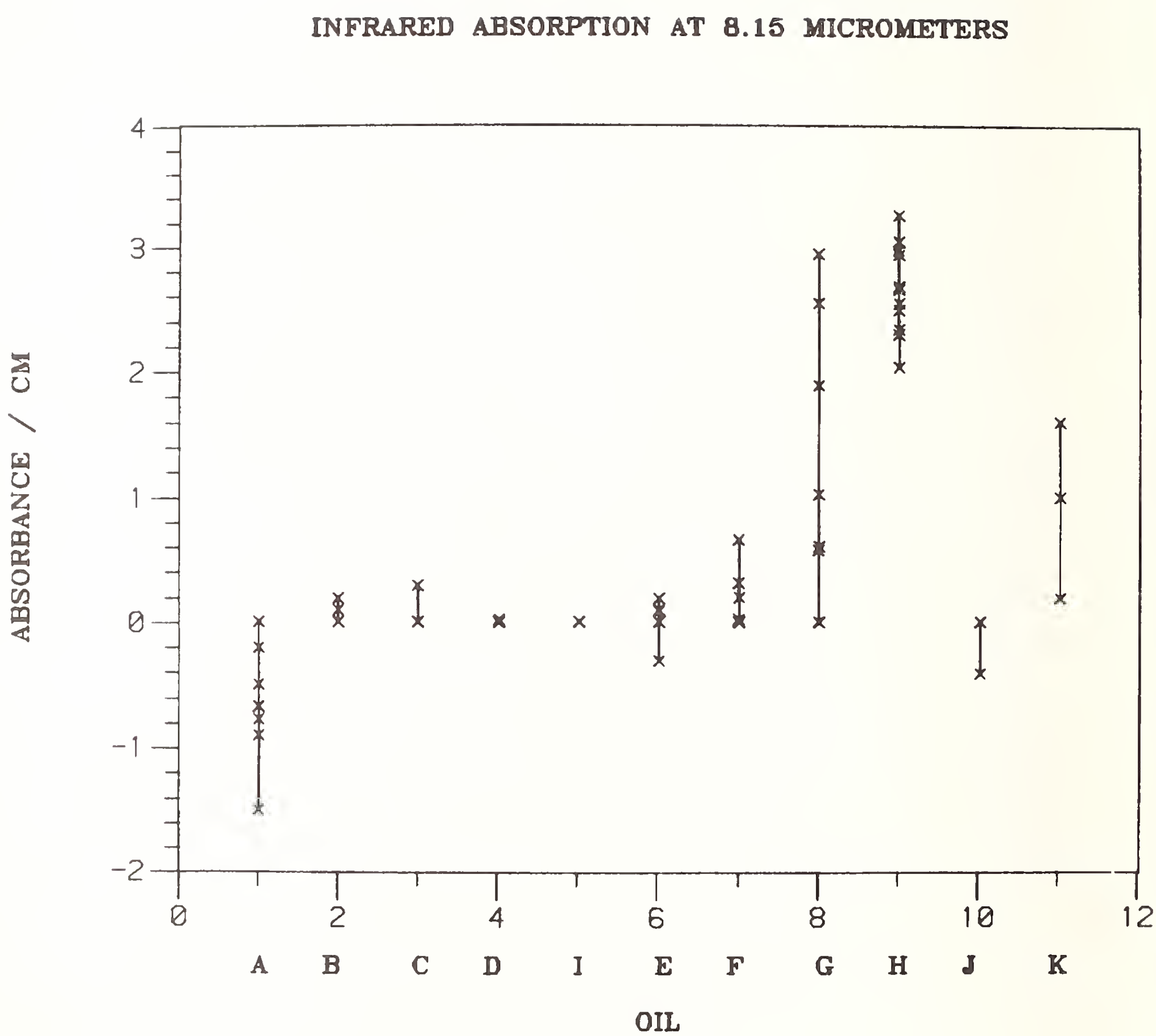
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	6.70	-	.00	.00	.00	.00	.00	2.78	.00	.00	.00
APR 80	7.18	.00	.00	.00	.00	.00	.00	2.01	.00	.00	-
MAY 80	6.90	.00	.00	.00	.00	.00	.00	2.59	.00	.00	-
JUN 80	6.70	.00	.00	.00	.00	.29	.00	1.72	.29	.10	-
JUL 80	6.99	.00	.00	.00	.00	.10	.00	2.59	.00	.57	-
AUG 80	12.40	.00	.00	.00	.00	.66	.19	3.23	.47	.00	-
SEP 80	13.90	.57	.00	1.71	.00	.57	.00	9.77	1.23	.31	-
OCT 80	13.90	.57	.00	1.61	.00	1.04	.00	2.28	1.33	.00	-
NOV 80	7.13	2.04	.00	1.73	1.02	.51	.00	2.55	2.04	.92	-
DEC 80	12.20	1.53	.00	2.55	.00	.20	.00	1.32	1.02	.00	-
JAN 81	10.10	1.32	.51	.00	-.31	-	.00	1.73	.00	.00	-
FEB 81	13.20	.00	.00	.00	.00	-	.00	7.13	.00	.00	.00
MAR 81	13.23	.00	.00	.00	.00	-	.00	2.75	.00	.02	.00
MEAN	10.041	.502	.039	.585	.055	.337	.015	3.265	.491	.148	.000
STD.DEV.	3.140	.730	.141	.938	.302	.350	.053	2.420	.687	.288	.000
MIN	6.70	.00	.00	.00	-.31	.00	.00	1.32	.00	.00	.00
MAX	13.90	2.04	.51	2.55	1.02	1.04	.19	9.77	2.04	.92	.00

INFRARED ABSORPTION AT 5.8 MICROMETERS

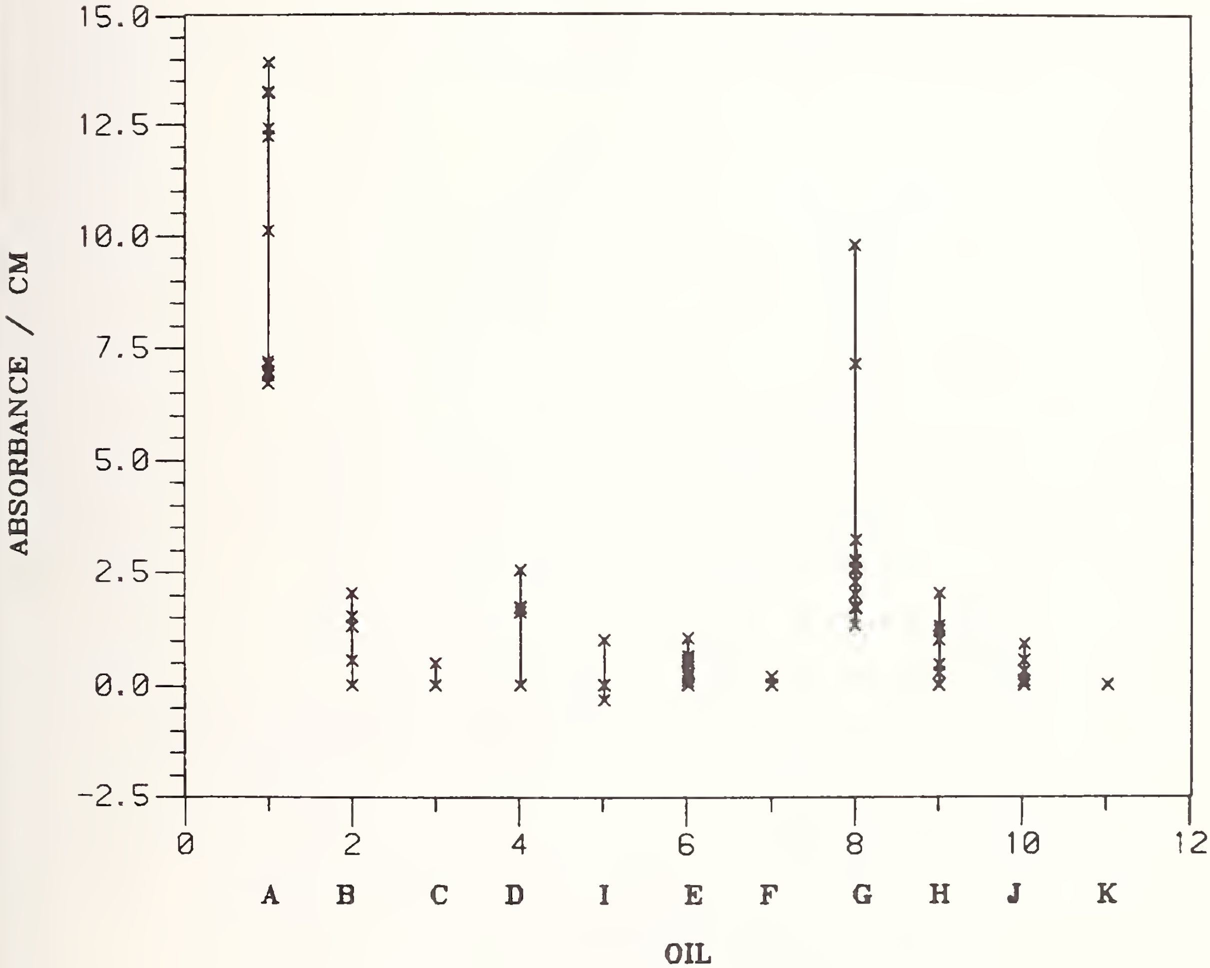


INFRARED ABSORPTION AT 6.2 MICROMETERS




INFRARED ABSORPTION AT 8.15 MICROMETERS
ABSORBANCE / CM
4
3
2
1
0
-1
-2
0
2
4
6
8
10
12
A
B
C
D
I
E
F
G
H
J
K
OIL

INFRARED ABSORPTION AT 10.3 MICROMETERS



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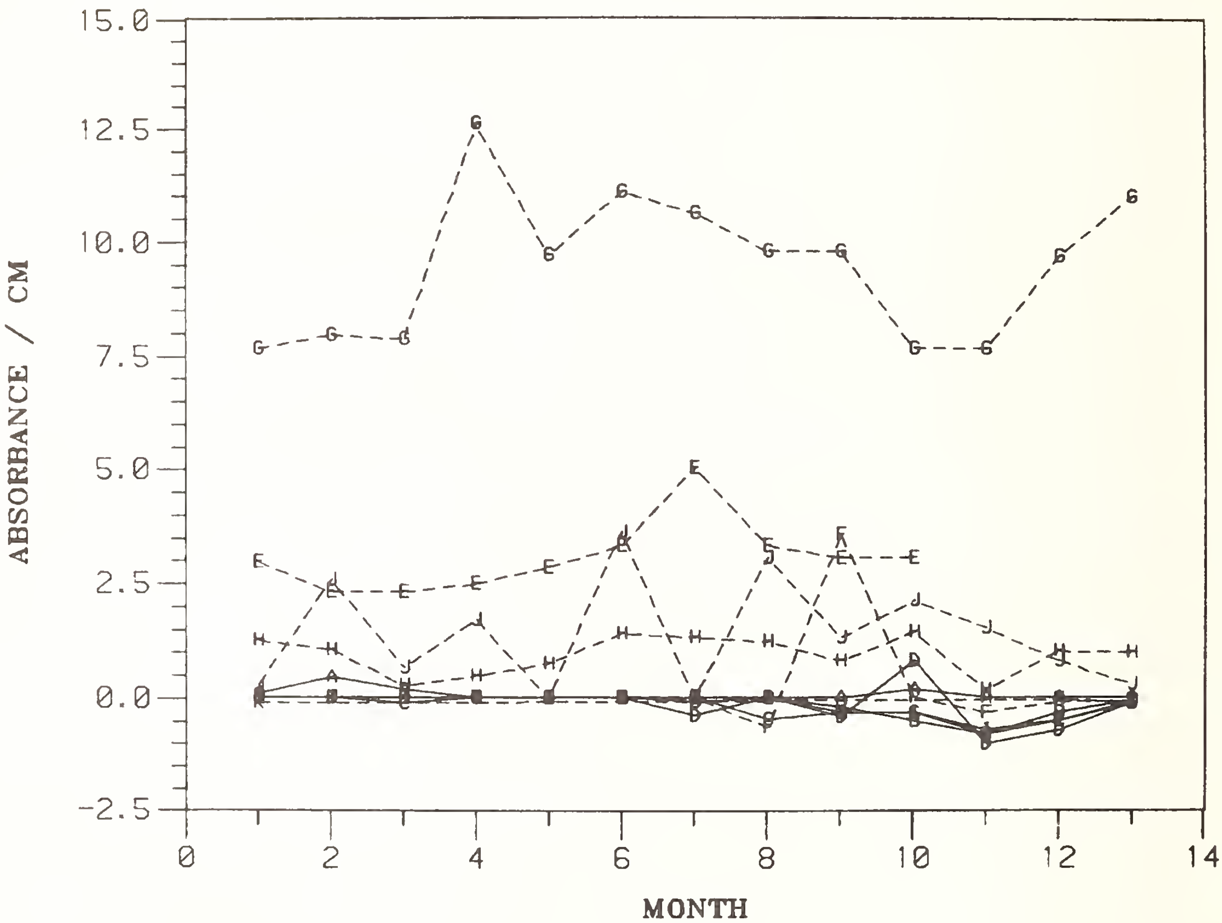

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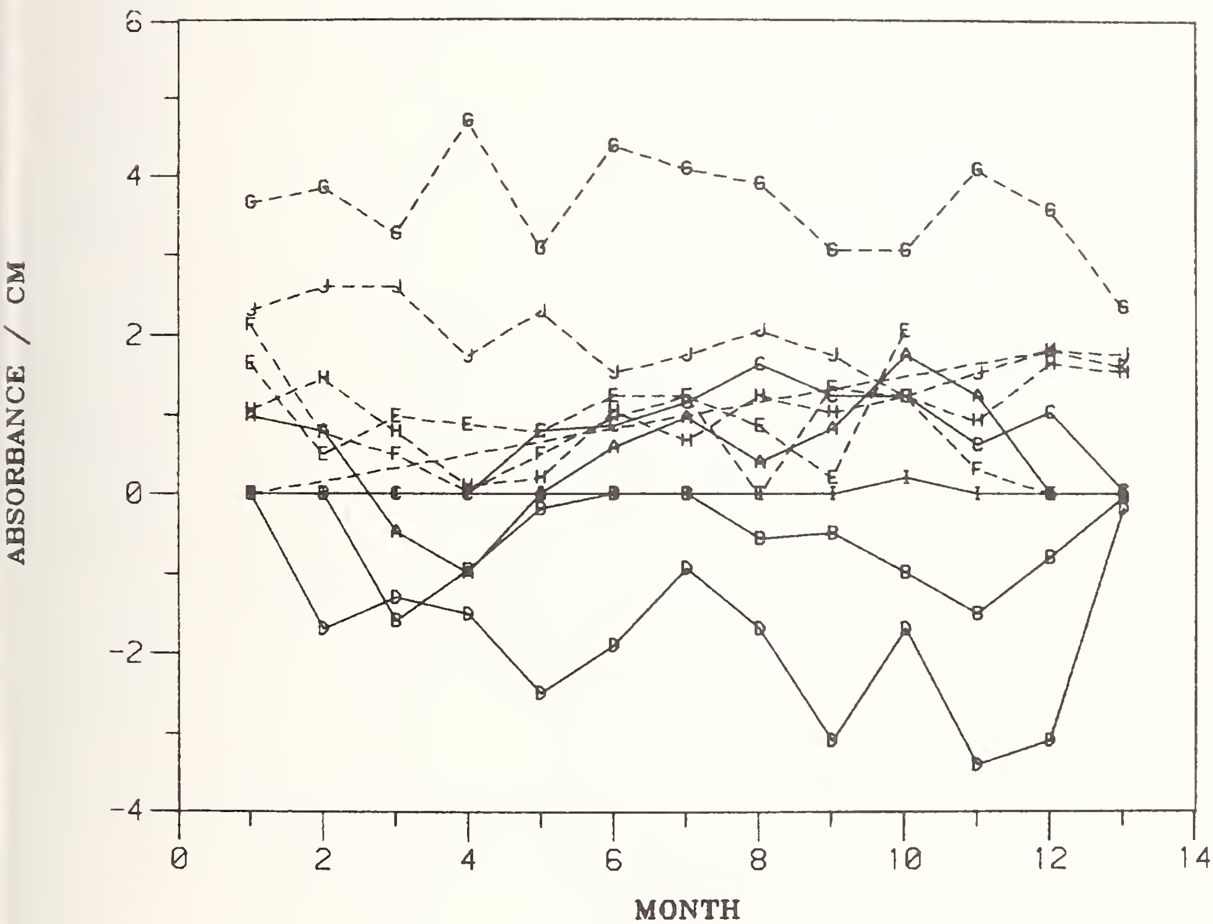

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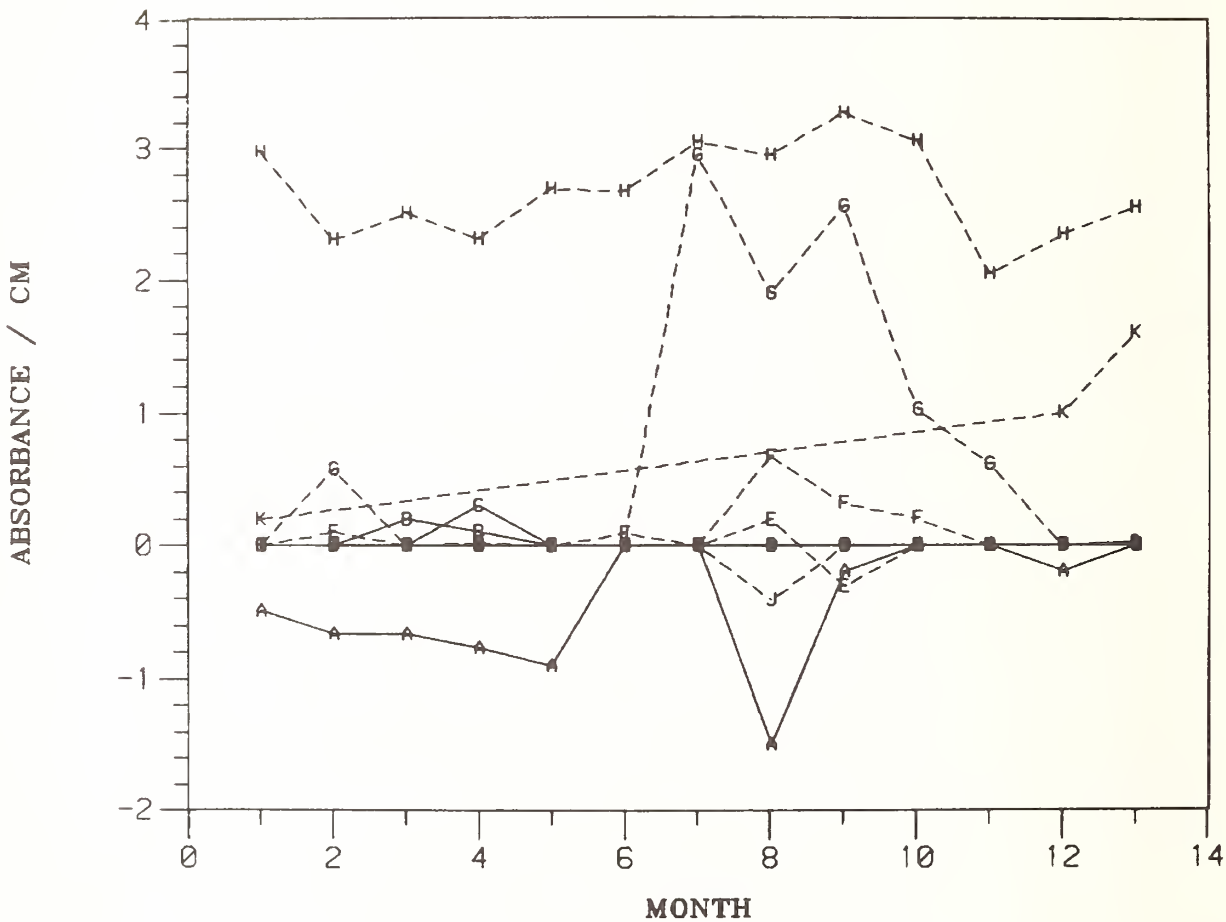

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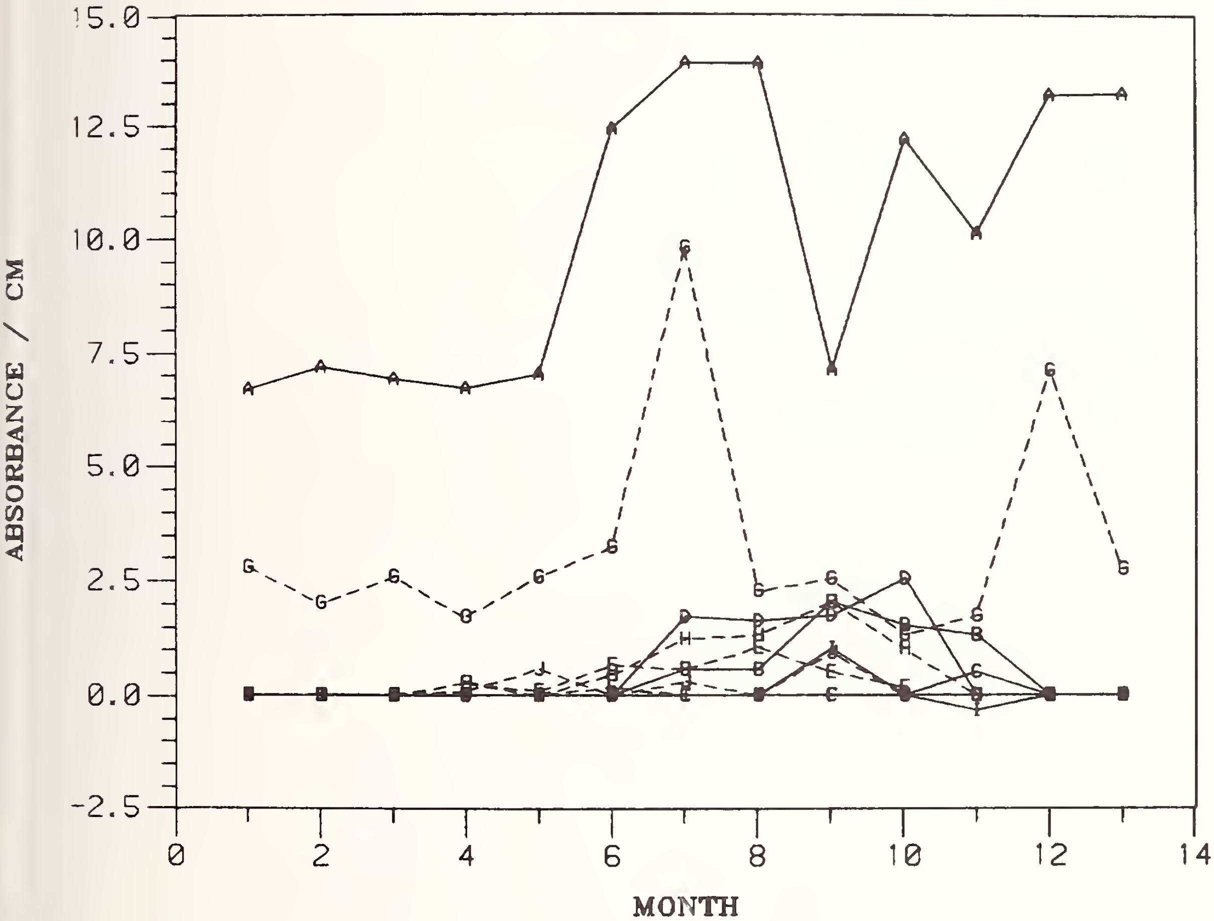


ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: CAFEONYL ABSORPTION CHANGE (UNITS AT 5.85 MICROMETERS VS MAR 80 SAMPLE) DIR SPECTROMETRY   LABORATORY: W

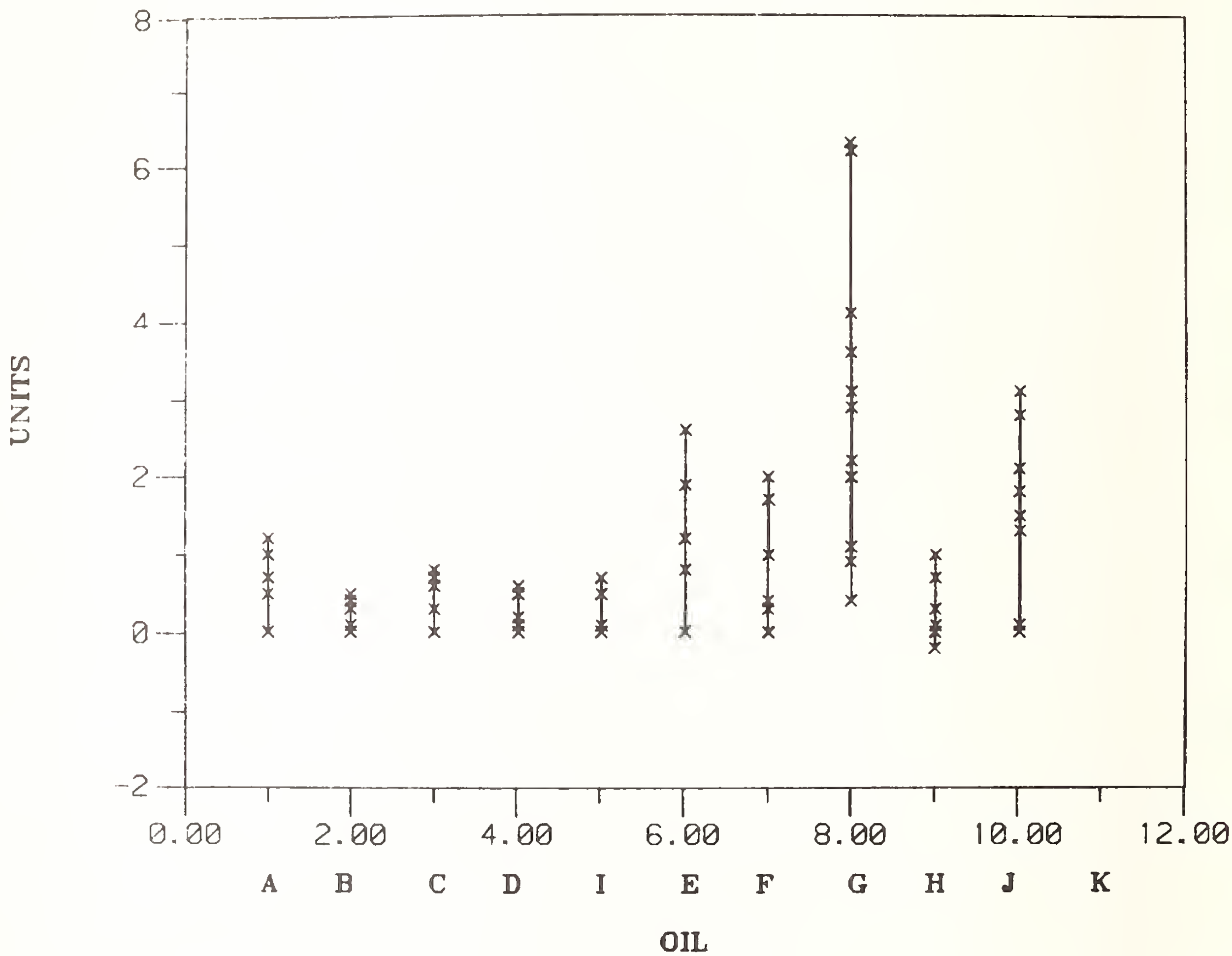
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	--	--	--	--
APR 80	.5	.0	.0	.0	--	.0	.0	1.1	.0	2.1	-
MAY 80	.0	.0	.0	.0	--	.0	.0	6.3	-.2	.0	-
JUN 80	.0	.0	.0	.0	--	.0	1.7	6.2	.0	1.3	-
JUL 80	.5	.0	.0	.0	--	2.6	.0	2.0	.0	3.1	-
AUG 80	.0	.0	.0	.0	.0	1.2	.0	4.1	.0	.0	-
SEP 80	.7	.0	.3	.0	.0	1.9	.0	2.9	.1	.0	-
OCT 80	.7	.0	.0	.0	.0	1.2	.3	3.6	1.0	3.1	-
NOV 80	1.2	.4	.8	.6	.5	1.2	2.0	3.1	.0	1.5	-
DEC 80	1.2	.3	.0	.5	.5	.8	1.0	2.0	.7	2.8	-
JAN 81	1.0	.4	.7	.2	.7	-	.4	.9	.3	1.8	-
FEB 81	1.0	.5	.6	.5	.7	-	.0	2.2	.0	.1	--
MAR 81	.0	.1	.0	.1	.1	-	.0	.4	.1	.1	--
MEAN	.57	.14	.20	.16	.31	.99	.45	2.90	.17	1.32	.00
STD.DEV.	.48	.20	.32	.24	.32	.90	.72	1.91	.34	1.27	.00
MIN	.0	.0	.0	.0	.0	.0	.0	.4	-.2	.0	.0
MAX	1.2	.5	.8	.6	.7	2.6	2.0	6.3	1.0	3.1	.0

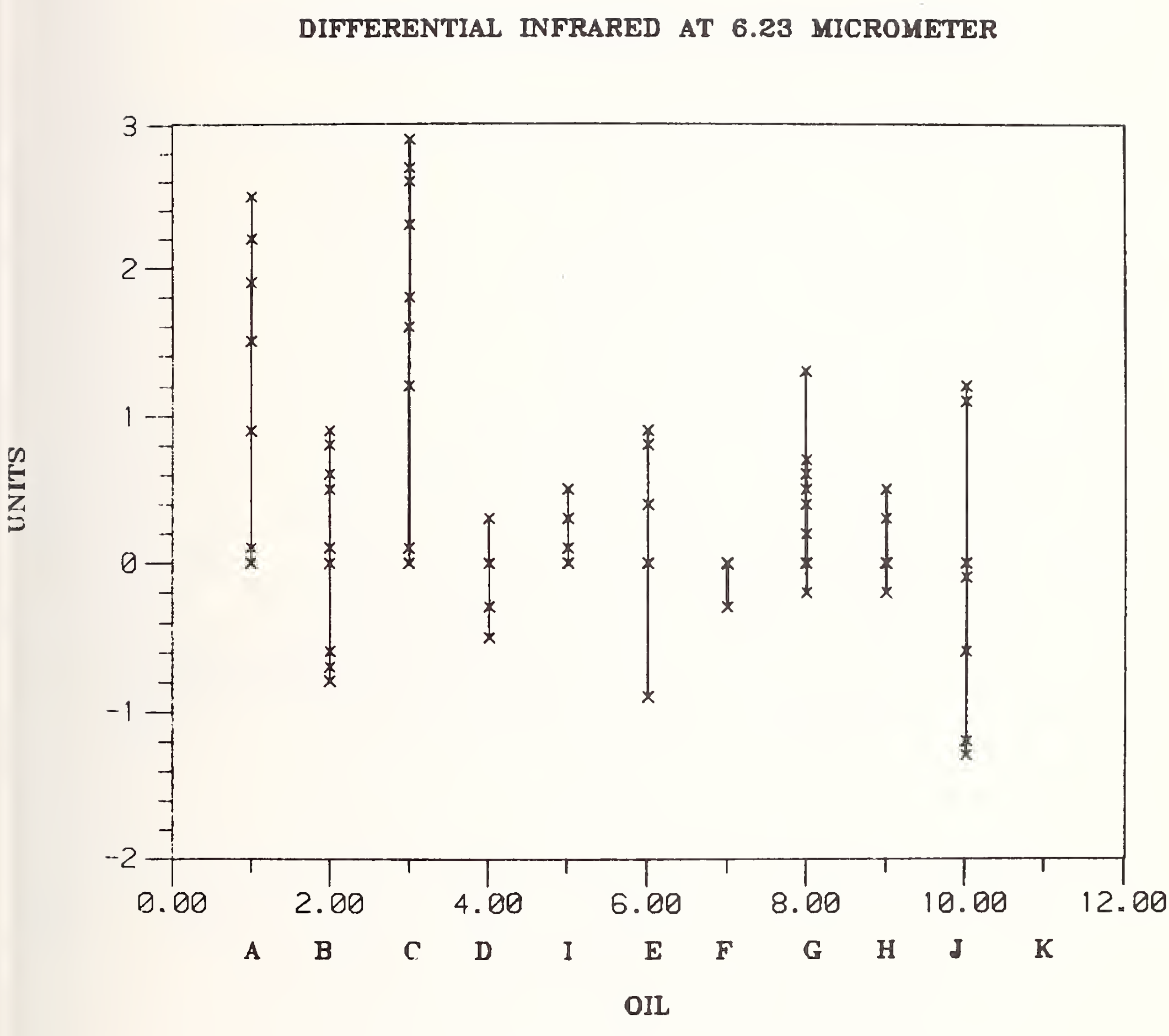
ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: ORGANIC NITRATES CHANGE (UNITS AT 6.23 MICROMETERS VS MAR 80 SAMPLE) DIR SPECTROMETRY LABORATORY: W

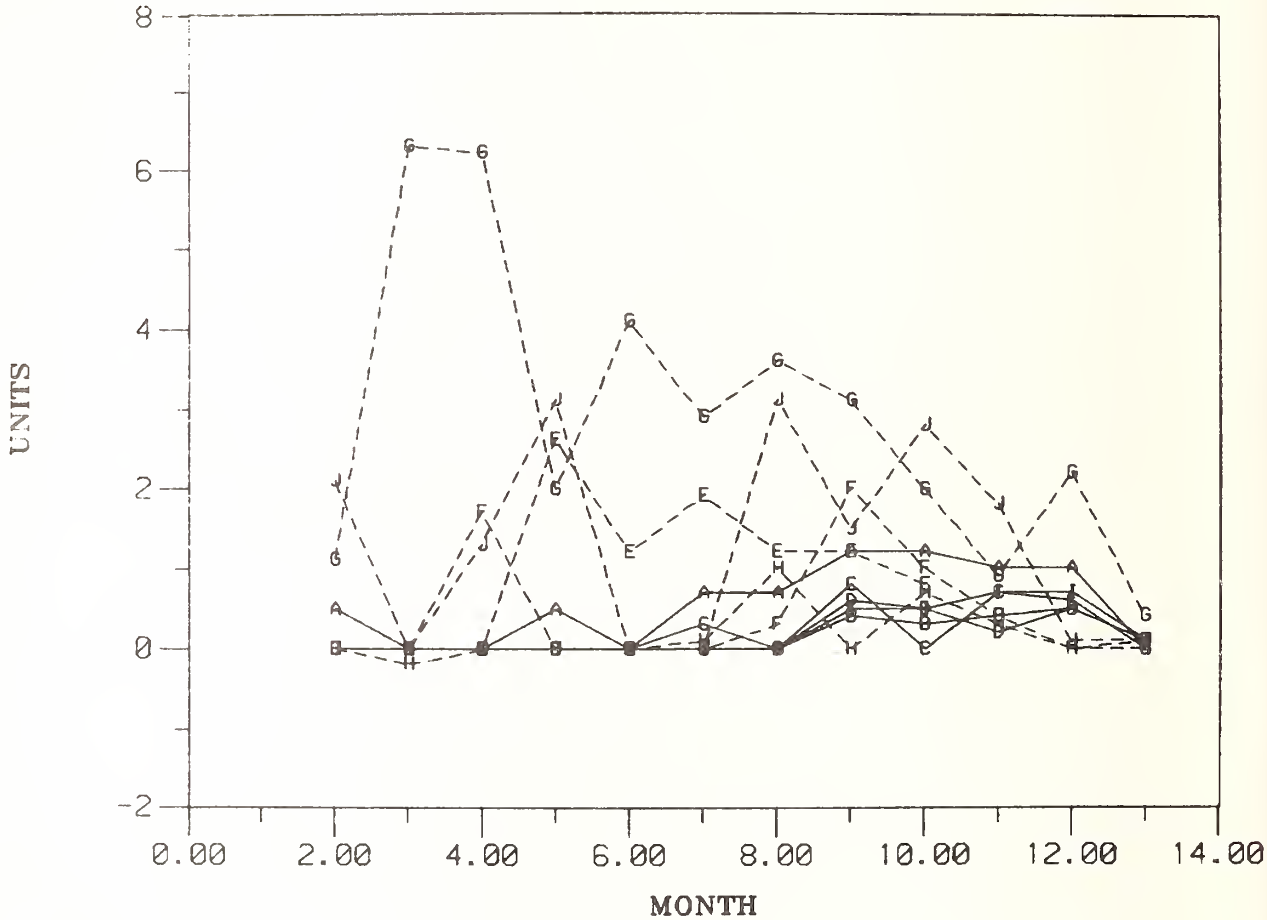
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	--	--	--	--
APR 80	.0	-.7	.0	.0	--	-.9	.0	.0	.0	.0	-
MAY 80	.0	-.8	.0	-.3	--	.0	.0	.0	.0	.0	-
JUN 80	.0	-.8	-	-.5	--	.0	.0	1.3	-.2	-.6	-
JUL 80	.0	-.6	.0	.0	--	.0	.0	.0	.0	.0	-
AUG 80	.9	.0	1.8	.0	.0	.9	.0	.6	.0	.0	-
SEP 80	1.5	.6	2.9	.0	.0	.0	.0	.7	.0	-1.2	-
OCT 80	1.9	.0	2.7	.0	.0	.0	-.3	.5	.5	-1.3	-
NOV 80	1.5	.8	2.6	.0	.3	.4	.0	.0	.0	-1.2	-
DEC 80	2.2	.5	1.6	.3	.3	.8	.0	-.2	.0	1.1	-
JAN 81	2.2	.6	1.2	.0	.5	-	.0	.4	.3	1.2	-
FEB 81	2.5	.9	2.3	.0	.5	-	.0	.0	.0	.0	--
MAR 81	.1	.1	.1	.0	.1	-	.0	.2	.0	-.1	--
MEAN	1.07	.05	1.38	-.04	.21	.13	-.02	.29	.05	-.17	.00
STD.DEV.	1.01	.64	1.18	.19	.22	.53	.09	.43	.18	.81	.00
MIN	.0	-.8	.0	-.5	.0	-.9	-.3	-.2	-.2	-1.3	.0
MAX	2.5	.9	2.9	.3	.5	.9	.0	1.3	.5	1.2	.0

DIFFERENTIAL INFRARED AT 5.85 MICROMETER

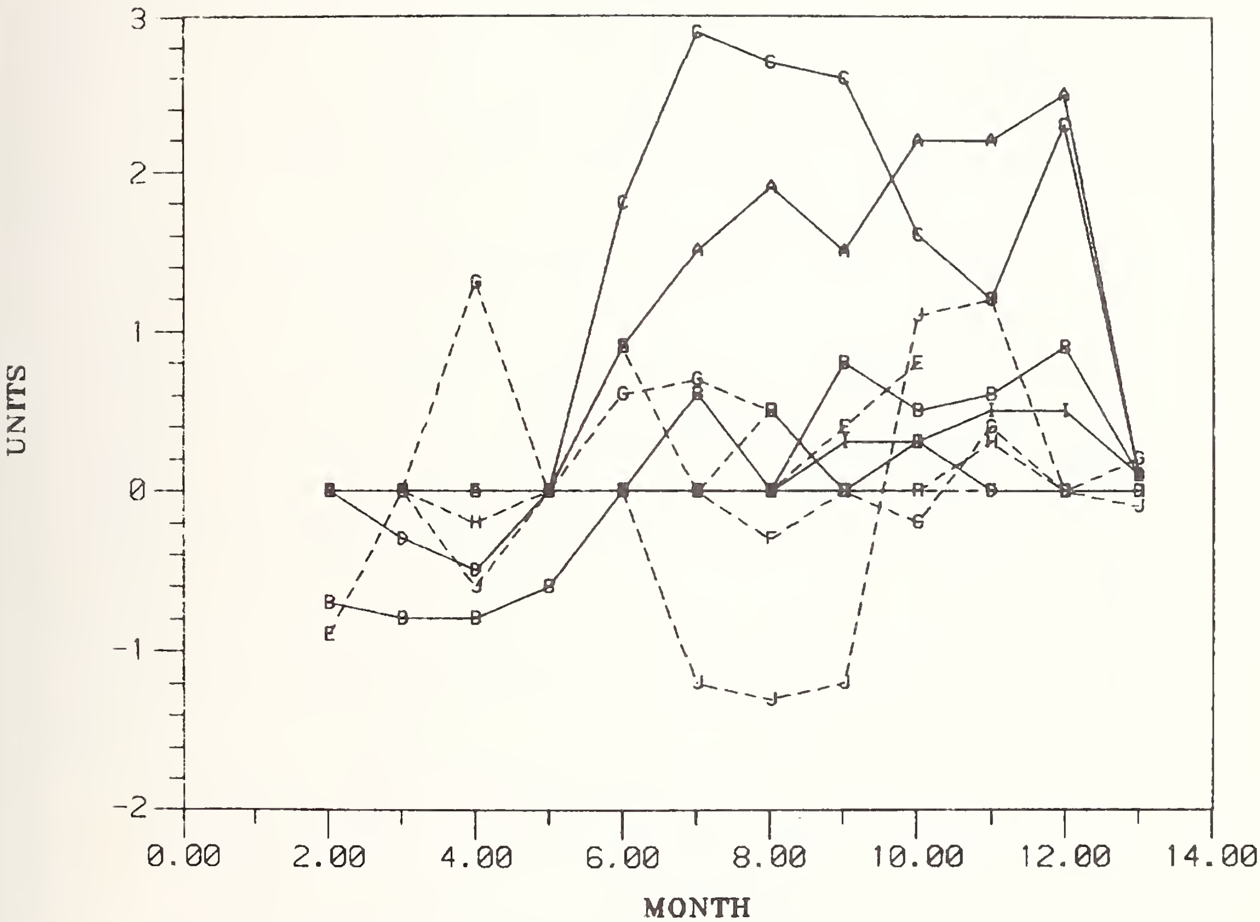



DIFFERENTIAL INFRARED AT 6.23 MICROMETER
UNITS
3
2
1
0
-1
-2
0.00
2.00
4.00
6.00
8.00
10.00
12.00
A
B
C
D
I
E
F
G
H
J
K
OIL

DIFFERENTIAL INFRARED AT 5.85 MICROMETER



DIFFERENTIAL INFRARED AT 6.23 MICROMETER

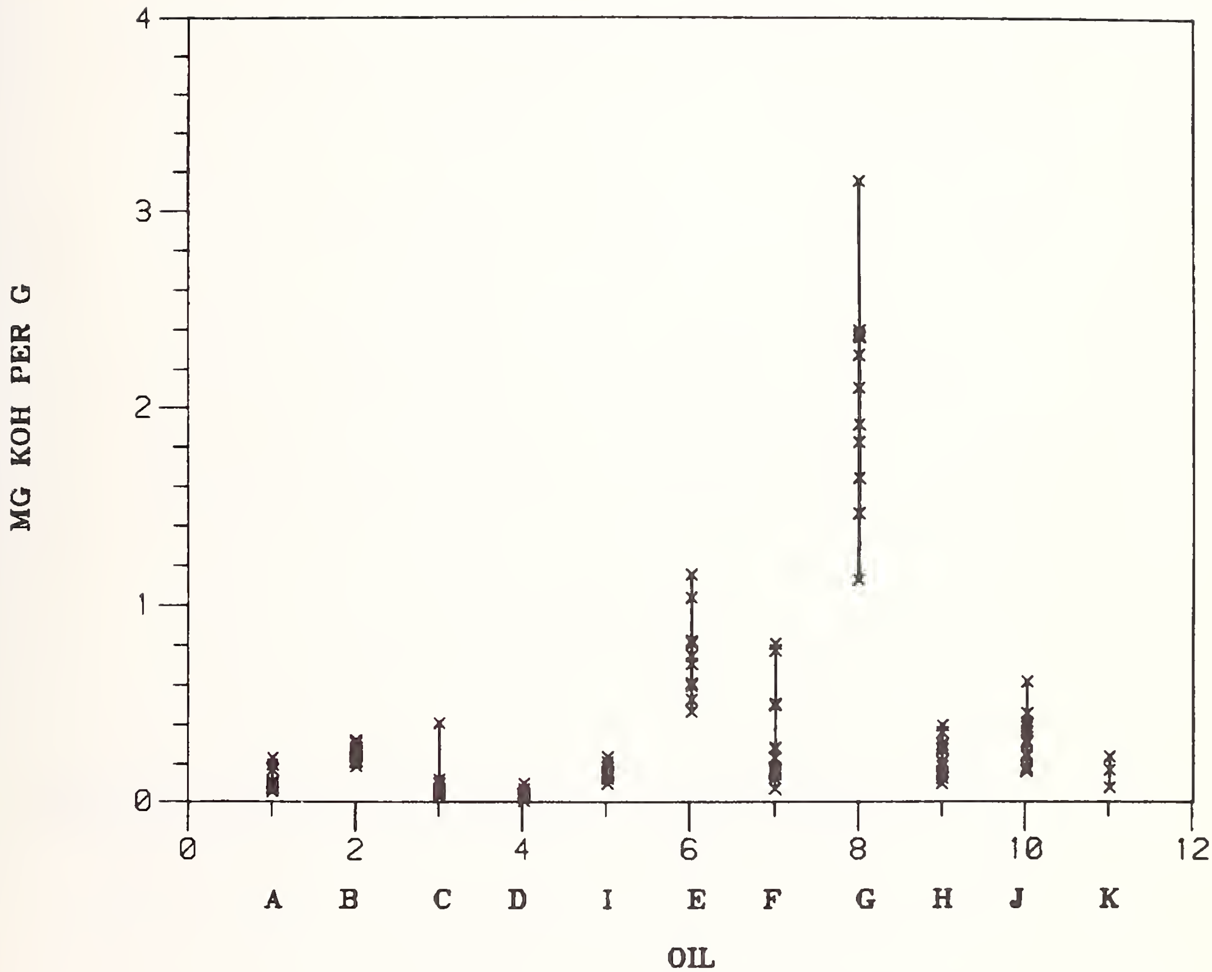


ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: SAFCNIFICATION NUMBER(MG KOH/G: TD=TOO DARK) ASTM D94 LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.05	-	.05	.02	.17	.60	.15	1.46	.09	.17	.07
APR 80	.06	.23	.03	.04	.14	.52	.22	2.10	.14	.40	-
MAY 80	.06	.24	.02	.06	.17	.46	.16	1.91	.15	.15	-
JUN 80	.08	.18	.11	.02	.14	.59	.80	2.37	.27	.23	-
JUL 80	.06	.21	.40	.03	.09	1.03	.12	1.12	.09	.15	-
AUG 80	.16	.20	.06	.04	.23	.74	.28	TD	.39	.61	-
SEP 80	.16	.24	.05	.02	.13	1.15	.27	2.35	.18	.16	-
OCT 80	.16	.27	.04	.04	.15	.82	.06	2.39	.35	.45	-
NOV 80	.07	.27	.06	.00	.15	.80	.77	TD	.29	.30	-
DEC 80	.10	.28	.05	.03	.14	.70	.49	1.64	.20	.31	-
JAN 81	.10	.25	.04	.02	.12	-	.14	1.82	.12	.36	-
FEB 81	.22	.31	.09	.06	.20	-	.17	2.26	.18	.38	.16
MAR 81	.19	.30	.04	.09	.15	-	.50	3.15	.26	.24	.23
MEAN	.113	.248	.080	.036	.152	.741	.318	2.052	.208	.301	.153
STD.DEV.	.058	.040	.099	.023	.035	.219	.246	.549	.097	.138	.080
MIN	.05	.18	.02	.00	.09	.46	.06	1.12	.09	.15	.07
MAX	.22	.31	.40	.09	.23	1.15	.80	3.15	.39	.61	.23

SAPONIFICATION NUMBER



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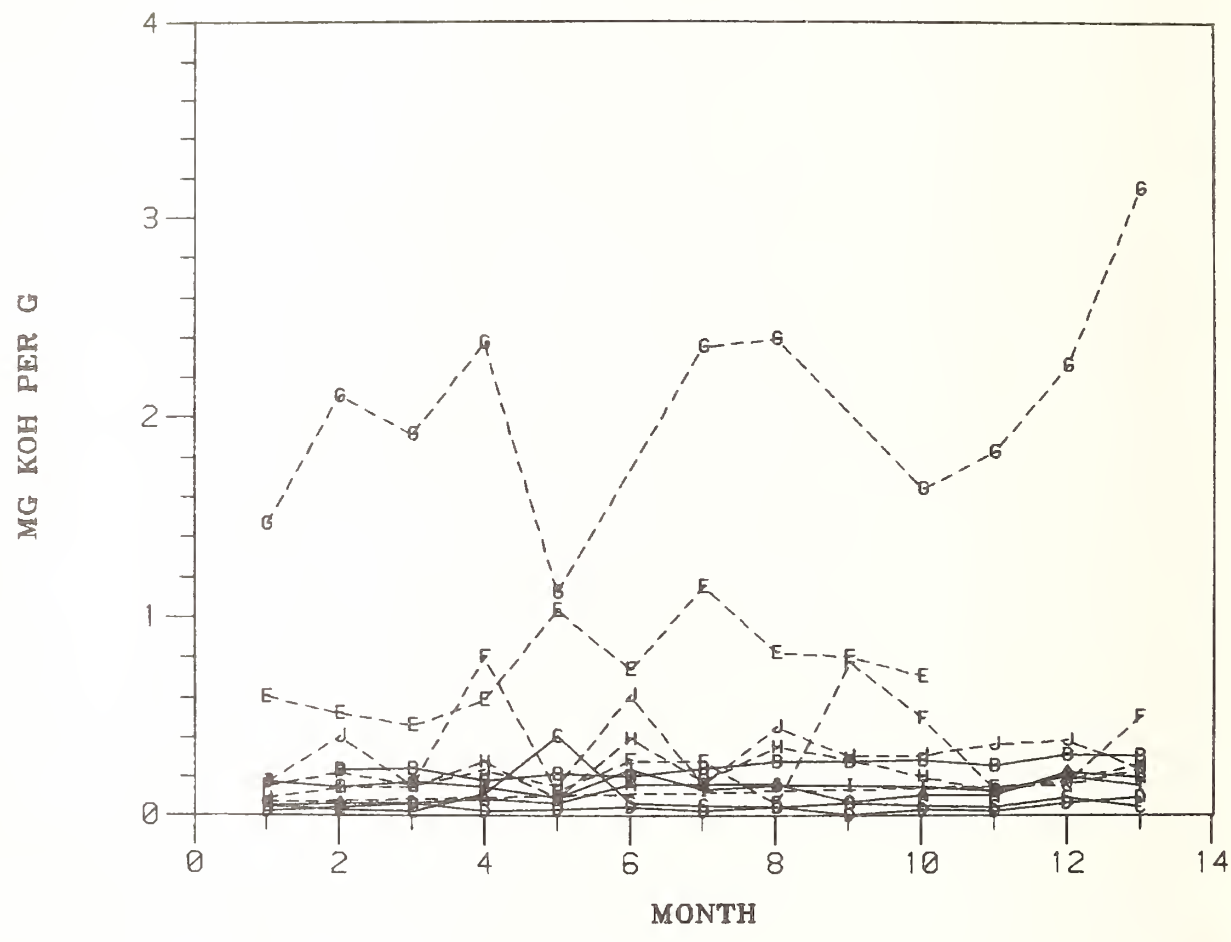
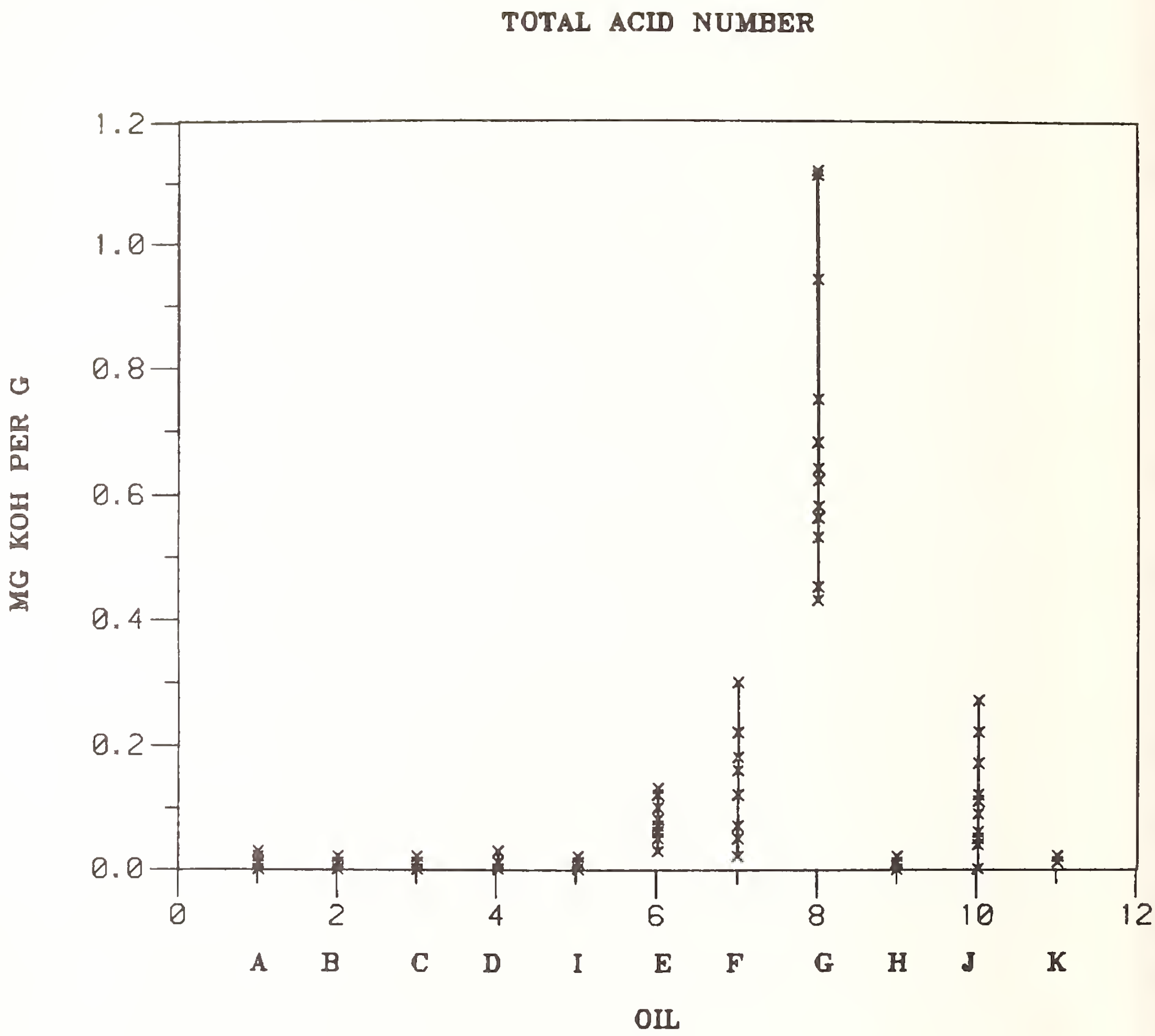


ASTM/NBS BASESTOCK CONSISTENCY STUDY

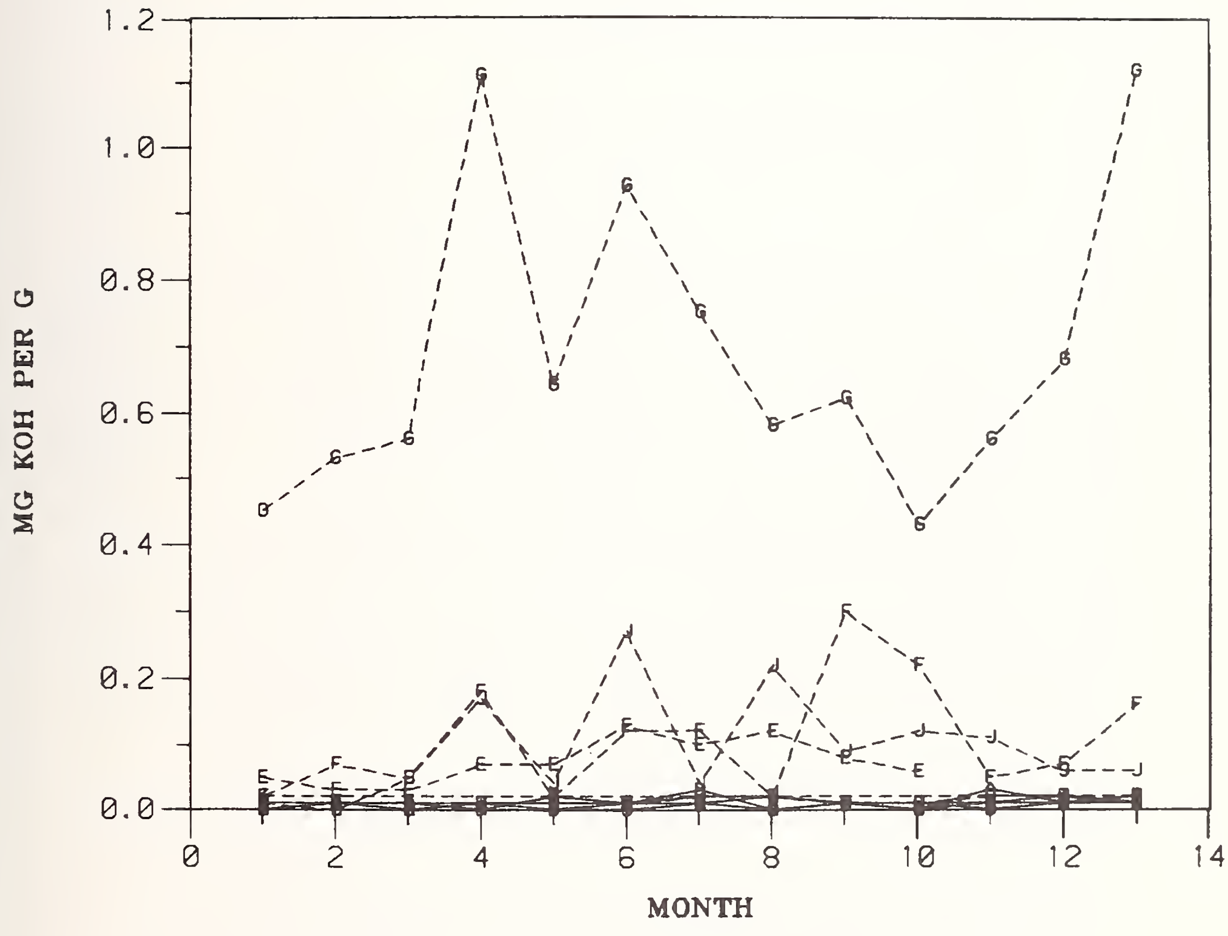
TEST: TOTAL ACID NUMBER(MG KOH/G) ASTM D664 LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.00	-	.00	.00	.01	.05	.02	.45	.01	.00	.02
APR 80	.01	.00	.01	.01	.01	.03	.07	.53	.00	.00	-
MAY 80	.01	.00	.00	.01	.01	.03	.05	.56	.00	.05	-
JUN 80	.00	.01	.01	.00	.01	.07	.18	1.11	.01	.17	-
JUL 80	.02	.00	.00	.00	.01	.07	.02	.64	.01	.04	-
AUG 80	.01	.00	.01	.01	.01	.13	.12	.94	.01	.27	-
SEP 80	.01	.01	.02	.03	.01	.10	.12	.75	.02	.04	-
OCT 80	.00	.00	.02	.00	.02	.12	.02	.58	.02	.22	-
NOV 80	.01	.01	.01	.01	.01	.08	.30	.62	.01	.09	-
DEC 80	.00	.01	.01	.01	.00	.06	.22	.43	.01	.12	-
JAN 81	.03	.01	.00	.00	.01	-	.05	.56	.02	.11	-
FEB 81	.01	.01	.01	.01	.02	-	.07	.68	.02	.06	.02
MAR 81	.02	.02	.01	.01	.01	-	.16	1.12	.02	.06	.01
MEAN	.010	.007	.008	.008	.011	.074	.108	.690	.012	.095	.017
STD.DEV.	.009	.007	.007	.008	.005	.034	.087	.229	.007	.082	.006
MIN	.00	.00	.00	.00	.00	.03	.02	.43	.00	.00	.01
MAX	.03	.02	.02	.03	.02	.13	.30	1.12	.02	.27	.02



TOTAL ACID NUMBER
MG KOH PER G
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
2
4
6
8
10
12
A B C D I E F G H J K
OIL

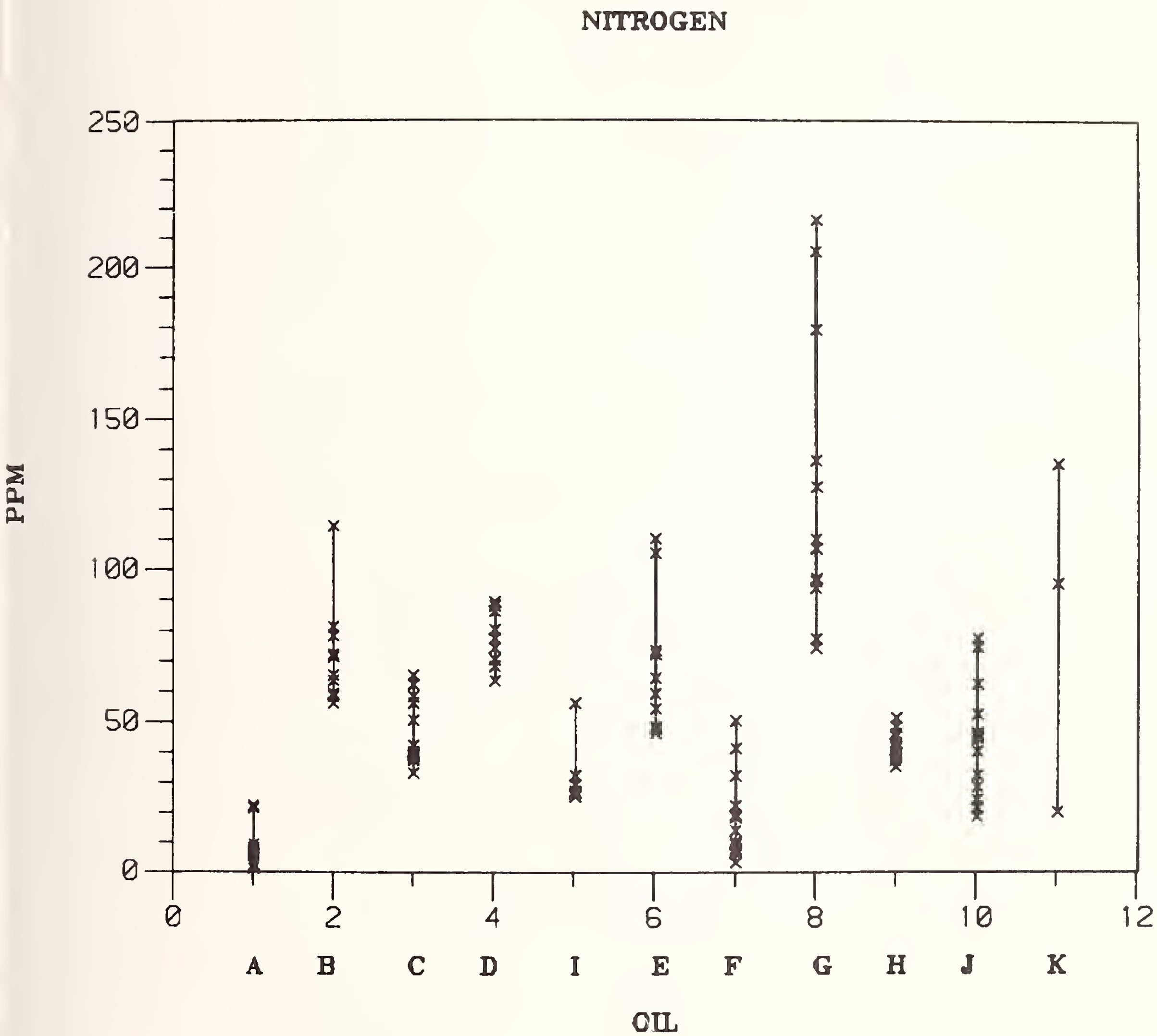
TOTAL ACID NUMBER



ASTM/NBS BASESTOCK CONSISTENCY STUDY

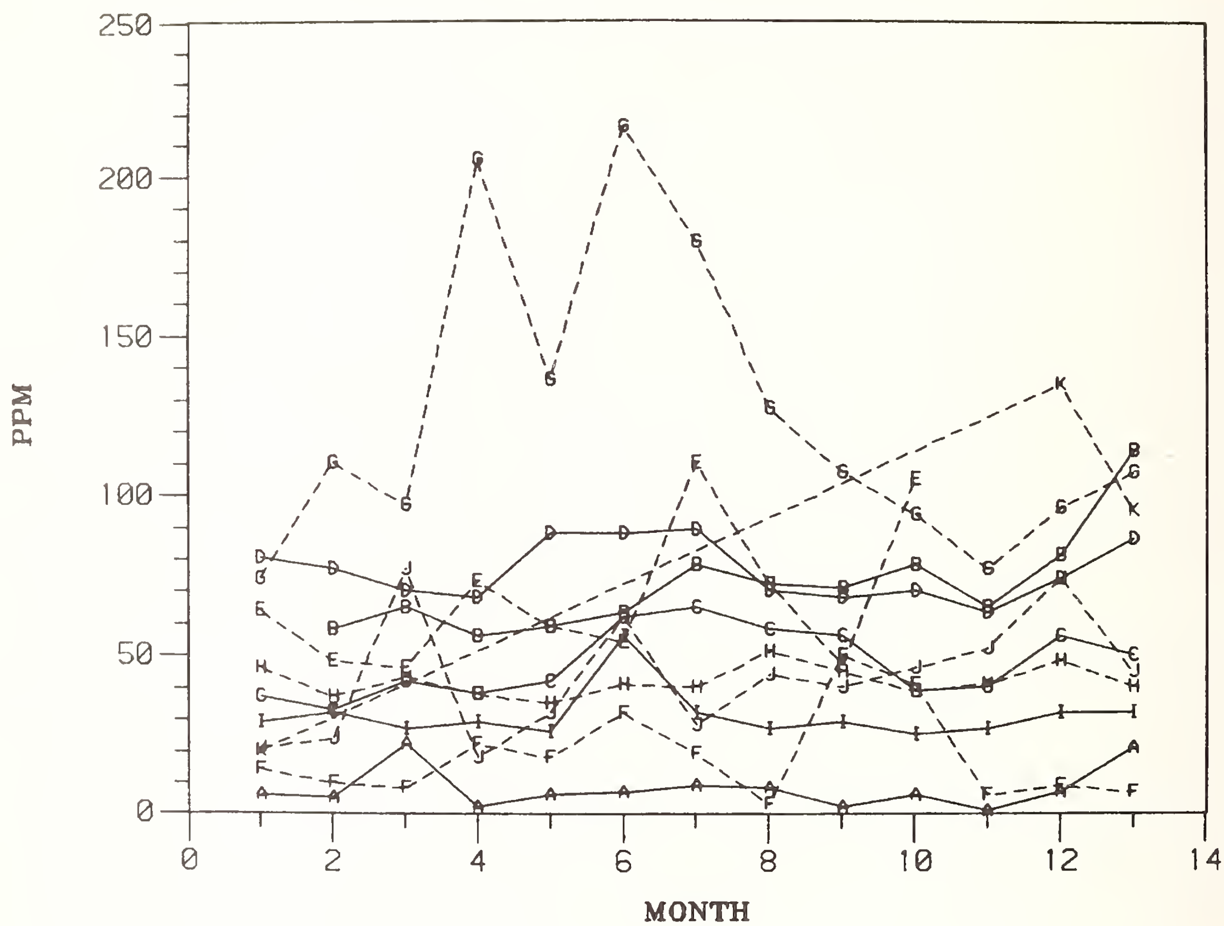
TEST: NITROGEN (ppm) CHEMILUMINESCENCE LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	6.	-	37.	80.	29.	64.	14.	74.	46.	21.	20.
APR 80	5.	58.	33.	77.	32.	48.	10.	110.	37.	24.	-
MAY 80	22.	65.	42.	70.	27.	46.	8.	97.	43.	77.	-
JUN 80	2.	56.	38.	68.	29.	73.	22.	205.	38.	18.	-
JUL 80	6.	59.	42.	88.	26.	59.	18.	136.	35.	32.	-
AUG 80	7.	63.	62.	88.	56.	54.	32.	216.	41.	62.	-
SEP 80	9.	78.	65.	89.	32.	110.	19.	179.	40.	28.	-
OCT 80	8.	72.	58.	70.	27.	72.	3.	127.	51.	44.	-
NOV 80	2.	71.	56.	68.	29.	47.	50.	107.	45.	40.	-
DEC 80	6.	78.	39.	70.	25.	105.	41.	94.	39.	46.	-
JAN 81	1.	65.	40.	63.	27.	-	6.	77.	41.	52.	-
FEB 81	7.	81.	56.	74.	32.	-	9.	96.	48.	74.	135.
MAR 81	21.	114.	50.	86.	32.	-	7.	107.	40.	45.	95.
MEAN	7.8	71.7	47.5	76.2	31.0	67.8	18.4	125.0	41.8	43.3	83.3
STD.DEV.	6.5	15.7	10.7	9.0	7.9	23.1	14.5	46.6	4.6	19.1	58.4
MIN	1.	56.	33.	63.	25.	46.	3.	74.	35.	18.	20.
MAX	22.	114.	65.	89.	56.	110.	50.	216.	51.	77.	135.



NITROGEN
PPM
250
200
150
100
50
0
0
2
4
6
8
10
12
A B C D I E F G H J K
OIL

NITROGEN

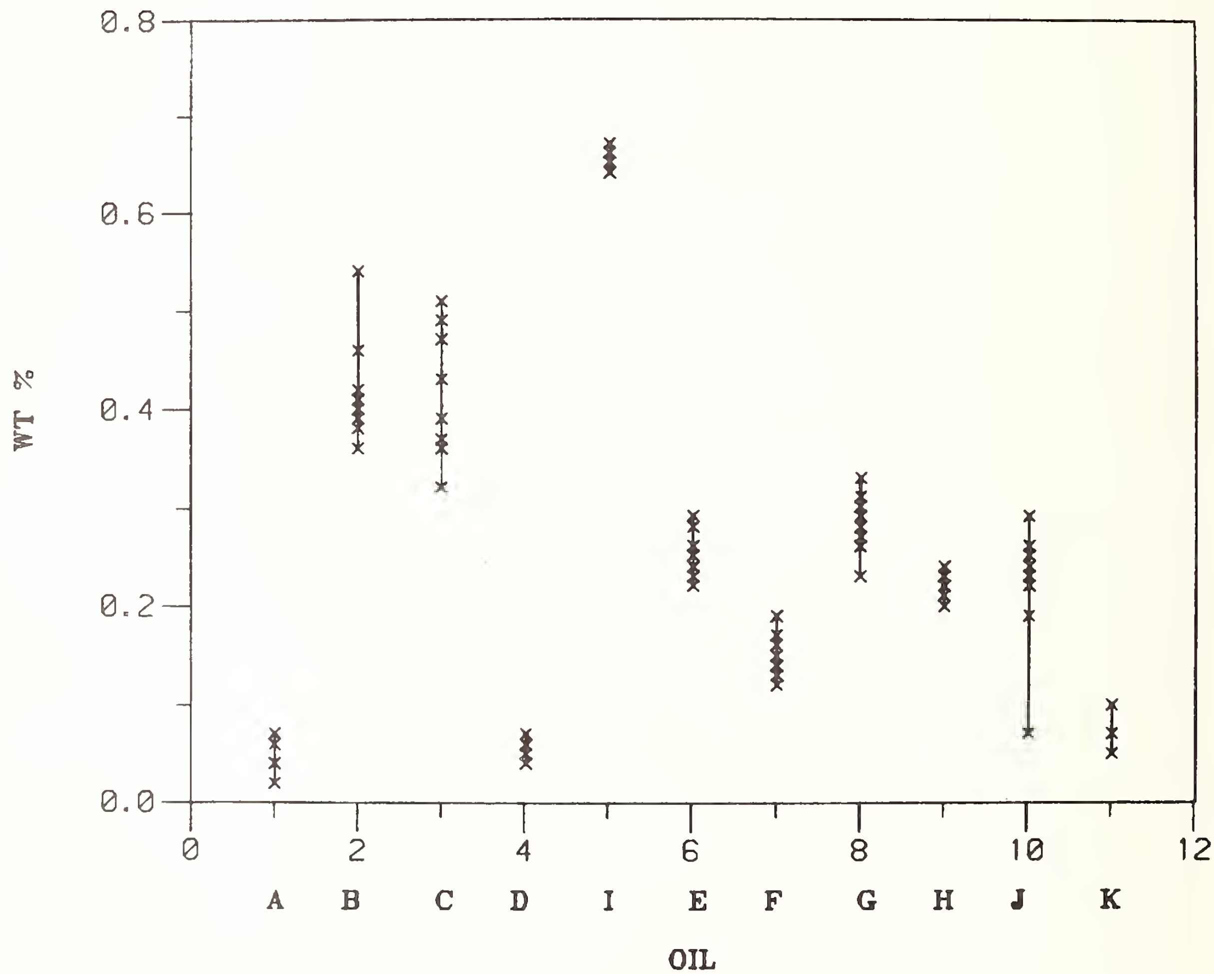


ASTM/NBS BASESTOCK CCNSISTENCY STUDY

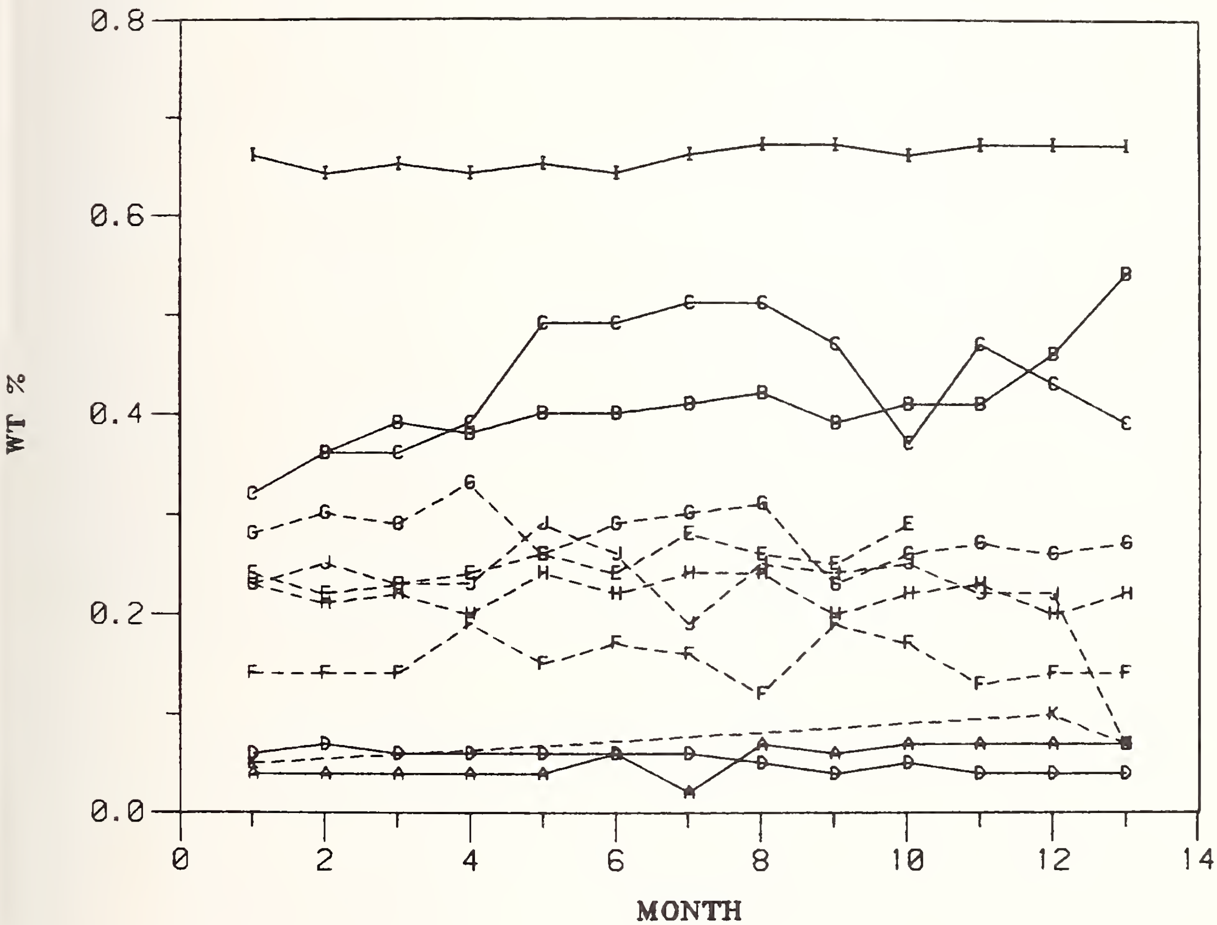
TEST: SULFUR (WT %) MODIFIED ASTM D2622 LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.04	-	.32	.06	.66	.24	.14	.28	.23	.23	.05
APR 80	.04	.36	.36	.07	.64	.22	.14	.30	.21	.25	-
MAY 80	.04	.39	.36	.06	.65	.23	.14	.29	.22	.23	-
JUN 80	.04	.38	.39	.06	.64	.24	.19	.33	.20	.23	-
JUL 80	.04	.40	.49	.06	.65	.26	.15	.26	.24	.29	-
AUG 80	.06	.40	.49	.06	.64	.24	.17	.29	.22	.26	-
SEP 80	.02	.41	.51	.06	.66	.28	.16	.30	.24	.19	-
OCT 80	.07	.42	.51	.05	.67	.26	.12	.31	.24	.25	-
NOV 80	.06	.39	.47	.04	.67	.25	.19	.23	.20	.24	-
DEC 80	.07	.41	.37	.05	.66	.29	.17	.26	.22	.25	-
JAN 81	.07	.41	.47	.04	.67	-	.13	.27	.23	.22	-
FEB 81	.07	.46	.43	.04	.67	-	.14	.26	.20	.22	.10
MAR 81	.07	.54	.39	.04	.67	-	.14	.27	.22	.07	.07
MEAN	.053	.414	.428	.053	.658	.251	.152	.281	.221	.225	.073
STD.DEV.	.017	.046	.066	.010	.012	.022	.022	.026	.015	.052	.025
MIN	.02	.36	.32	.04	.64	.22	.12	.23	.20	.07	.05
MAX	.07	.54	.51	.07	.67	.29	.19	.33	.24	.29	.10

SULFUR



SULFUR

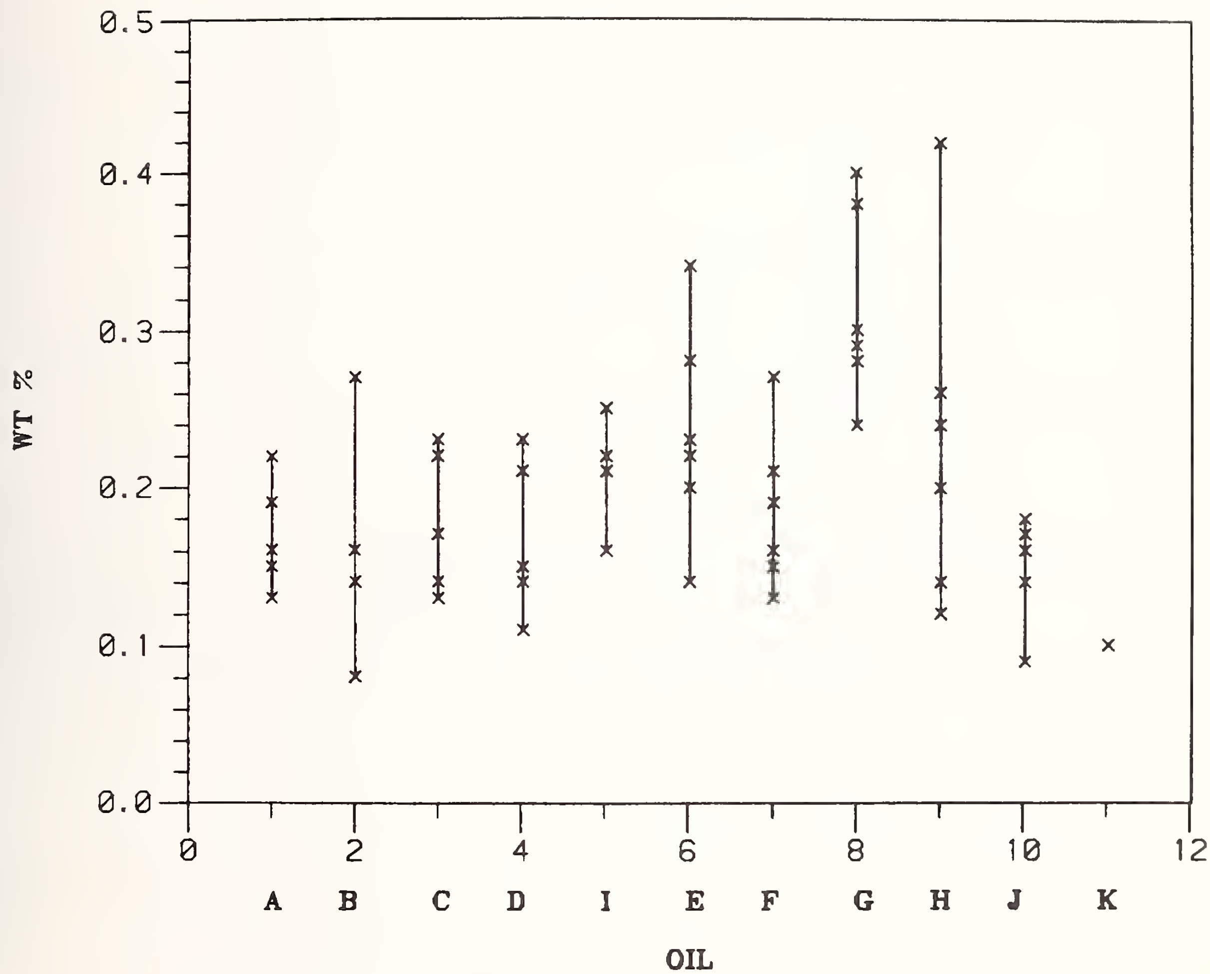


ASTM/NBS BASESTOCK CONSISTENCY STUDY

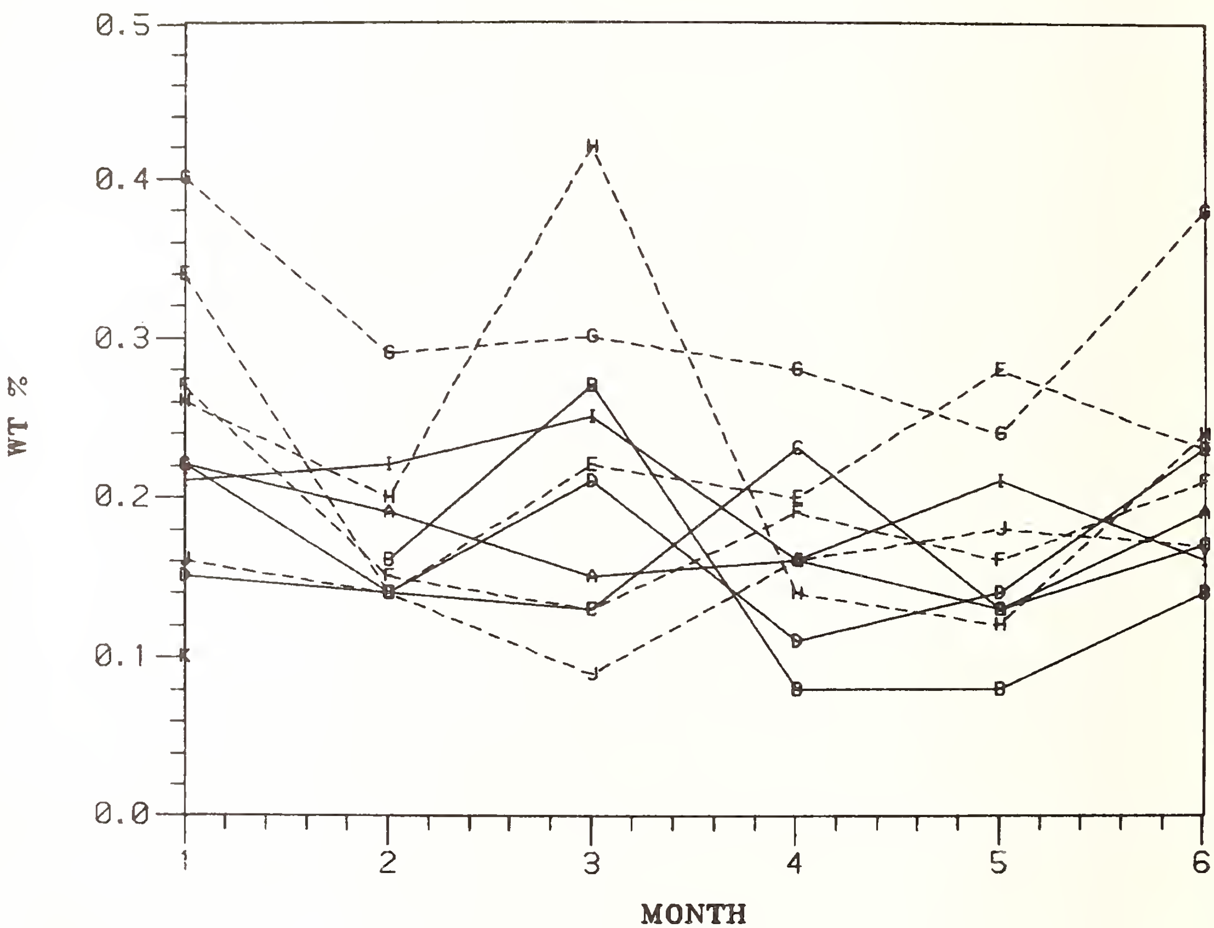
TEST: TOTAL OXYGEN (WT%) MODIFIED UOP METHOD 649-74 LABORATORY: O

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.22	-	.22	.15	.21	.34	.27	.40	.26	.16	.10
APR 80	.19	.16	.14	.14	.22	.14	.15	.29	.20	.14	-
MAY 80	.15	.27	.13	.21	.25	.22	.13	.30	.42	.09	-
JUN 80	.16	.08	.23	.11	.16	.20	.19	.28	.14	.16	-
JUL 80	.13	.08	.13	.14	.21	.28	.16	.24	.12	.18	-
AUG 80	.19	.14	.17	.23	.16	.23	.21	.38	.24	.17	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	.173	.146	.170	.163	.202	.235	.185	.315	.230	.150	.100
STD.DEV.	.033	.078	.045	.046	.035	.069	.050	.062	.108	.032	.000
MIN	.13	.08	.13	.11	.16	.14	.13	.24	.12	.09	.10
MAX	.22	.27	.23	.23	.25	.34	.27	.40	.42	.18	.10

TOTAL OXYGEN



TOTAL OXYGEN



ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: CHLORINE (WT%) MODIFIED ASTM D2622 LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	<.01	-	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
APR 80	<.01	<.01	<.01	<.01	<.01	.12	<.01	.13	<.01	<.01	-
MAY 80	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	-
JUN 80	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	-
JUL 80	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	-
AUG 80	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	-
SEP 80	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	-
OCT 80	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	-
NOV 80	<.01	<.01	<.01	<.01	<.01	<.01	<.01	.02	<.01	<.01	-
DEC 80	<.01	<.01	<.01	<.01	<.01	.01	.02	.02	<.01	<.01	-
JAN 81	<.01	<.01	<.01	<.01	<.01	-	<.01	.04	<.01	<.01	-
FEB 81	<.01	<.01	<.01	<.01	<.01	-	<.01	<.01	<.01	<.01	<.01
MAR 81	<.01	<.01	<.01	<.01	<.01	-	<.01	.06	<.01	<.01	<.01
MEAN	<.010	<.010	<.010	<.010	<.010	.021	.011	.027	<.010	<.010	<.010
STD.DEV.	.000	.000	.000	.000	.000	.035	.003	.034	.000	.000	.000
MIN	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
MAX	<.01	<.01	<.01	<.01	<.01	.12	.02	.13	<.01	<.01	<.01

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: CHLORINE (ppm) NEUTRON ACTIVATION ANALYSIS — LABORATORY: N

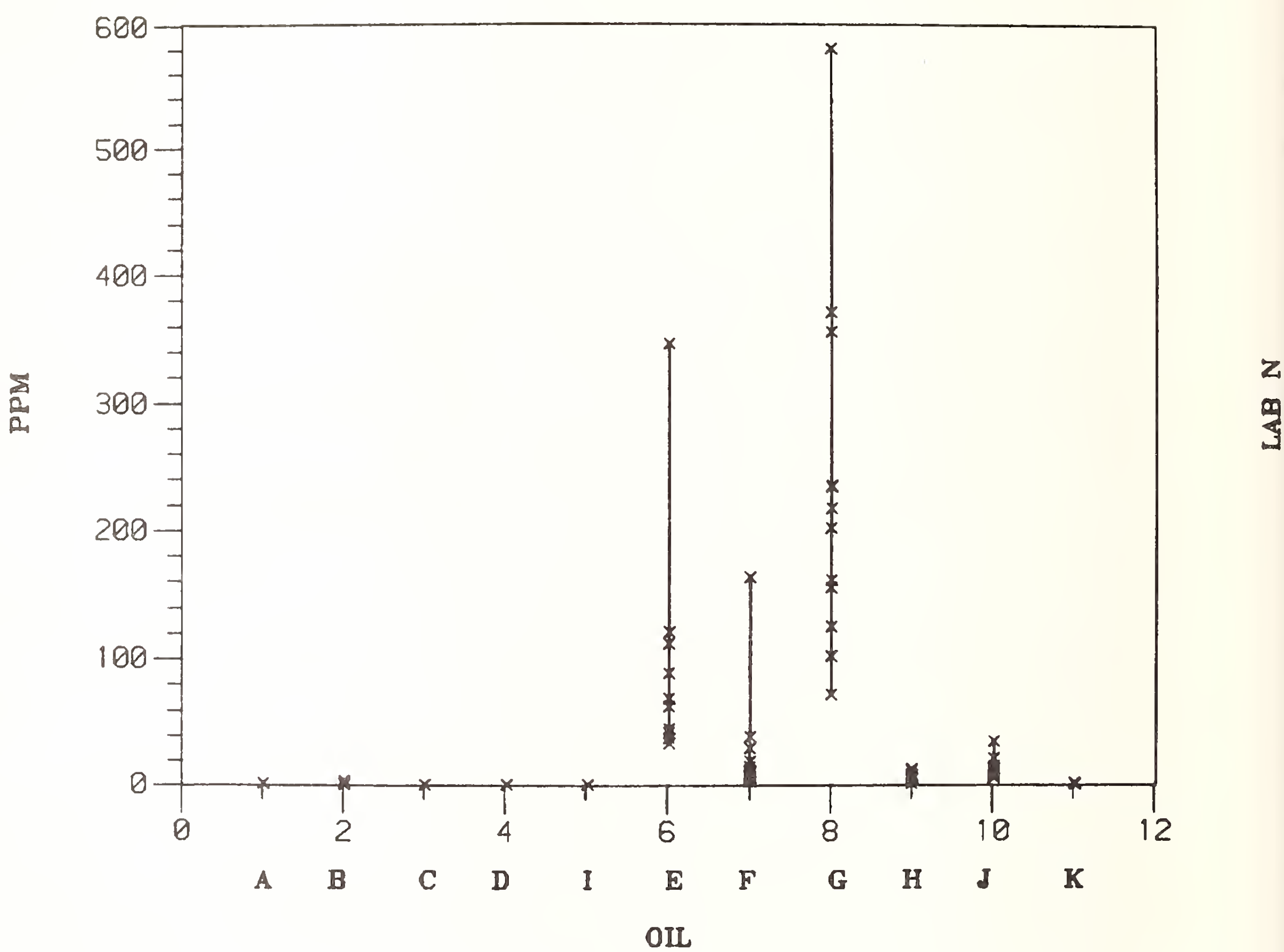
DATE	A	B	C	D	I	E	F	G	H	J	K
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
MAR 80	.91	-	.12	.12	.45	37.80	29.00	102.00	7.70	4.90	.49
APR 80	.71	2.90	.13	.16	.47	346.00	15.00	371.00	5.40	14.70	-
MAY 80	.77	.13	.10	.14	.47	120.00	5.70	235.00	8.70	6.30	-
JUN 80	.65	.09	.09	.09	.45	111.00	9.10	71.60	6.90	7.00	-
JUL 80	.80	.53	.16	.15	.45	88.00	7.70	102.00	.70	34.60	-
AUG 80	.85	.58	.10	.09	.39	45.00	11.70	125.00	11.40	21.20	-
SEP 80	.72	.15	.12	.07	.42	62.00	4.80	234.00	12.70	5.80	-
OCT 80	.62	.09	.07	.07	.41	33.30	2.70	217.00	6.90	8.90	-
NOV 80	.84	.16	.09	.07	.44	41.50	38.90	201.00	5.90	5.80	-
DEC 80	.68	.13	.12	.10	.43	68.50	163.00	161.00	8.30	7.30	-
JAN 81	.64	.07	.16	.07	.42	-	19.20	355.00	5.90	12.50	-
FEB 81	.60	.17	.14	.06	.38	-	6.00	155.00	6.80	5.70	.60
MAR 81	.52	.97	.20	.11	.39	-	3.50	580.00	5.50	11.80	.68
MEAN	.716	.497	.123	.100	.428	95.310	24.331	223.815	7.138	11.269	.590
STD.DEV.	.113	.805	.035	.034	.030	93.192	43.022	140.780	2.939	8.427	.095
MIN	.52	.07	.07	.06	.38	33.30	2.70	71.60	.70	4.90	.49
MAX	.91	2.90	.20	.16	.47	346.00	163.00	580.00	12.70	34.60	.68

ASTM/NBS BASESTOCK CONSISTENCY STUDY

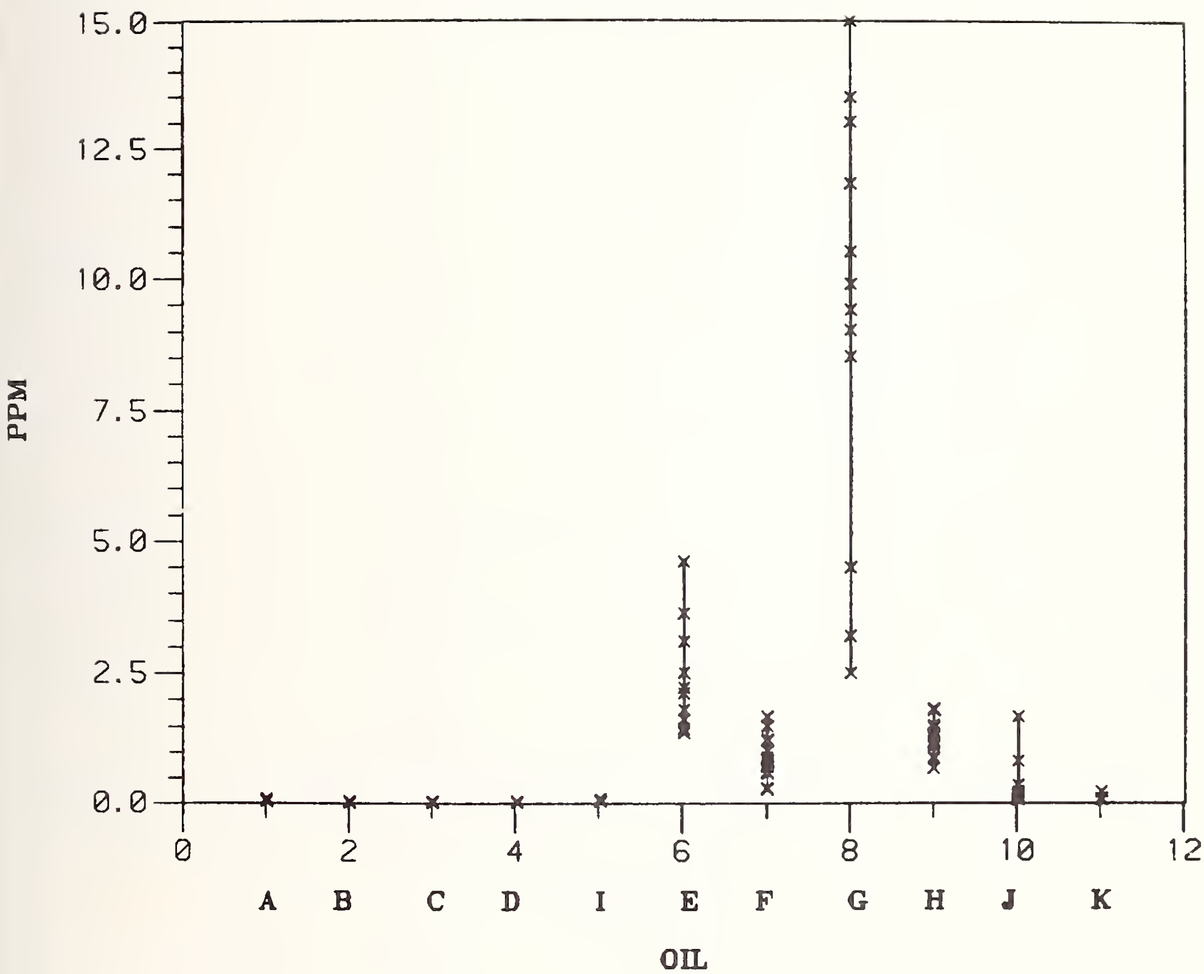
TEST: BROMINE (ppm) NEUTRON ACTIVATION ANALYSIS — LABORATORY: N

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.06	-	.03	.03	.07	1.60	.84	9.40	1.50	.05	.05
APR 80	.04	.02	.02	.02	.03	1.43	1.65	13.00	1.36	.22	-
MAY 80	.05	.01	.01	.01	.02	1.34	1.22	11.80	.68	.14	-
JUN 80	.04	.02	.01	.01	.03	1.80	.89	2.50	1.31	1.66	-
JUL 80	.07	.01	.03	.03	.03	3.60	1.19	3.20	1.46	.22	-
AUG 80	.02	.03	.02	.02	.03	3.10	1.02	4.50	1.82	.80	-
SEP 80	.03	.03	.02	.02	.03	4.60	.69	9.00	1.10	.08	-
OCT 80	.02	.02	.01	.01	.02	2.50	.57	9.90	1.80	.33	-
NOV 80	.03	.02	.02	.02	.02	2.20	.60	15.00	.89	.17	-
DEC 80	.04	.01	.01	.01	.03	2.10	1.48	13.50	1.13	.33	-
JAN 81	.03	.01	.01	.01	.03	-	.76	11.80	.86	.14	-
FEB 81	.02	.02	.01	.01	.03	-	.26	8.50	.88	.14	.09
MAR 81	.02	.02	.02	.02	.03	-	.28	10.50	1.20	.08	.22
MEAN	.036	.018	.017	.017	.031	2.427	.881	9.431	1.230	.335	.120
STD.DEV.	.016	.007	.008	.008	.013	1.052	.424	3.928	.357	.443	.089
MIN	.02	.01	.01	.01	.02	1.34	.26	2.50	.68	.05	.05
MAX	.07	.03	.03	.03	.07	4.60	1.65	15.00	1.82	1.66	.22

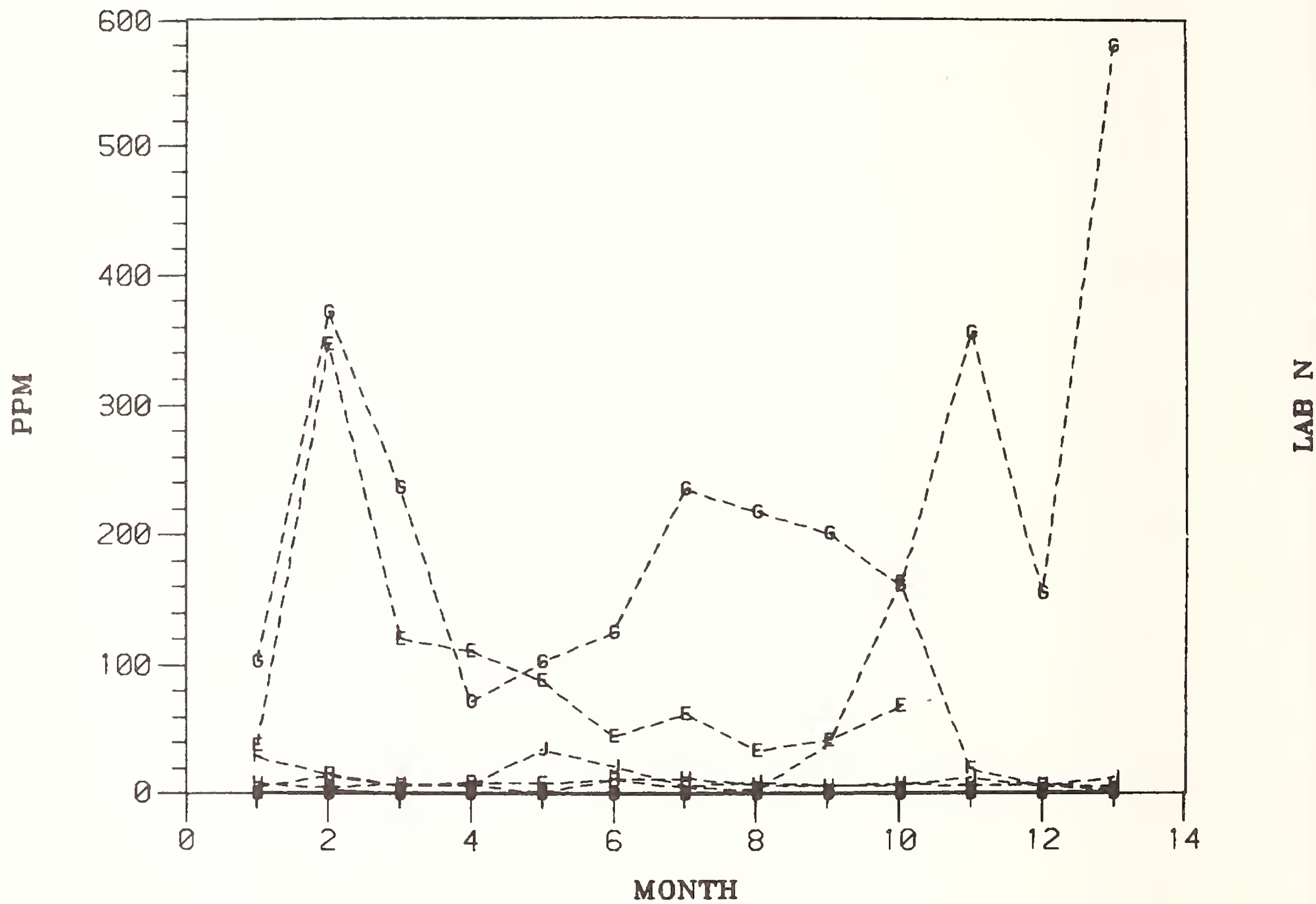
CHLORINE



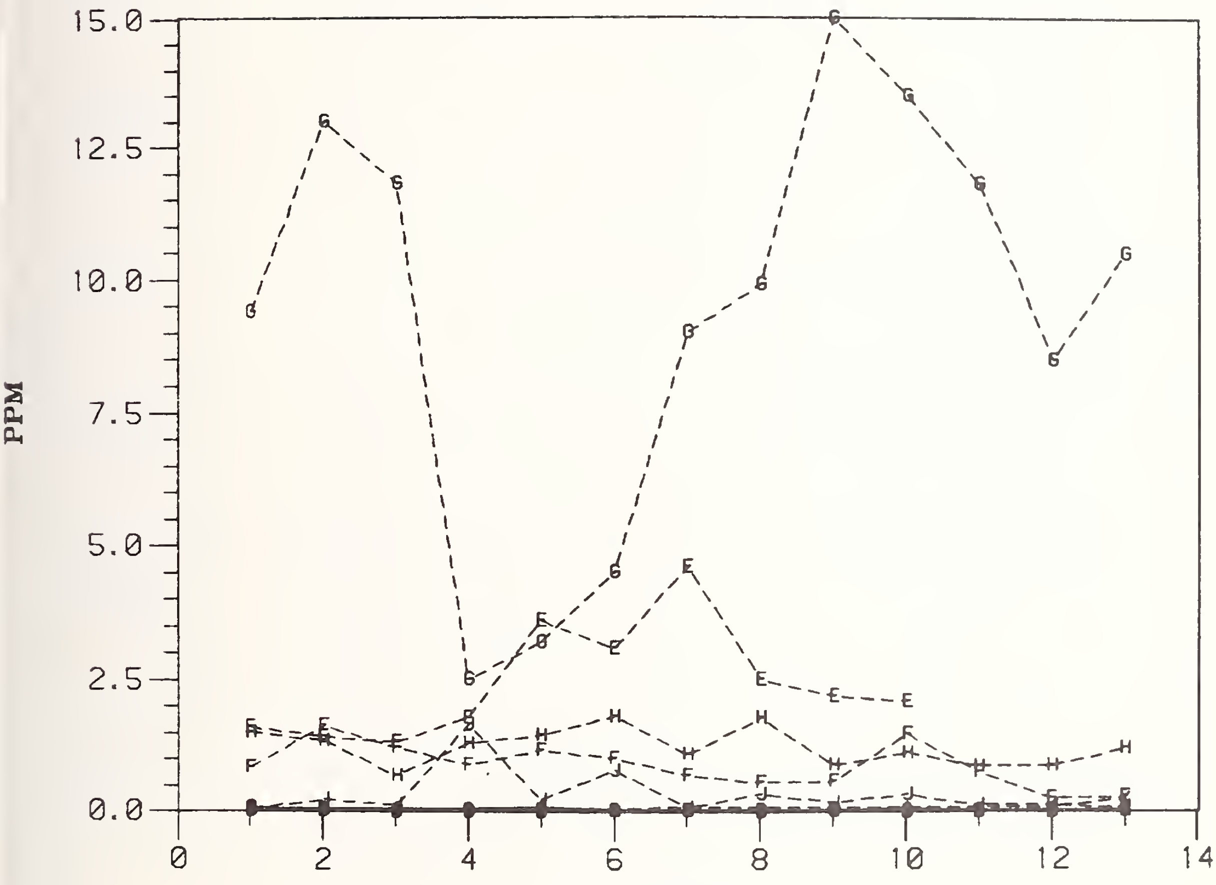
BROMINE



CHLORINE



BROMINE

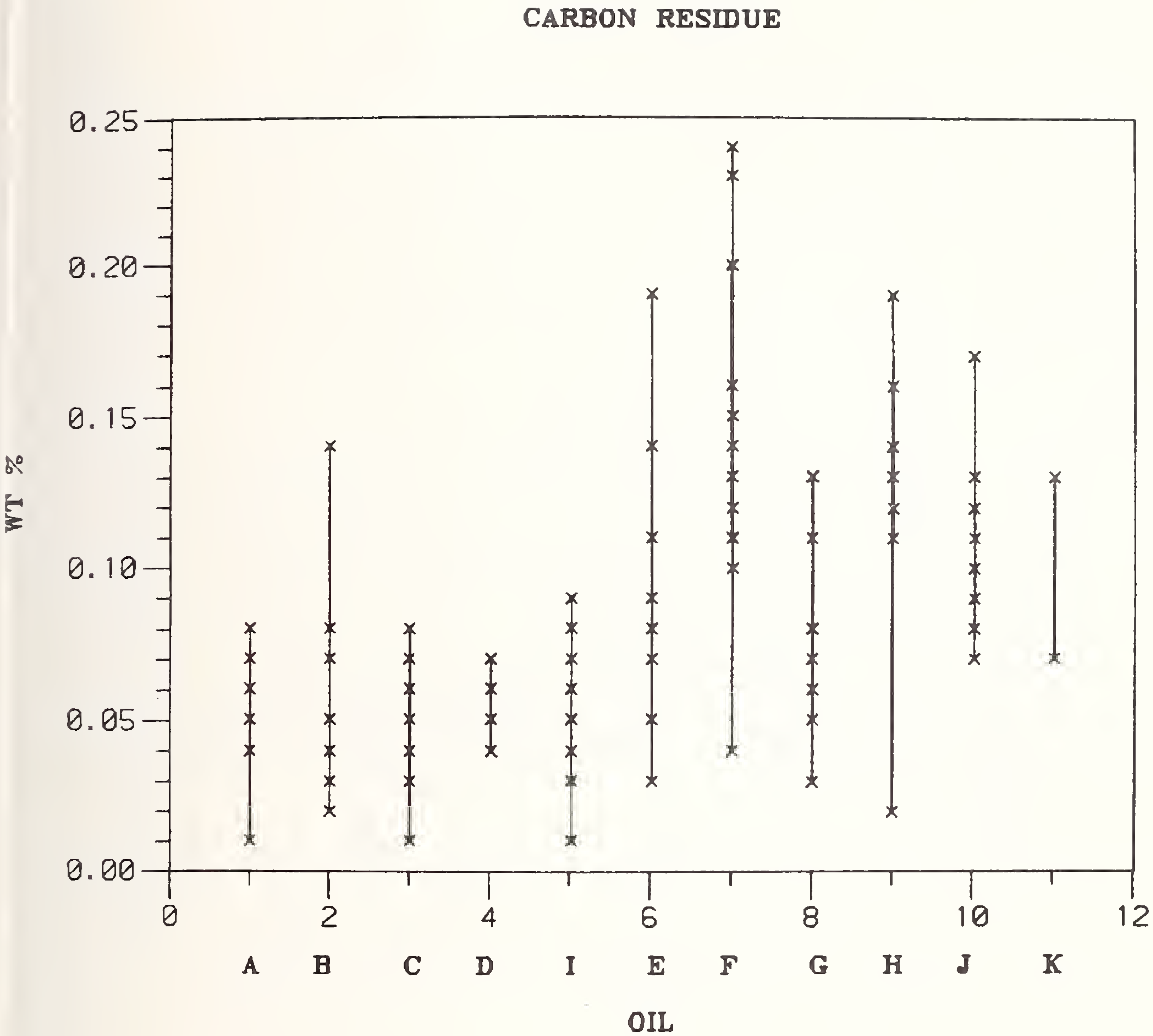


ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: CAFECN RESIDUE (WT %) ASTM D524

LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.05	-	.06	.06	.08	.19	.14	.13	.14	.12	.07
APR 80	.01	.03	.01	.07	.01	.03	.04	.03	.02	.08	-
MAY 80	.04	.04	.07	.04	.04	.05	.15	.13	.14	.10	-
JUN 80	.04	.04	.05	.04	.05	.09	.23	.08	.13	.08	-
JUL 80	.04	.07	.03	.06	.05	.08	.11	.08	.13	.13	-
AUG 80	.08	.08	.08	.07	.09	.11	.20	.13	.19	.17	-
SEP 80	.08	.07	.05	.05	.05	.14	.16	.07	.13	.09	-
OCT 80	.06	.04	.04	.05	.06	.08	.10	.08	.16	.07	-
NOV 80	.05	.05	.03	.05	.05	.07	.20	.05	.13	.11	-
DEC 80	.06	.05	.06	.05	.03	.09	.24	.07	.11	.10	-
JAN 81	.06	.02	.05	.04	.05	-	.12	.06	.13	.10	-
FEB 81	.07	.08	.06	.06	.07	-	.11	.08	.14	.12	.13
MAR 81	.06	.14	.05	.04	.06	-	.13	.11	.12	.09	.13
MEAN	.054	.059	.049	.052	.053	.093	.148	.085	.128	.105	.110
STD.DEV.	.019	.032	.018	.011	.021	.045	.057	.032	.038	.026	.035
MIN	.01	.02	.01	.04	.01	.03	.04	.03	.02	.07	.07
MAX	.08	.14	.08	.07	.09	.19	.24	.13	.19	.17	.13


CARBON RESIDUE
WT %
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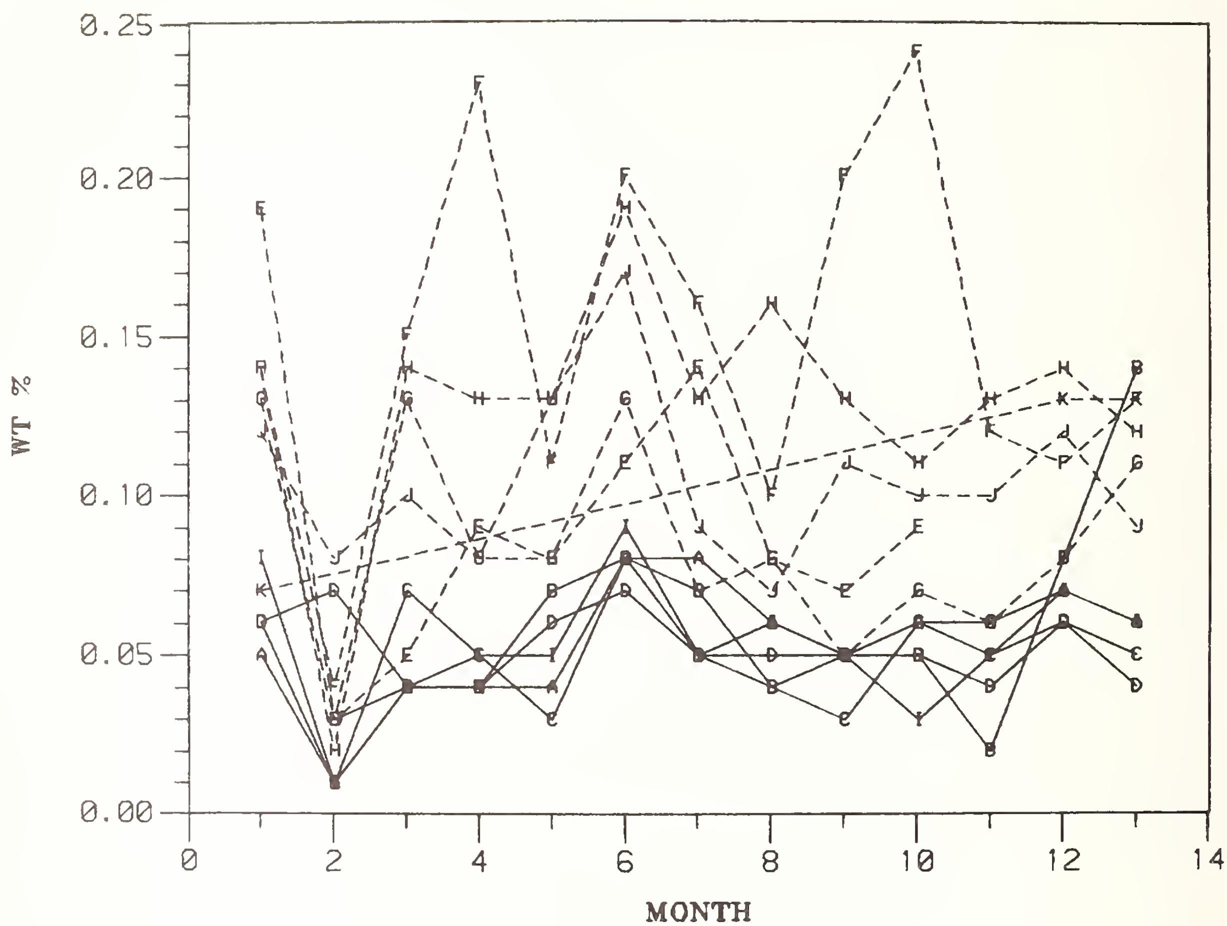
0.20
0.15
0.10
0.05
0.00
0
2
4
6
8
10
12
A
B
C
D
I
E
F
G
H
J
K
OIL

CARBON RESIDUE

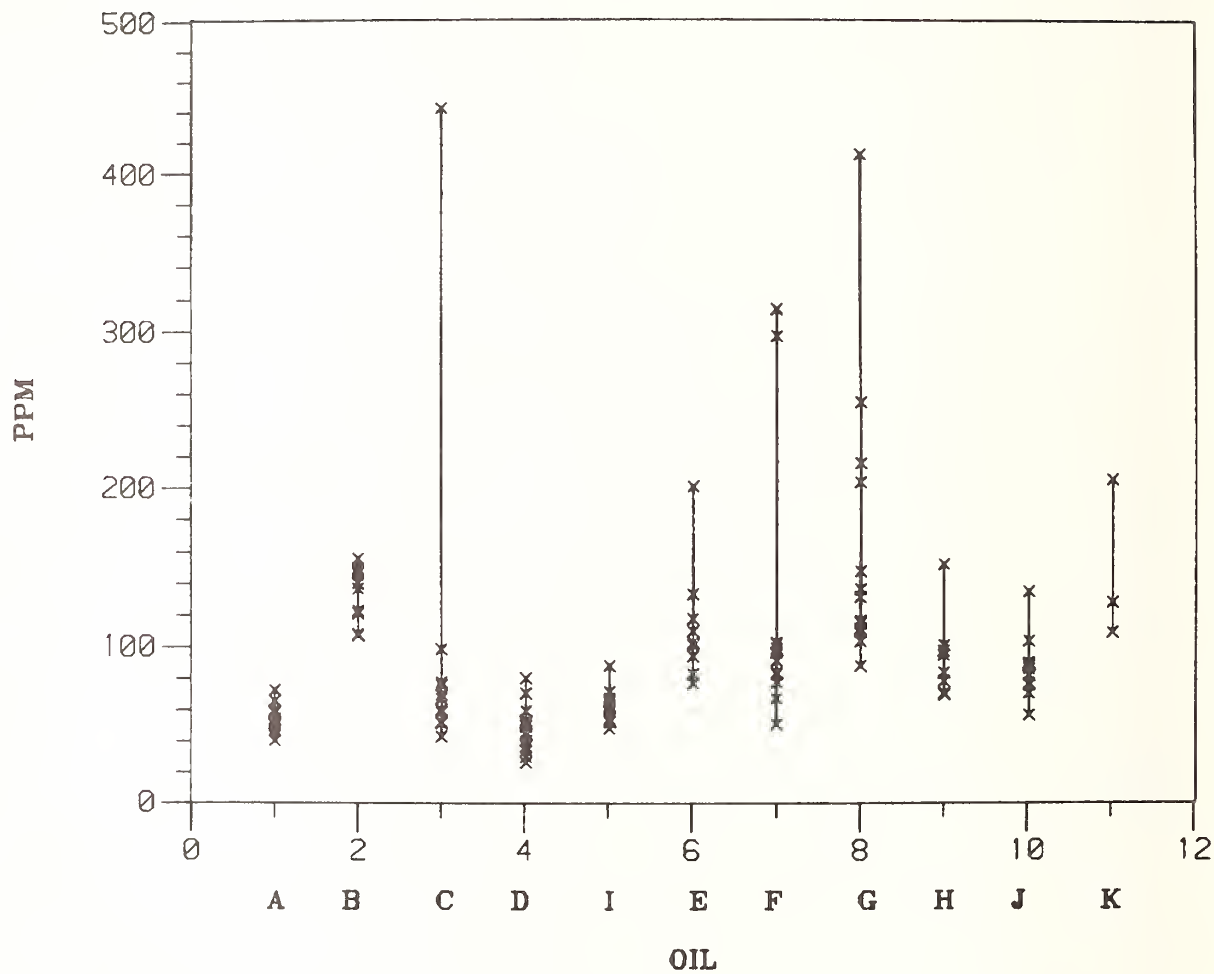


ASTM/NBS BASESTOCK CONSISTENCY STUDY

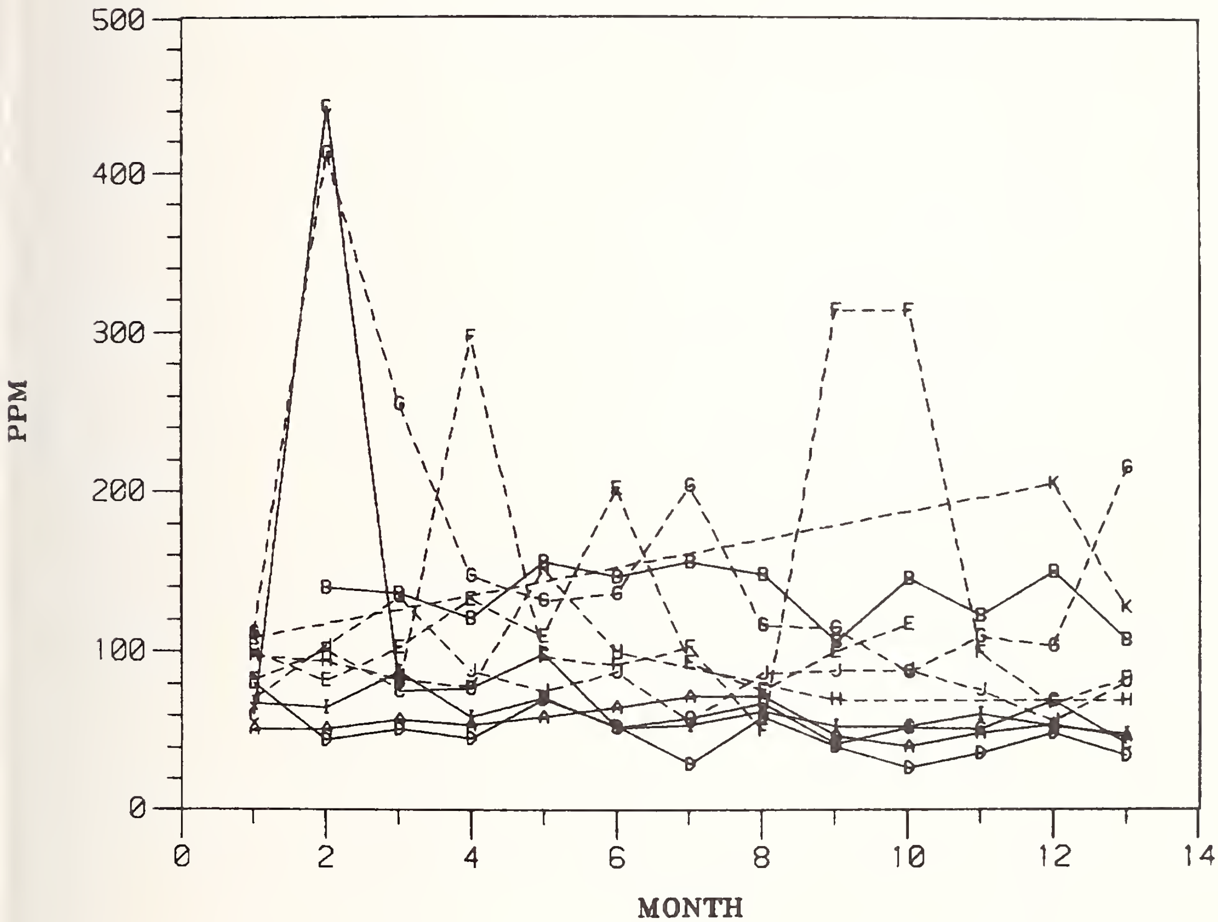
TEST: WATER (ppm: NT= NOT TITRATABLE) MODIFIED ASTM D1744 LABORATORY: N

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	51.	-	60.	80.	67.	100.	82.	111.	97.	70.	108.
APR 80	51.	139.	442.	44.	65.	82.	101.	412.	94.	103.	-
MAY 80	57.	136.	75.	51.	87.	102.	77.	254.	83.	134.	-
JUN 80	54.	120.	77.	45.	59.	132.	296.	147.	78.	88.	-
JUL 80	59.	155.	98.	70.	71.	109.	96.	131.	151.	75.	-
AUG 80	65.	146.	52.	53.	52.	201.	91.	136.	100.	87.	-
SEP 80	72.	155.	58.	29.	54.	93.	102.	203.	NT	56.	-
OCT 80	72.	148.	67.	59.	62.	76.	50.	116.	NT	86.	-
NOV 80	47.	106.	42.	40.	53.	100.	313.	114.	70.	88.	-
DEC 80	40.	145.	52.	26.	53.	117.	313.	87.	NT	89.	-
JAN 81	49.	122.	51.	36.	61.	-	99.	109.	NT	76.	-
FEB 81	54.	149.	69.	49.	53.	-	67.	103.	NT	56.	205.
MAR 81	46.	107.	42.	34.	48.	-	83.	215.	69.	81.	127.
MEAN	55.2	135.7	91.2	47.4	60.4	111.2	136.2	164.5	92.8	83.8	146.7
STD.DEV.	9.7	17.6	106.6	15.6	10.5	35.4	98.7	89.5	26.3	20.1	51.4
MIN	40.	106.	42.	26.	48.	76.	50.	87.	69.	56.	108.
MAX	72.	155.	442.	80.	87.	201.	313.	412.	151.	134.	205.

WATER (KARL FISCHER TITRATION)



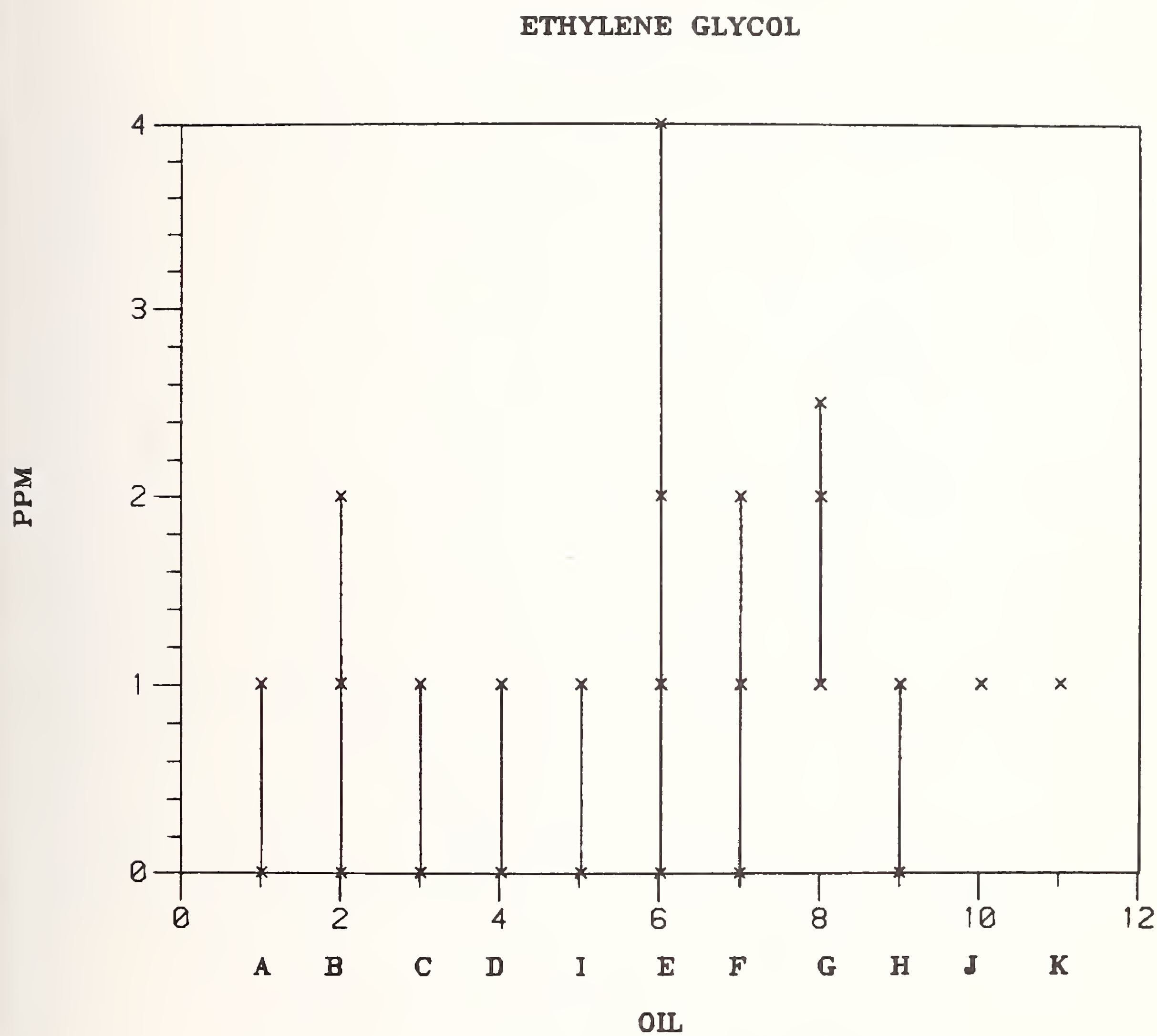
WATER (KARL FISCHER TITRATION)



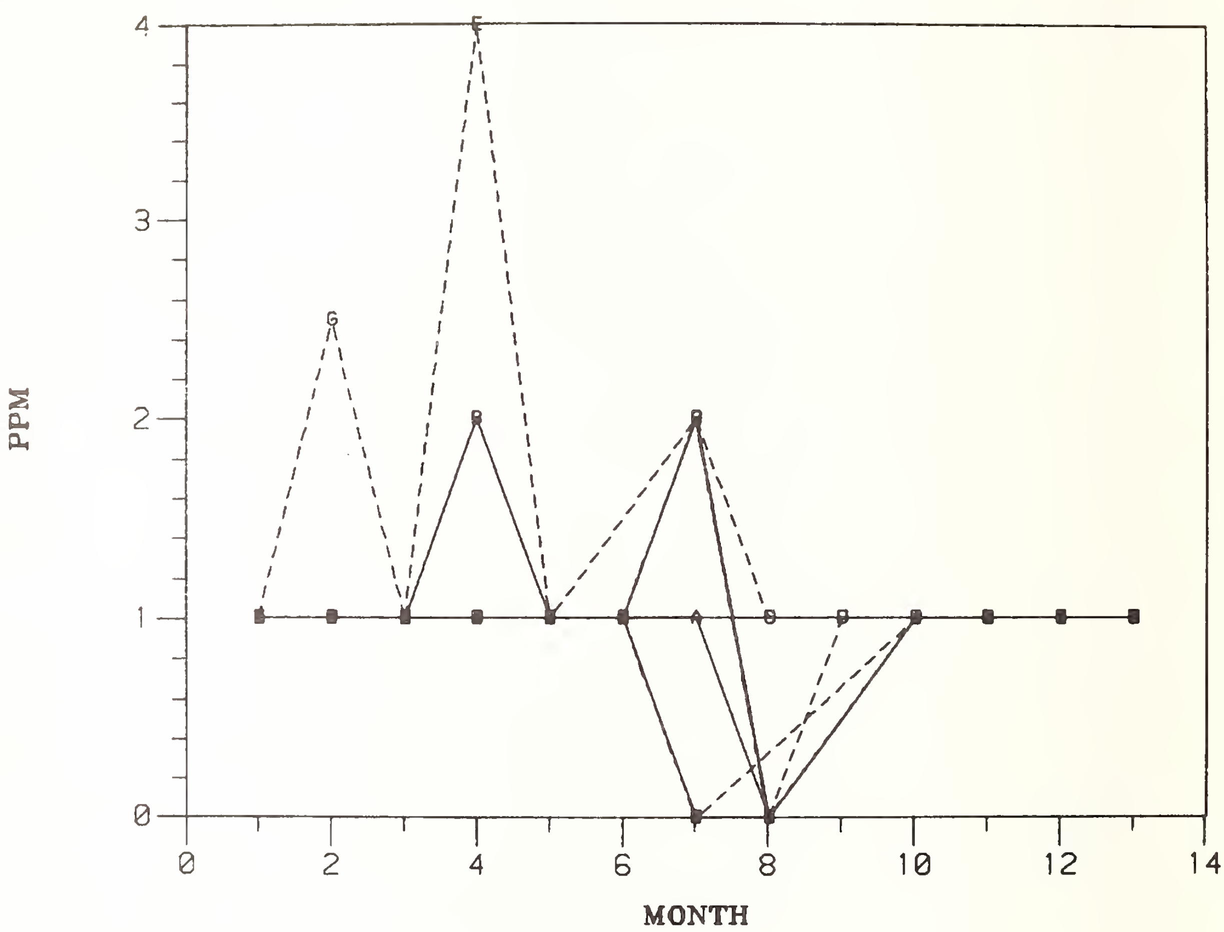
ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: ETHYLENE GLYCOL (ppm) PROPOSED ASTM TEST METHOD — LABORATORY: S

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	<1.	-	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.
APR 80	<1.	<1.	<1.	<1.	<1.	<1.	<1.	2.5	<1.	<1.	-
MAY 80	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	-
JUN 80	<1.	2.	<1.	<1.	<1.	4.	<1.	<1.	<1.	<1.	-
JUL 80	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	-
AUG 80	<1.	<1.	<1.	<1.	<1.	<1.	--	--	<1.	<1.	-
SEP 80	<1.	2.	0.	0.	0.	2.	2.	2.	0.	--	-
OCT 80	0.	0.	0.	0.	0.	0.	0.	1.	--	<1.	-
NOV 80	--	--	--	--	--	--	<1.	--	--	<1.	-
DEC 80	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	-
JAN 81	<1.	<1.	<1.	<1.	<1.	-	<1.	<1.	<1.	<1.	-
FEB 81	<1.	<1.	<1.	<1.	<1.	-	<1.	<1.	<1.	<1.	<1.
MAR 81	<1.	<1.	<1.	<1.	<1.	-	1.	<1.	<1.	<1.	<1.
MEAN	.9	1.1	.8	.8	.8	1.3	1.0	1.2	.9	1.0	1.0
STD.DEV.	.3	.5	.4	.4	.4	1.1	.4	.5	.3	.0	.0
MIN	0.	0.	0.	0.	0.	0.	0.	<1.	0.	<1.	<1.
MAX	<1.	2.	<1.	<1.	<1.	4.	2.	2.5	<1.	<1.	<1.


ETHYLENE GLYCOL
PPM
0
1
2
3
4
0
2
4
6
8
10
12
A B C D I E F G H J K
OIL

ETHYLENE GLYCOL

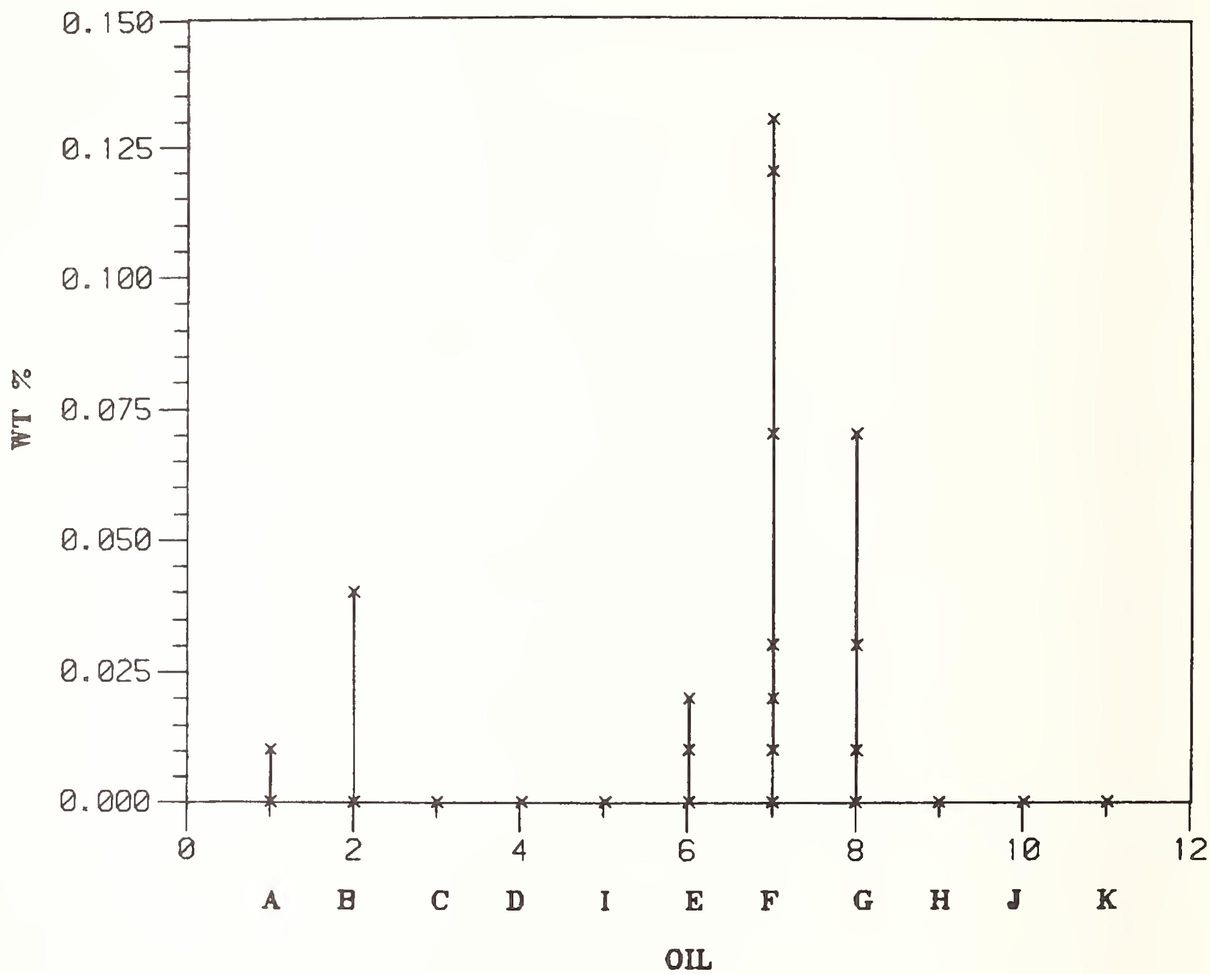


ASTM/NBS BASESTOCK CONSISTENCY STUDY

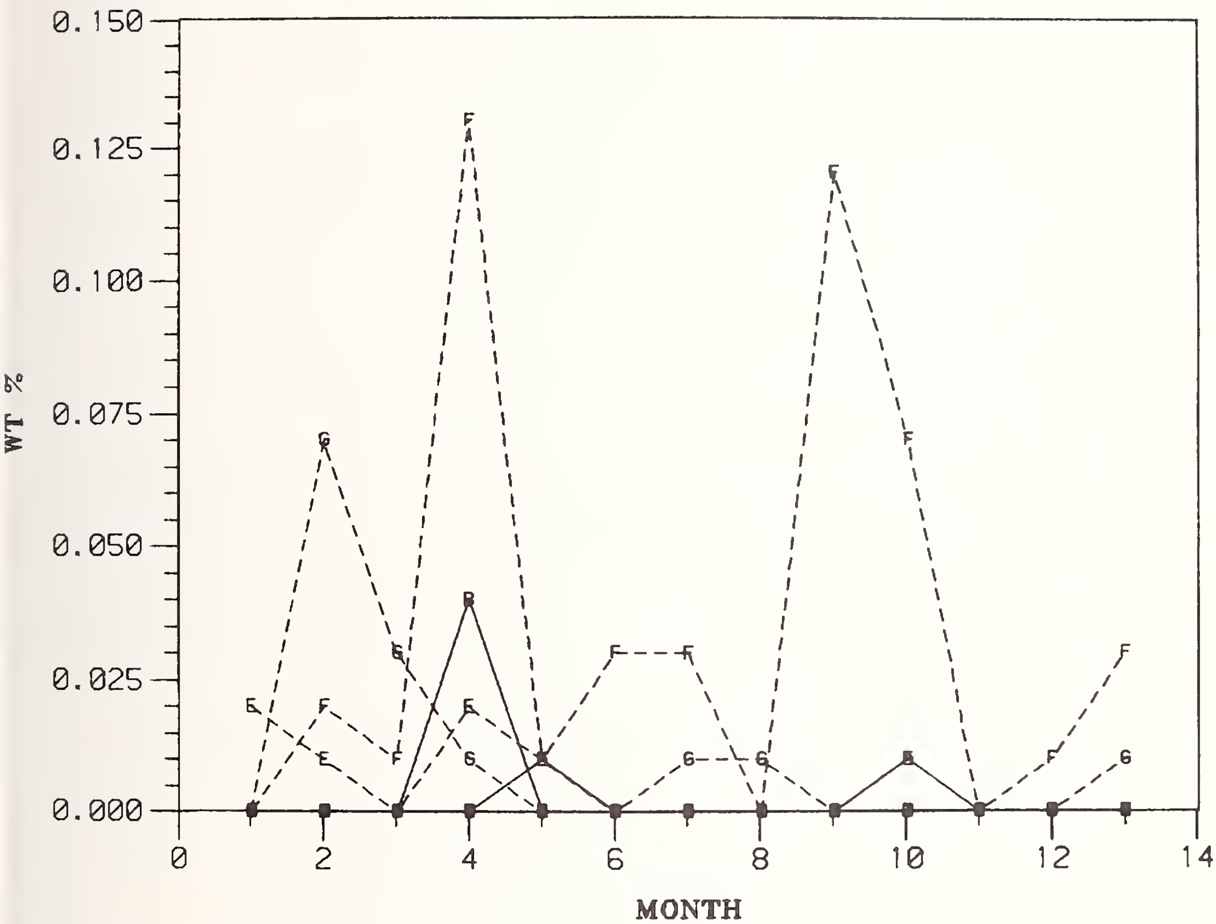
TEST: SULFATED ASH (WT%) ASTM D874 LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.00	–	.00	.00	.00	.02	.00	.00	.00	.00	.00
APR 80	.00	.00	.00	.00	.00	.01	.02	.07	.00	.00	–
MAY 80	.00	.00	.00	.00	.00	.00	.01	.03	.00	.00	–
JUN 80	.00	.04	.00	.00	.00	.02	.13	.01	.00	.00	–
JUL 80	.01	.00	.00	.00	.00	.01	.01	.00	.00	.00	–
AUG 80	.00	.00	.00	.00	.00	.00	.03	.00	.00	.00	–
SEP 80	.00	.00	.00	.00	.00	.00	.03	.01	.00	.00	–
OCT 80	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	–
NOV 80	.00	.00	.00	.00	.00	.00	.12	.00	.00	.00	–
DEC 80	.01	.00	.00	.00	.00	.01	.07	.00	.00	.00	–
JAN 81	.00	.00	.00	.00	.00	–	.00	.00	.00	.00	–
FEB 81	.00	.00	.00	.00	.00	–	.01	.00	.00	.00	.00
MAR 81	.00	.00	.00	.00	.00	–	.03	.01	.00	.00	.00
MEAN	.002	.003	.000	.000	.000	.007	.035	.011	.000	.000	.000
STD.DEV.	.004	.012	.000	.000	.000	.008	.044	.020	.000	.000	.000
MIN	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
MAX	.01	.04	.00	.00	.00	.02	.13	.07	.00	.00	.00

SULFATED ASH



SULFATED ASH

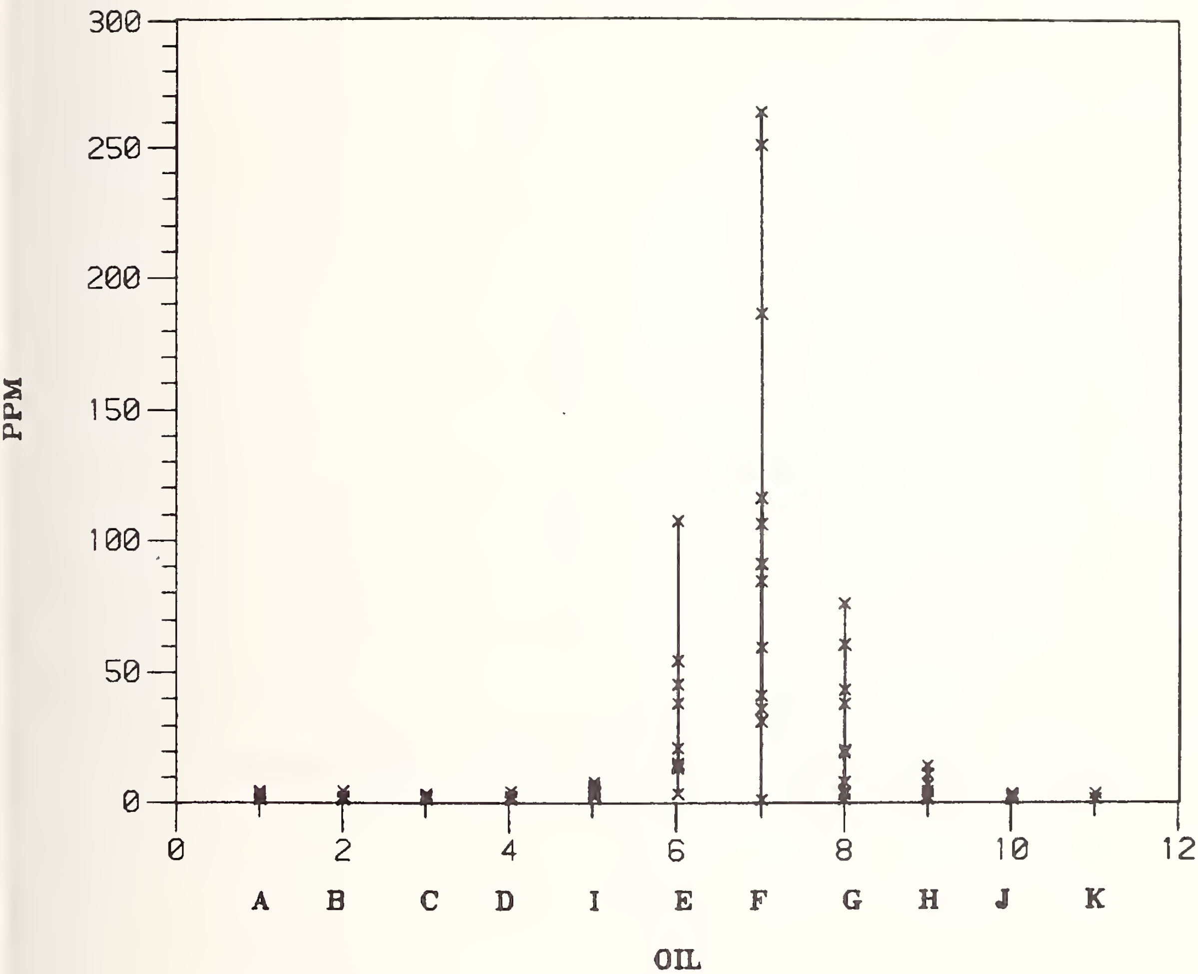


ASTM/NBS BASESTOCK CONSISTENCY STUDY

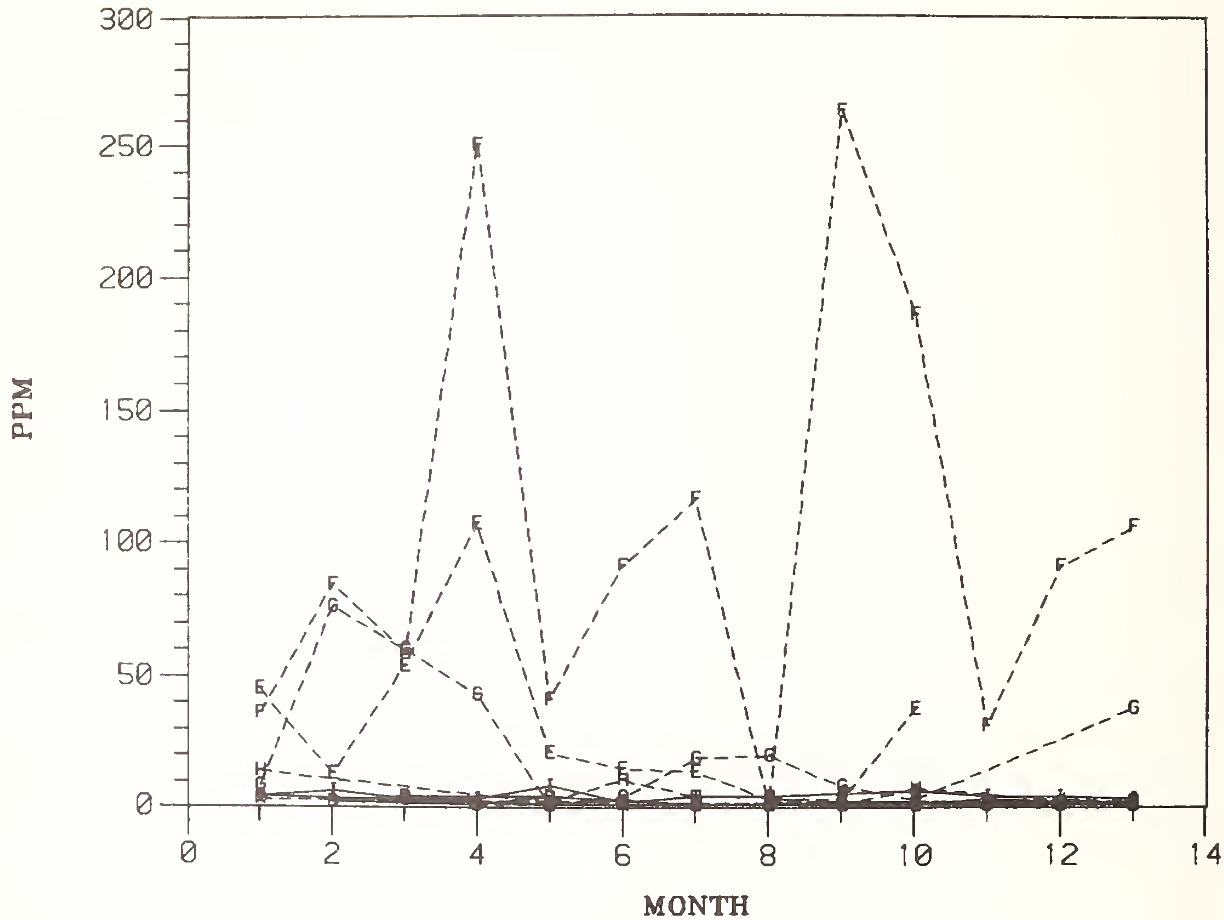
TEST: TOTAL METALS, SUMMATION OF AES (ppm) ATOMIC EMISSION SPECTROMETRY LABORATORY: R

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	4.	-	ND	ND	4.	45.	36.	8.	14.	ND	3.
APR 80	ND	2.	ND	2.	6.	13.	84.	76.	ND	ND	-
MAY 80	ND	4.	3.	ND	3.	54.	59.	60.	ND	ND	-
JUN 80	ND	ND	ND	1.	2.	107.	250.	43.	ND	1.	-
JUL 80	1.	4.	1.	4.	8.	21.	41.	1.	2.	1.	-
AUG 80	1.	ND	ND	ND	2.	15.	91.	4.	11.	3.	-
SEP 80	1.	1.	1.	1.	4.	14.	116.	19.	4.	1.	-
OCT 80	1.	1.	1.	1.	4.	3.	1.	20.	4.	2.	-
NOV 80	ND	1.	1.	2.	5.	3.	263.	8.	1.	2.	-
DEC 80	1.	1.	2.	2.	6.	38.	186.	3.	7.	2.	-
JAN 81	3.	1.	ND	1.	4.	-	31.	ND	ND	2.	-
FEB 81	2.	1.	ND	ND	4.	-	91.	ND	ND	3.	1.
MAR 81	1.	2.	1.	1.	3.	-	106.	38.	1.	2.	ND
MEAN	1.7	1.8	1.4	1.7	4.2	31.3	104.2	25.5	5.5	1.9	2.0
STD.DEV.	1.1	1.2	.8	1.0	1.7	31.8	82.0	25.4	4.8	.7	1.4
MIN	1.	1.	1.	1.	2.	3.	1.	1.	1.	1.	1.
MAX	4.	4.	3.	4.	8.	107.	263.	76.	14.	3.	3.

TOTAL METALS



TOTAL METALS



ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: CALCIUM (ppm) ATOMIC EMISSICN SPECTROMETRY LABORATORY: R

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	ND	-	ND	ND	1.	14.	8.	ND	10.	ND	1.
APR 80	ND	ND	ND	ND	1.	8.	19.	85.	ND	ND	-
MAY 80	ND	1.	1.	ND	<1.	2.	1.	66.	ND	ND	-
JUN 80	ND	ND	ND	ND	1.	26.	142.	5.	ND	1.	-
JUL 80	1.	2.	1.	1.	3.	9.	14.	1.	1.	ND	-
AUG 80	ND	ND	ND	ND	1.	10.	1.	ND	8.	ND	-
SEP 80	1.	1.	1.	1.	2.	11.	7.	4.	4.	1.	-
OCT 80	1.	1.	1.	1.	2.	3.	1.	7.	3.	1.	-
NOV 80	ND	1.	1.	1.	2.	1.	131.	1.	1.	1.	-
DEC 80	1.	1.	1.	1.	2.	26.	87.	1.	1.	1.	-
JAN 81	3.	1.	ND	1.	2.	-	6.	ND	ND	1.	-
FEB 81	ND	1.	ND	ND	2.	-	4.	ND	ND	1.	1.
MAR 81	1.	2.	1.	1.	2.	-	2.	6.	1.	1.	ND
MEAN	1.3	1.2	1.0	1.0	1.7	11.0	32.5	19.6	3.6	1.0	1.0
STD.DEV.	.8	.4	.0	.0	.6	8.9	51.5	32.1	3.5	.0	.0
MIN	ND	ND	ND	ND	<1.	1.	1.	ND	ND	ND	ND
MAX	3.	2.	1.	1.	3.	26.	142.	85.	10.	1.	1.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: LEAD (ppm) ATOMIC EMISSION SPECTROMETRY LABORATORY: R

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND
APR 80	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-
MAY 80	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-
JUN 80	ND	ND	ND	ND	ND	ND	ND	<2.	ND	ND	-
JUL 80	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-
AUG 80	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-
SEP 80	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-
OCT 80	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-
NOV 80	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.	-
DEC 80	ND	ND	1.	1.	1.	ND	ND	ND	2.	ND	-
JAN 81	ND	ND	ND	ND	ND	-	ND	ND	ND	ND	-
FEB 81	ND	ND	ND	ND	ND	-	ND	ND	ND	ND	ND
MAR 81	ND	ND	ND	ND	ND	-	ND	ND	ND	ND	ND
MEAN	ND	ND	1.0	1.0	1.0	ND	ND	ND	2.0	1.0	ND
STD.DEV.	ND	ND	.0	.0	.0	ND	ND	ND	.0	.0	ND
MIN	ND	ND	1.	1.	1.	ND	ND	ND	2.	1.	ND
MAX	ND	ND	1.	1.	1.	ND	ND	<2.	2.	1.	ND

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: MAGNESIUM (ppm) ATOMIC EMISSION SPECTROMETRY

LABORATORY: R

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	ND	-	ND	ND	ND	8.	ND	ND	1.	ND	ND
APR 80	ND	ND	ND	ND	ND	ND	ND	4.	ND	ND	-
MAY 80	ND	ND	ND	ND	ND	5.	ND	2.	ND	ND	-
JUN 80	ND	ND	ND	ND	ND	20.	<1.	9.	ND	ND	-
JUL 80	ND	ND	ND	ND	ND	1.	7.	ND	ND	ND	-
AUG 80	ND	ND	ND	ND	ND	1.	ND	4.	1.	ND	-
SEP 80	ND	ND	ND	ND	ND	ND	ND	2.	ND	ND	-
OCT 80	ND	ND	ND	ND	ND	ND	ND	1.	1.	ND	-
NOV 80	ND	ND	ND	ND	ND	ND	2.	ND	ND	ND	-
DEC 80	ND	ND	ND	ND	ND	1.	1.	1.	ND	ND	-
JAN 81	ND	ND	ND	ND	ND	-	ND	ND	ND	ND	-
FEB 81	ND	ND	ND	ND	ND	-	ND	ND	ND	ND	ND
MAR 81	ND	ND	ND	ND	ND	-	ND	12.	ND	ND	ND
MEAN	ND	ND	ND	ND	ND	6.0	3.3	4.4	1.0	ND	ND
STD.DEV.	--	--	--	--	--	7.4	2.9	4.0	--	--	--
MIN	ND	ND	ND	ND	ND	1.	<1.	1.	1.	ND	ND
MAX	ND	ND	ND	ND	ND	20.	7.	12.	1.	ND	ND

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: POTASSIUM (ppm) NEUTRON ACTIVATION ANALYSIS

LABORATORY: N

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<.3	<.5
APR 80	<1.0	<.5	<.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
MAY 80	<.3	<.5	<.3	<.3	<1.0	<.5	<.5	<1.0	<.5	<.3	-
JUN 80	<.5	<.3	<.3	<.5	<1.0	<1.0	<1.0	<.5	<.3	<1.0	-
JUL 80	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<.5	<1.0	<1.0	-
AUG 80	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
SEP 80	<.5	<1.0	<1.0	<.5	<2.0	<1.0	<1.0	<2.0	<1.0	<.5	-
OCT 80	<1.0	<.5	<.5	<.5	--	<1.0	<1.0	<1.0	<.5	<1.0	-
NOV 80	<1.0	<1.0	<.5	<.5	<1.0	<1.0	<1.0	<1.0	<.5	<1.0	-
DEC 80	<1.0	<.5	<.5	<.5	<1.0	<1.0	<1.0	<2.0	<1.0	<1.0	-
JAN 81	<.5	<.5	<.3	<.3	<1.0	-	<1.0	<1.0	<.5	<1.0	-
FEB 81	<1.0	<.5	<.5	<.5	<1.0	-	<.5	<1.0	<.5	<.5	<.5
MAR 81	<.5	<.4	<.3	<.3	<1.0	-	<.5	<1.0	<.4	<.5	<.4
MEAN	.79	.64	.59	.61	1.08	.95	.88	1.08	.71	.78	.47
STD.DEV.	.28	.27	.30	.28	.29	.16	.22	.45	.29	.30	.06
MIN	<.3	<.3	<.3	<.3	<1.0	<.5	<.5	<.5	<.3	<.3	<.4
MAX	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0	<1.0	<2.0	<1.0	<1.0	<.5

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: SODIUM (ppm) NEUTRON ACTIVATION ANALYSIS LABORATORY: N

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.05	–	.50	.50	1.01	.40	.52	.05	.11	.02	.09
APR 80	.04	.04	.04	.04	1.02	.09	.13	.24	.04	.96	–
MAY 80	.02	.01	.02	.04	1.15	.05	.20	.70	.02	.01	–
JUN 80	.02	.02	.03	.06	1.17	.59	.85	.17	.01	.15	–
JUL 80	.05	.03	.04	.60	1.20	.06	.13	.10	.02	.03	–
AUG 80	.03	.02	.03	.02	1.06	.34	.05	.06	.08	.63	–
SEP 80	.08	.08	.02	.02	1.15	.05	.19	.27	.03	.05	–
OCT 80	.11	.02	.03	.04	1.05	.12	–	.19	.04	.31	–
NOV 80	.07	.03	.01	.01	1.18	.04	1.04	.07	.04	.10	–
DEC 80	.21	.03	.03	.03	1.00	.16	1.18	.12	.08	.37	–
JAN 81	.08	.03	.02	.04	1.06	–	.26	.27	.08	.64	–
FEB 81	.11	.05	.03	.02	1.04	–	.06	.12	.02	.28	.13
MAR 81	.10	.05	.01	.01	1.02	–	.21	.13	.05	.17	.04
MEAN	.075	.034	.063	.110	1.085	.190	.402	.192	.048	.286	.087
STD.DEV.	.052	.019	.132	.197	.073	.189	.400	.170	.031	.294	.045
MIN	.02	.01	.01	.01	1.00	.04	.05	.05	.01	.01	.04
MAX	.21	.08	.50	.60	1.20	.59	1.18	.70	.11	.96	.13

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: SODIUM (ppm) ATOMIC EMISSION SPECTROMETRY

LABORATORY: R

DATE	VIRGIN BASESTOCK A	B	C	D	REF I	RE-REFINED BASESTOCKS E	F	G	H	J	K
MAR 80	ND	-	ND	ND	1.	ND	ND	ND	ND	ND	ND
APR 80	ND	ND	ND	ND	1.	ND	ND	ND	ND	ND	-
MAY 80	ND	ND	ND	ND	1.	ND	ND	1.	ND	ND	-
JUN 80	ND	ND	ND	ND	ND	<1.	<1.	1.	ND	ND	-
JUL 80	ND	ND	ND	ND	ND	6.	ND	ND	ND	ND	-
AUG 80	ND	ND	ND	ND	1.	ND	ND	ND	ND	ND	-
SEP 80	ND	ND	ND	ND	2.	ND	ND	ND	ND	ND	-
OCT 80	ND	ND	ND	ND	2.	ND	ND	ND	ND	1.	-
NOV 80	ND	ND	ND	ND	2.	ND	2.	ND	ND	ND	-
DEC 80	ND	ND	ND	ND	1.	ND	2.	ND	ND	1.	-
JAN 81	ND	ND	ND	ND	2.	-	ND	ND	ND	1.	-
FEB 81	ND	ND	ND	ND	1.	-	ND	ND	ND	1.	ND
MAR 81	ND	ND	ND	ND	1.	-	ND	ND	ND	ND	ND
MEAN	ND	ND	ND	ND	1.4	6.0	2.0	1.0	ND	1.0	ND
STD.DEV.	-	-	-	-	.5	-	-	-	-	-	-
MIN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MAX	ND	ND	ND	ND	2.	6.	2.	1.	ND	1.	ND

ASTM/NBS BASESTOCK CONSISTENCY STUDY

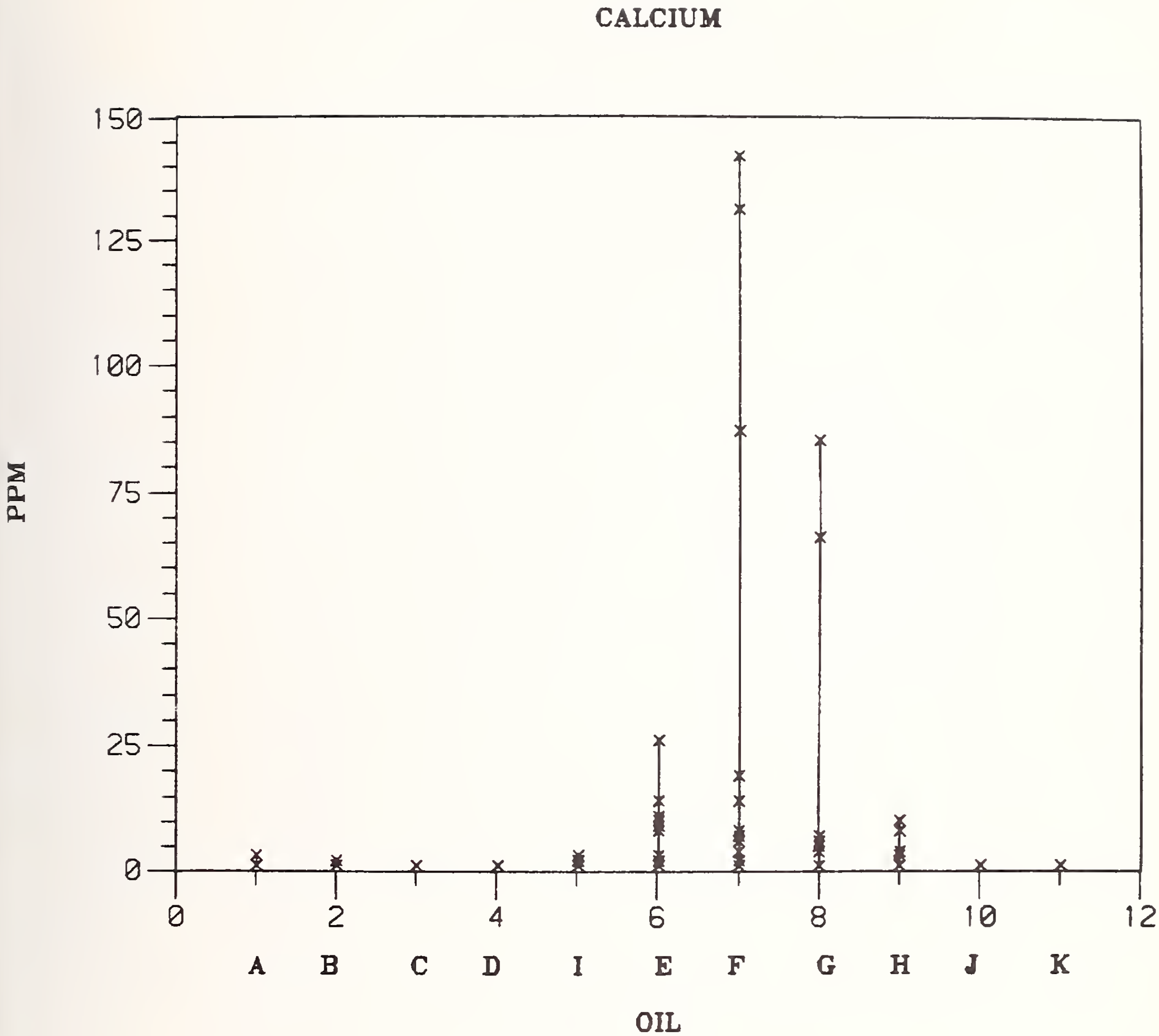
TEST: TIN (ppm) ATOMIC EMISSION SPECTROMETRY LABORATORY: R

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	4.	-	ND	ND	1.	ND	ND	ND	ND	ND	ND
APR 80	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-
MAY 80	ND	ND	ND	ND	<1.	ND	ND	ND	ND	ND	-
JUN 80	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-
JUL 80	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.	-
AUG 80	1.	2.	ND	ND	ND	1.	ND	ND	ND	2.	-
SEP 80	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-
OCT 80	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-
NOV 80	ND	ND	ND	1.	1.	1.	ND	ND	ND	ND	-
DEC 80	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-
JAN 81	ND	ND	ND	ND	ND	-	1.	ND	ND	1.	-
FEB 81	2.	2.	ND	ND	ND	-	ND	ND	ND	ND	ND
MAR 81	ND	ND	ND	ND	ND	-	ND	ND	ND	ND	ND
MEAN	2.3	2.0	ND	1.0	1.0	1.0	1.0	ND	ND	1.3	ND
STD.DEV.	1.5	-	-	-	-	-	-	-	-	.6	-
MIN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MAX	4.	2.	ND	1.	1.	1.	1.	ND	ND	2.	ND

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

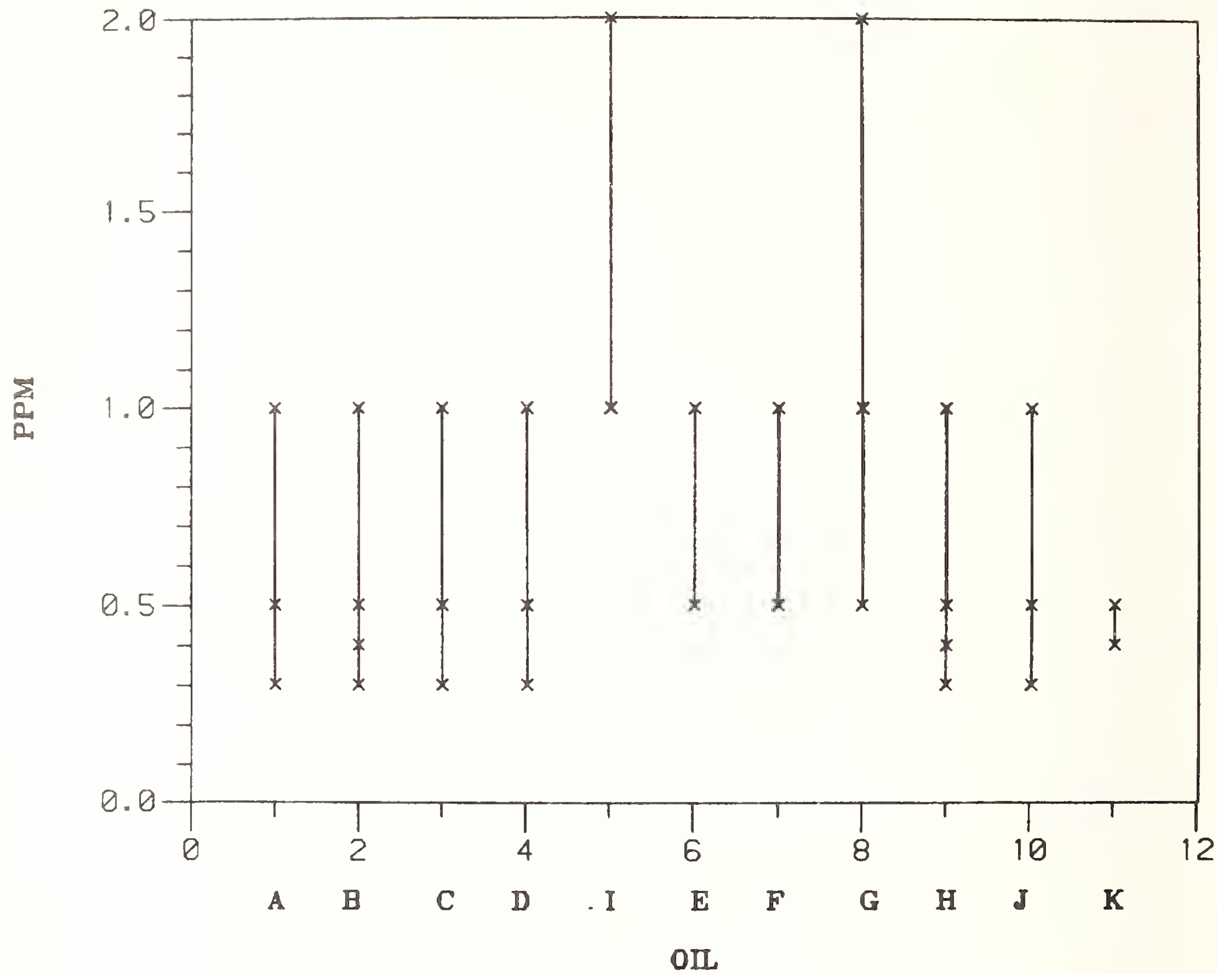
TEST: ZINC (ppm) ATOMIC EMISSION SPECTROMETRY — LABORATORY: R

DATE	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
	A	B	C	D	I	E	F	G	H	J	K
MAR 80	ND	-	ND	ND	1.	23.	28.	ND	3.	ND	2.
APR 80	ND	ND	ND	ND	2.	5.	65.	2.	ND	ND	-
MAY 80	ND	2.	2.	ND	1.	13.	58.	1.	ND	ND	-
JUN 80	ND	ND	ND	1.	1.	61.	108.	27.	ND	ND	-
JUL 80	ND	2.	ND	3.	5.	5.	17.	ND	ND	ND	-
AUG 80	ND	ND	ND	ND	ND	3.	90.	ND	ND	1.	-
SEP 80	ND	ND	ND	ND	ND	1.	106.	13.	ND	ND	-
OCT 80	ND	ND	ND	ND	ND	ND	ND	9.	ND	ND	-
NOV 80	ND	ND	ND	ND	NC	ND	121.	ND	ND	ND	-
DEC 80	ND	ND	ND	ND	2.	11.	88.	1.	2.	ND	-
JAN 81	ND	ND	ND	ND	ND	-	24.	ND	ND	ND	-
FEB 81	ND	ND	ND	ND	ND	-	76.	ND	ND	ND	ND
MAR 81	ND	ND	ND	ND	ND	-	92.	17.	ND	ND	ND
MEAN	ND	2.0	2.0	2.0	2.0	15.2	72.8	10.0	2.5	1.0	2.0
STD.DEV.	-	-	-	1.4	1.5	19.8	34.8	9.8	.7	-	-
MIN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MAX	ND	2.	2.	3.	5.	61.	121.	27.	3.	1.	2.



CALCIUM
PPM
150
125
100
75
50
25
0
0
2
4
6
8
10
12
A
B
C
D
I
E
F
G
H
J
K
OIL

POTASSIUM BY NAA



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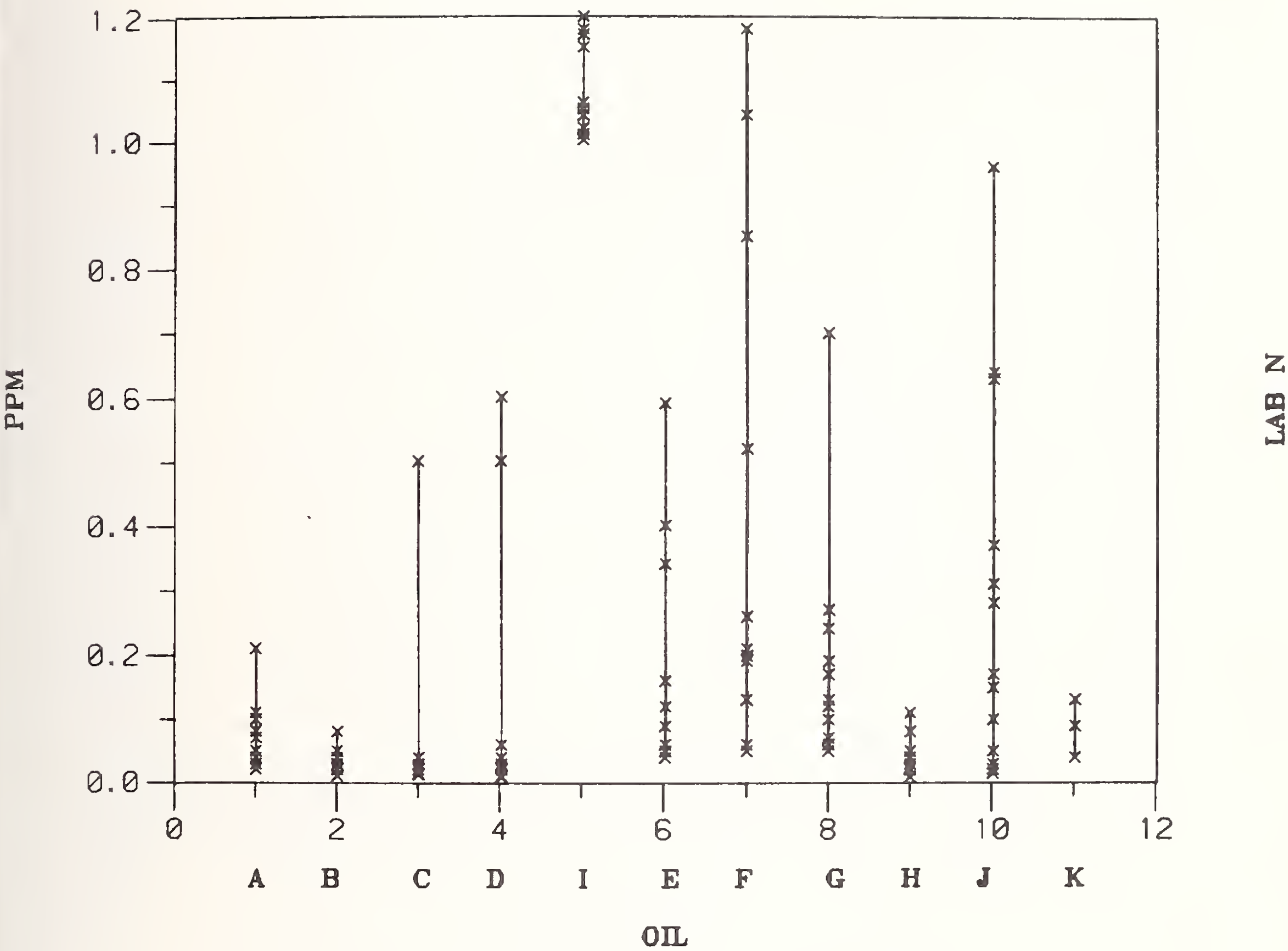

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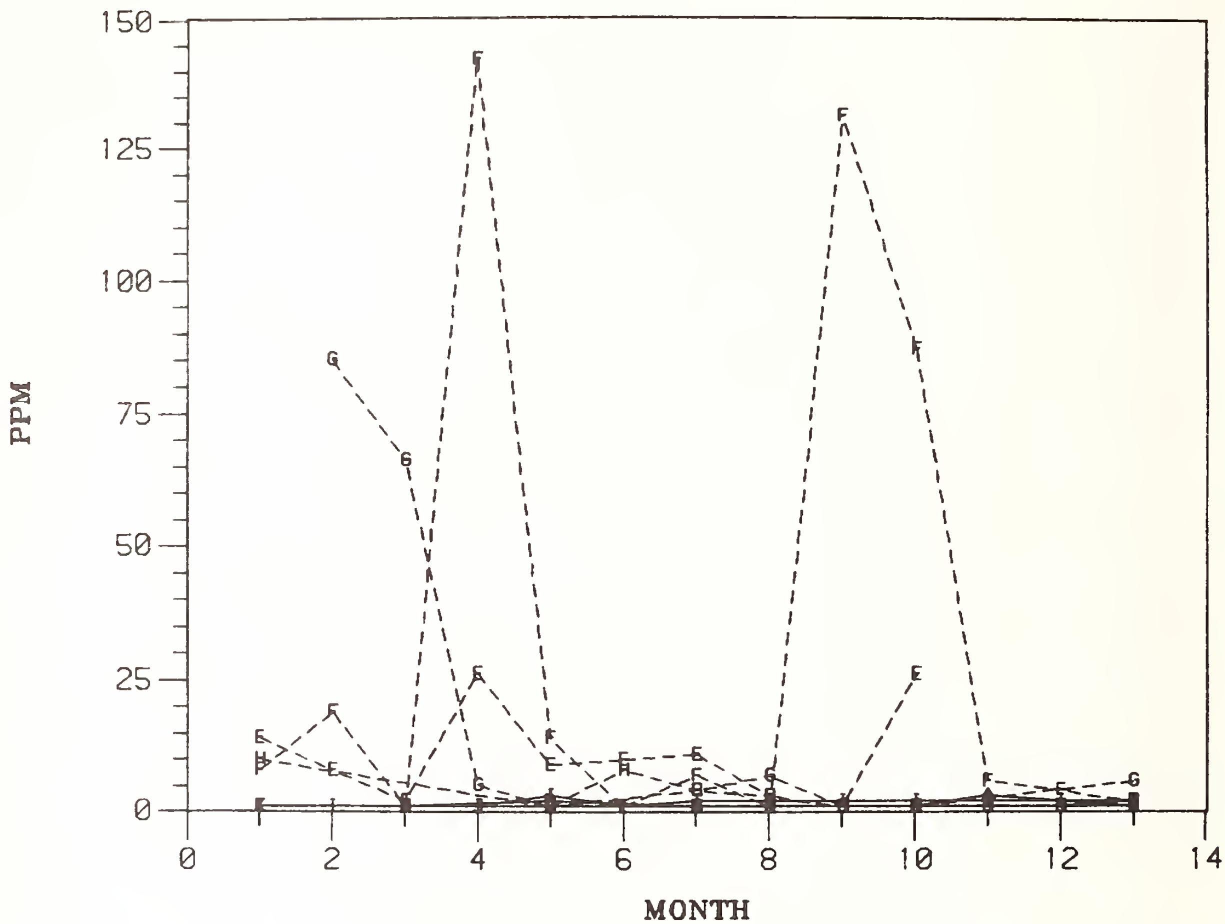
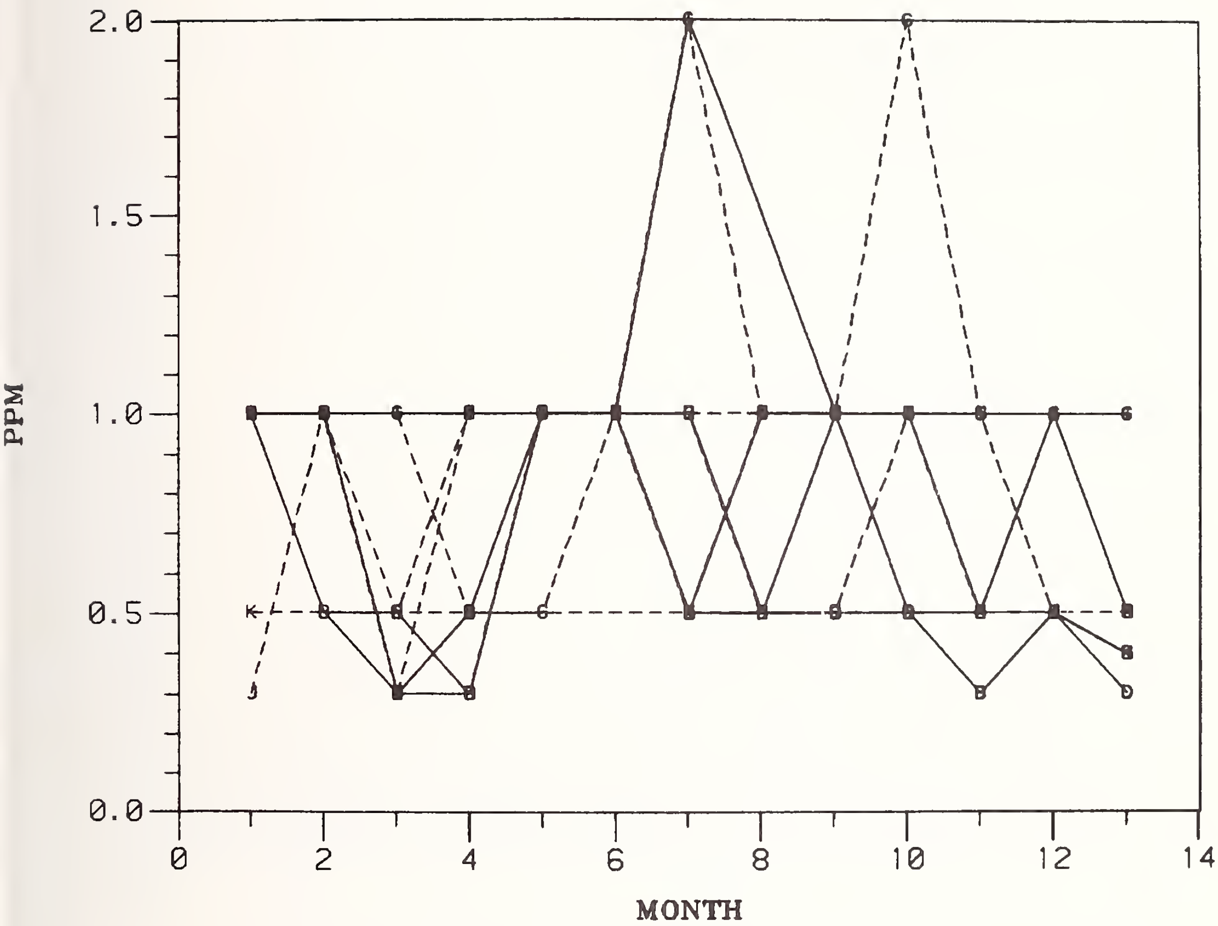


POTASSIUM BY NAA



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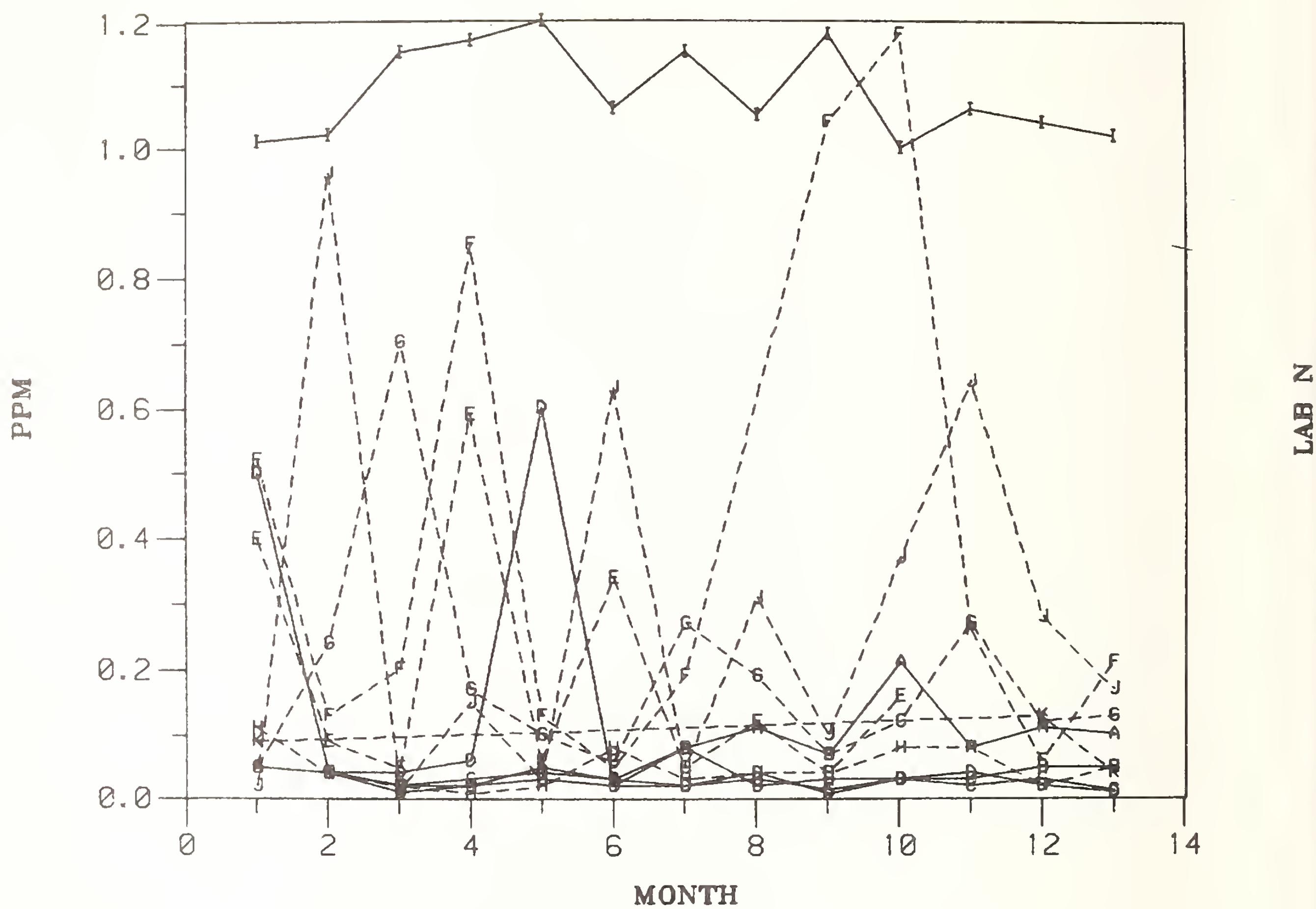


ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: SILICON (ppm) ATOMIC EMISSION SPECTROMETRY LABORATORY: R

DATE	VIRGIN BASESTOCK A	B	C	D	REF I	RE-REFINED BASESTOCKS E	F	G	H	J	K
MAR 80	ND	-	ND	ND	ND	ND	ND	8.	ND	ND	ND
APR 80	ND	ND	ND	ND	ND	ND	ND	<1.	ND	ND	-
MAY 80	ND	ND	ND	ND	<1.	<1.	ND	6.	ND	ND	-
JUN 80	ND	ND	ND	ND	ND	<1.	<1.	<1.	ND	ND	-
JUL 80	ND	ND	ND	ND	ND	ND	3.	ND	ND	ND	-
AUG 80	ND	ND	ND	ND	ND	ND	<1.	ND	2.	ND	-
SEP 80	ND	ND	ND	ND	ND	2.	1.	ND	ND	ND	-
OCT 80	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-
NOV 80	ND	ND	ND	ND	ND	1.	7.	7.	ND	ND	-
DEC 80	ND	ND	ND	ND	ND	ND	8.	ND	2.	ND	-
JAN 81	ND	ND	ND	ND	ND	-	ND	ND	ND	ND	-
FEB 81	ND	ND	ND	ND	ND	-	10.	ND	ND	ND	ND
MAR 81	ND	ND	ND	ND	ND	-	12.	3.	ND	ND	ND
MEAN	ND	ND	ND	ND	ND	1.5	6.8	6.0	2.0	ND	ND
STD.DEV.	-	-	-	-	-	.7	4.2	2.2	-	-	-
MIN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MAX	ND	ND	ND	ND	<1.	2.	12.	8.	2.	ND	ND

V

HYDROCARBON TYPE ANALYSIS

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: SATURATES (WT%) ASTM D2007

LABORATORY: M

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	84.0	-	75.1	84.0	72.6	78.0	78.4	75.0	75.3	74.4	75.7
APR 80	--	78.0	--	83.0	--	79.9	79.2	--	--	--	-
MAY 80	--	--	71.6	--	72.3	--	--	72.8	--	--	-
JUN 80	80.6	73.0	--	--	--	77.1	--	--	76.4	--	-
JUL 80	--	--	67.4	81.3	--	--	77.5	72.2	--	74.1	-
AUG 80	76.2	73.1	69.3	82.8	70.5	76.9	77.0	72.6	74.8	72.3	-
SEP 80	--	--	67.4	80.5	71.2	--	--	--	73.3	--	-
OCT 80	--	73.3	--	--	--	--	76.5	71.8	--	74.3	-
NOV 80	79.1	--	68.6	82.5	--	75.6	--	--	--	--	-
DEC 80	--	--	--	--	70.2	--	--	73.5	74.1	73.5	-
JAN 81	--	74.1	67.3	84.7	--	-	77.3	--	--	75.7	-
FEB 81	76.2	71.9	69.3	84.0	71.6	-	--	73.4	75.7	--	73.9
MAR 81	--	70.5	--	--	--	-	77.5	74.1	--	76.2	--
MEAN	79.22	73.41	69.50	82.85	71.40	77.50	77.63	73.17	74.93	74.36	74.80
STD.DEV.	3.28	2.33	2.68	1.42	.96	1.59	.90	1.05	1.12	1.31	1.27
MIN	76.2	70.5	67.3	80.5	70.2	75.6	76.5	71.8	73.3	72.3	73.9
MAX	84.0	78.0	75.1	84.7	72.6	79.9	79.2	75.0	76.4	76.2	75.7

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: SATURATES, RUN 2 (WT%) ASTM D2007 LABORATORY: M

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	84.2	-	75.2	--	73.2	--	--	--	--	--	--
APR 80	--	76.8	--	83.8	--	78.7	79.1	--	--	--	-
MAY 80	--	--	--	--	72.5	--	--	71.3	--	--	-
JUN 80	82.3	--	--	--	--	--	--	--	--	--	-
JUL 80	--	--	--	--	--	--	77.6	--	--	74.7	-
AUG 80	76.6	73.5	--	--	--	--	--	--	--	--	-
SEP 80	--	--	66.5	--	70.8	--	--	--	--	--	-
OCT 80	--	71.9	--	--	--	--	77.0	71.3	--	--	-
NOV 80	--	--	--	82.6	--	75.3	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	74.1	74.8	72.3	-
JAN 81	--	--	68.3	--	--	-	--	--	--	--	-
FEB 81	--	--	--	84.3	--	-	--	73.6	75.5	--	--
MAR 81	--	--	--	--	--	-	--	--	--	76.3	--
MEAN	81.03	74.07	70.00	83.57	72.17	77.00	77.90	72.62	75.15	74.43	--
STD.DEV.	3.96	2.50	4.59	.87	1.23	2.40	1.08	1.53	.49	2.01	--
MIN	76.6	71.9	66.5	82.6	70.8	75.3	77.0	71.3	74.8	72.3	--
MAX	84.2	76.8	75.2	84.3	73.2	78.7	79.1	74.1	75.5	76.3	--

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: SATURATES (WT%) ASTM D2549 LABORATORY: V

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	84.1	-	75.4	81.0	72.6	79.0	76.9	75.4	73.1	75.8	77.9
APR 80	83.6	78.0	71.8	83.9	71.3	78.3	78.4	72.5	73.8	75.0	-
MAY 80	84.2	77.0	71.7	85.0	73.8	79.2	79.2	78.0	76.3	77.0	-
JUN 80	84.2	71.4	72.6	85.0	74.1	79.4	79.5	74.4	77.1	77.2	-
JUL 80	82.7	75.9	70.6	81.5	72.9	79.0	78.8	76.4	76.9	76.2	-
AUG 80	80.1	76.1	70.0	85.1	76.7	78.6	76.4	74.0	76.5	76.7	-
SEP 80	80.2	74.8	70.3	84.9	74.4	78.5	78.7	75.0	78.4	77.6	-
OCT 80	79.5	72.8	68.3	85.0	73.0	77.4	79.2	75.7	75.6	76.4	-
NOV 80	80.4	75.3	69.3	85.2	73.1	79.8	80.8	76.3	77.1	76.5	-
DEC 80	78.8	74.9	71.9	85.0	72.6	76.9	79.9	76.4	76.2	78.8	-
JAN 81	80.3	78.0	70.3	86.2	75.2	-	79.4	78.0	77.5	78.2	-
FEB 81	80.7	77.2	72.2	87.6	74.9	-	79.0	78.0	77.4	74.6	71.2
MAR 81	79.9	71.3	70.8	85.6	73.0	-	78.9	76.9	74.6	77.3	76.7
MEAN	81.36	75.22	71.17	84.69	73.66	78.61	78.85	75.92	76.19	76.72	75.27
STD.DEV.	2.08	2.33	1.76	1.75	1.40	.89	1.15	1.67	1.54	1.18	3.57
MIN	78.8	71.3	68.3	81.0	71.3	76.9	76.4	72.5	73.1	74.6	71.2
MAX	84.2	78.0	75.4	87.6	76.7	79.8	80.8	78.0	78.4	78.8	77.9

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: SATURATES HYDROCARBONS (WT%) TLC/FID

LABORATORY: U

DATE	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
	A	B	C	D	I	E	F	G	H	J	K
MAR 80	92.3	-	84.0	91.9	81.4	87.0	87.7	86.1	86.0	86.6	87.0
APR 80	--	--	--	--	--	--	--	--	--	85.2	-
MAY 80	--	--	--	--	--	--	--	--	--	86.4	-
JUN 80	91.8	86.4	81.2	92.4	82.4	87.6	84.6	82.9	87.1	87.7	-
JUL 80	--	--	--	--	--	--	--	--	--	--	-
AUG 80	--	--	--	--	--	--	--	--	--	--	-
SEP 80	89.4	87.9	77.1	91.2	87.6	84.3	85.8	84.1	85.0	87.8	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	85.6	83.2	76.3	90.8	81.3	84.9	83.5	84.5	86.1	79.8	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	84.5	--	--	81.9	79.2
MAR 81	84.6	77.2	75.1	89.9	78.9	-	83.3	81.9	82.2	83.3	78.8
MEAN	88.74	83.68	78.74	91.24	82.32	85.95	84.90	83.90	85.28	84.84	81.67
STD.DEV.	3.52	4.74	3.73	0.97	3.22	1.60	1.64	1.60	1.88	2.90	4.62
MIN	84.6	77.2	75.1	89.9	78.9	84.3	83.3	81.9	82.2	79.8	78.8
MAX	92.3	87.9	84.0	92.4	87.6	87.6	87.7	86.1	87.1	87.8	87.0

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: SATURATES (WT%) HPLC/MS

LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	74.48	73.83	--	76.17
APR 80	--	--	--	--	--	77.21	74.84	--	--	--	-
MAY 80	--	--	71.07	--	71.16	--	--	--	--	--	-
JUN 80	80.86	--	--	--	--	--	--	--	74.15	--	-
JUL 80	--	--	69.46	--	--	--	76.10	--	--	--	-
AUG 80	74.76	--	--	--	--	77.14	--	--	--	75.64	-
SEP 80	--	--	--	--	72.43	--	--	--	75.32	--	-
OCT 80	--	--	--	--	--	--	77.77	73.55	--	--	-
NOV 80	79.34	--	--	--	--	77.11	--	--	--	--	-
DEC 80	--	--	--	--	71.70	--	--	--	75.73	--	-
JAN 81	--	--	69.30	--	--	-	78.13	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	73.94
MAR 81	--	--	--	--	--	-	--	75.86	--	76.93	71.54
MEAN	78.320	.000	69.943	.000	71.763	77.153	76.710	74.630	74.757	76.285	73.883
STD.DEV.	3.175	.000	.979	.000	.637	.051	1.529	1.162	.911	.912	2.316
MIN	74.76	.00	69.30	.00	71.16	77.11	74.84	73.55	73.83	75.64	71.54
MAX	80.86	.00	71.07	.00	72.43	77.21	78.13	75.86	75.73	76.93	76.17

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: SATURATES, O-RING (WT%) HPLC/MS

LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	18.915	17.823	--	--
APR 80	--	--	--	--	--	17.399	15.467	--	--	--	-
MAY 80	--	--	19.291	--	17.962	--	--	--	--	--	-
JUN 80	22.670	--	--	--	--	--	--	--	16.927	--	-
JUL 80	--	--	20.364	--	--	--	16.482	--	--	--	-
AUG 80	19.474	--	--	--	--	16.852	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	21.0720	.0000	19.8275	.0000	17.9620	17.1255	15.9745	18.9150	17.3750	.0000	.0000
STD.DEV.	2.2599	.0000	.7587	.0000	.0000	.3868	.7177	.0000	.6336	.0000	.0000
MIN	19.474	.000	19.291	.000	17.962	16.852	15.467	18.915	16.927	.000	.000
MAX	22.670	.000	20.364	.000	17.962	17.399	16.482	18.915	17.823	.000	.000

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: SATURATES, 1-RING (WT%) HPLC/MS LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	19.686	19.394	--	--
APR 80	--	--	--	--	--	18.827	16.556	--	--	--	-
MAY 80	--	--	15.511	--	16.400	--	--	--	--	--	-
JUN 80	23.916	--	--	--	--	--	--	--	18.790	--	-
JUL 80	--	--	16.248	--	--	--	17.572	--	--	--	-
AUG 80	21.184	--	--	--	--	18.183	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	22.5500	.0000	15.8795	.0000	16.4000	18.5050	17.0640	19.6860	19.0920	.0000	.0000
STD.DEV.	1.9318	.0000	.5211	.0000	.0000	.4554	.7184	.0000	.4271	.0000	.0000
MIN	21.184	.000	15.511	.000	16.400	18.183	16.556	19.686	18.790	.000	.000
MAX	23.916	.000	16.248	.000	16.400	18.827	17.572	19.686	19.394	.000	.000

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: SATURATES, 2-RING (WT%) HPLC/MS

LABORATORY: T

DATE :	VIRGIN BASESTOCK				: REF :	RE-REFINED BASESTOCKS					
DATE :	A	B	C	D	I	E	F	G	H	J	K
MAR 80 :	--	-	--	--	--	--	--	14.484	14.444	--	--
APR 80 :	--	--	--	--	--	14.541	14.500	--	--	--	-
MAY 80 :	--	--	13.753	--	11.641	--	--	--	--	--	-
JUN 80 :	13.698	--	--	--	--	--	--	--	14.289	--	-
JUL 80 :	--	--	12.748	--	--	--	14.674	--	--	--	-
AUG 80 :	13.924	--	--	--	--	14.963	--	--	--	--	-
SEP 80 :	--	--	--	--	--	--	--	--	--	--	-
OCT 80 :	--	--	--	--	--	--	--	--	--	--	-
NOV 80 :	--	--	--	--	--	--	--	--	--	--	-
DEC 80 :	--	--	--	--	--	--	--	--	--	--	-
JAN 81 :	--	--	--	--	--	-	--	--	--	--	-
FEB 81 :	--	--	--	--	--	-	--	--	--	--	--
MAR 81 :	--	--	--	--	--	-	--	--	--	--	--
MEAN :	13.8110	.0000	13.2505	.0000	11.6410	14.7520	14.5870	14.4840	14.36650	.0000	.0000
STD.DEV. :	.1598	.0000	.7106	.0000	.0000	.2984	.1230	.0000	.10960	.0000	.0000
MIN :	.000	13.698	.000	12.748	.000	11.641	14.541	14.500	.000	14.289	.000
MAX :	.000	13.924	.000	13.753	.000	11.641	14.963	14.674	.000	14.289	.000

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: SATURATES, 3-RING (WT%) HPLC/MS LABORATORY: T

DATE	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	9.033	9.055	--	--
APR 80	--	--	--	--	--	10.063	10.575	--	--	--	-
MAY 80	--	--	9.645	--	11.147	--	--	--	--	--	-
JUN 80	7.632	--	--	--	--	--	--	--	9.415	--	-
JUL 80	--	--	8.782	--	--	--	10.356	--	--	--	-
AUG 80	7.329	--	--	--	--	9.744	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	7.4805	.0000	9.2135	.0000	11.1470	9.9035	10.4655	9.0330	9.2350	.0000	.0000
STD.DEV.	.2143	.0000	.6102	.0000	.0000	.2256	.1549	.0000	.2546	.0000	.0000
MIN	7.329	.000	8.782	.000	11.147	9.744	10.356	9.033	9.055	.000	.000
MAX	7.632	.000	9.645	.000	11.147	10.063	10.575	9.033	9.415	.000	.000

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: SATURATES, 4-RING (WT%) HPLC/MS

LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	7.727	8.166	--	--
APR 80	--	--	--	--	--	10.253	11.116	--	--	--	-
MAY 80	--	--	7.835	--	8.522	--	--	--	--	--	-
JUN 80	6.593	--	--	--	--	--	--	--	8.924	--	-
JUL 80	--	--	6.920	--	--	--	10.808	--	--	--	-
AUG 80	6.949	--	--	--	--	10.820	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	6.7710	.0000	7.3775	.0000	8.5220	10.5365	10.9620	7.7270	8.5450	.0000	.0000
STD.DEV.	.2517	.0000	.6470	.0000	.0000	.4009	.2178	.0000	.5360	.0000	.0000
MIN	6.593	.000	6.920	.000	8.522	10.253	10.808	7.727	8.166	.000	.000
MAX	6.949	.000	7.835	.000	8.522	10.820	11.116	7.727	8.924	.000	.000

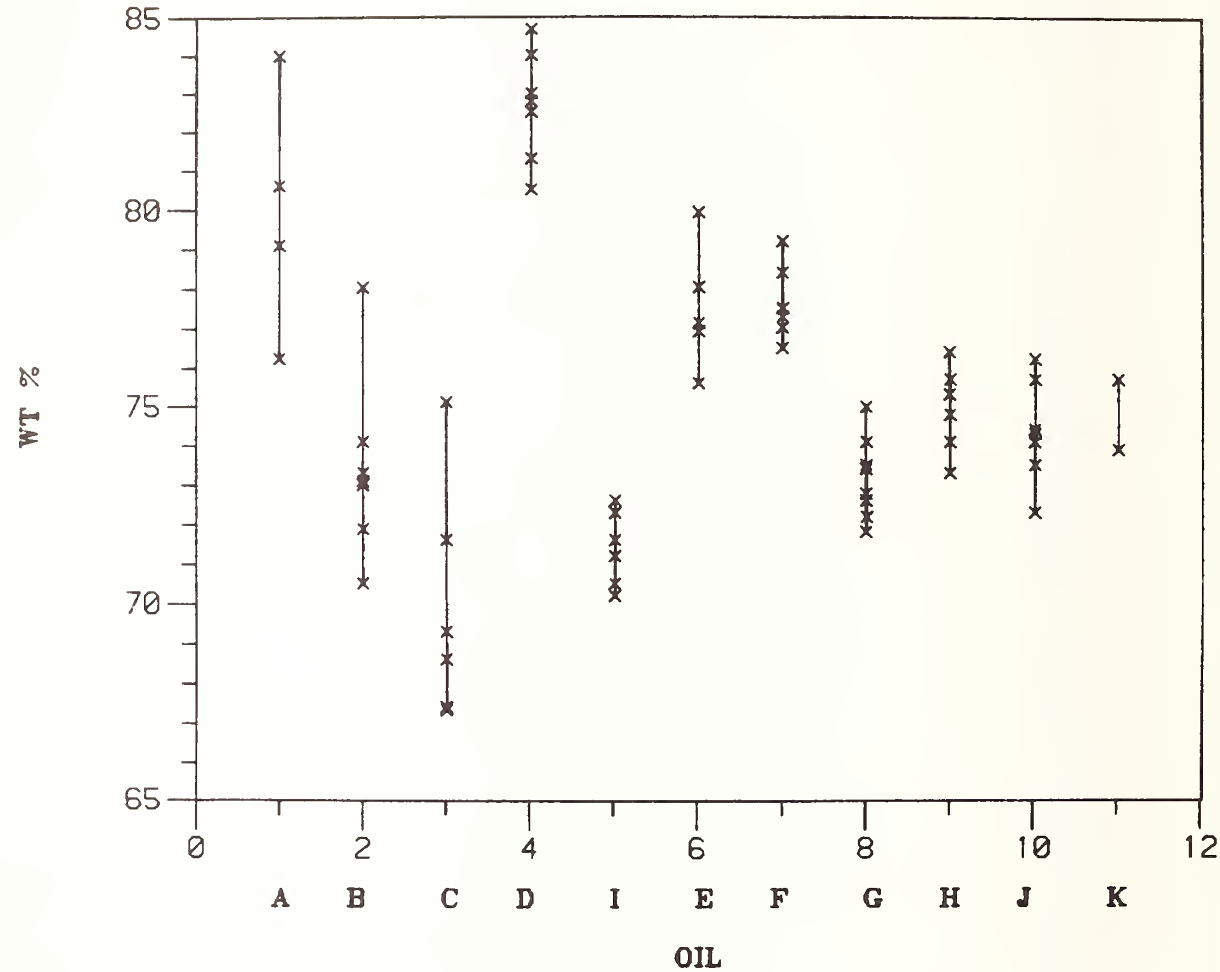
ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: SATURATES, 5-RING (WT%) HPLC/MS

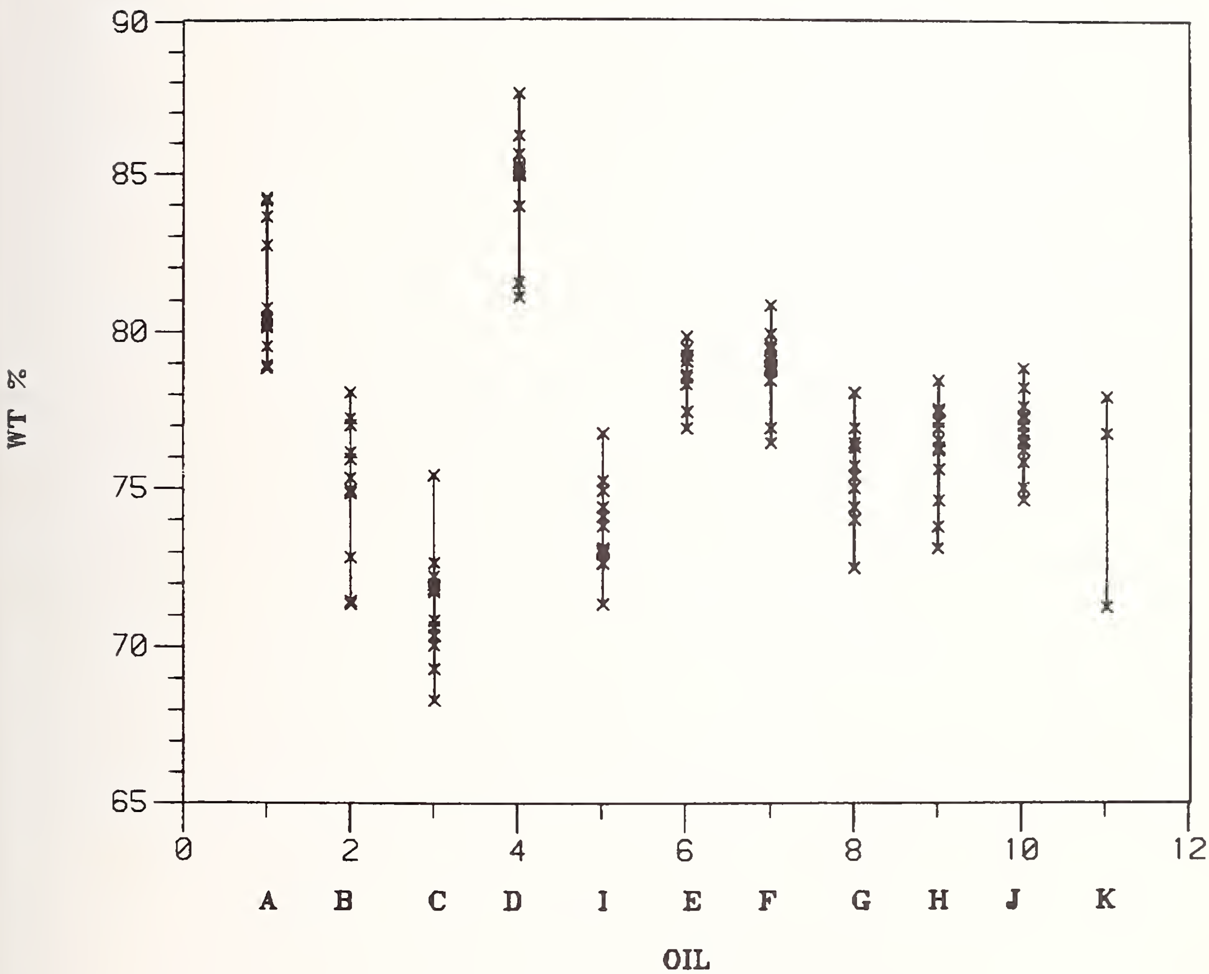
LABORATORY: T

		VIRGIN BASESTOCK			REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	4.645	4.948	--	--
APR 80	--	--	--	--	--	6.126	6.626	--	--	--	-
MAY 80	--	--	5.035	--	5.487	--	--	--	--	--	-
JUN 80	6.352	--	--	--	--	--	--	--	5.804	--	-
JUL 80	--	--	4.398	--	--	--	6.208	--	--	--	-
AUG 80	5.901	--	--	--	--	6.579	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	6.1265	.0000	4.7165	.0000	5.4870	6.3525	6.4170	4.6450	5.3760	.0000	.0000
STD.DEV.	.3189	.0000	.4504	.0000	.0000	.3203	.2956	.0000	.6053	.0000	.0000
MIN	5.901	.000	4.398	.000	5.487	6.126	6.208	4.645	4.948	.000	.000
MAX	6.352	.000	5.035	.000	5.487	6.579	6.626	4.645	5.804	.000	.000

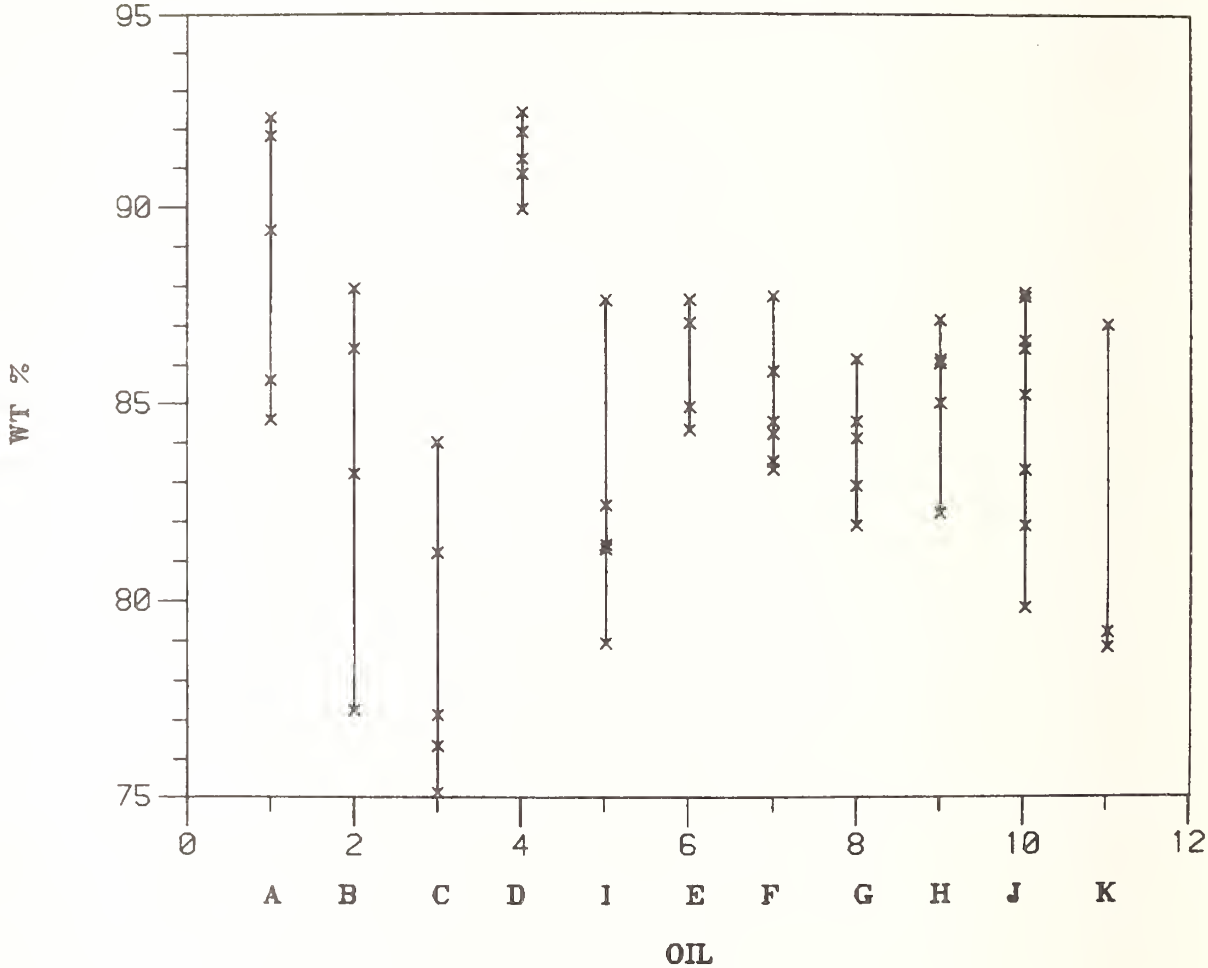
SATURATES BY ASTM D2007



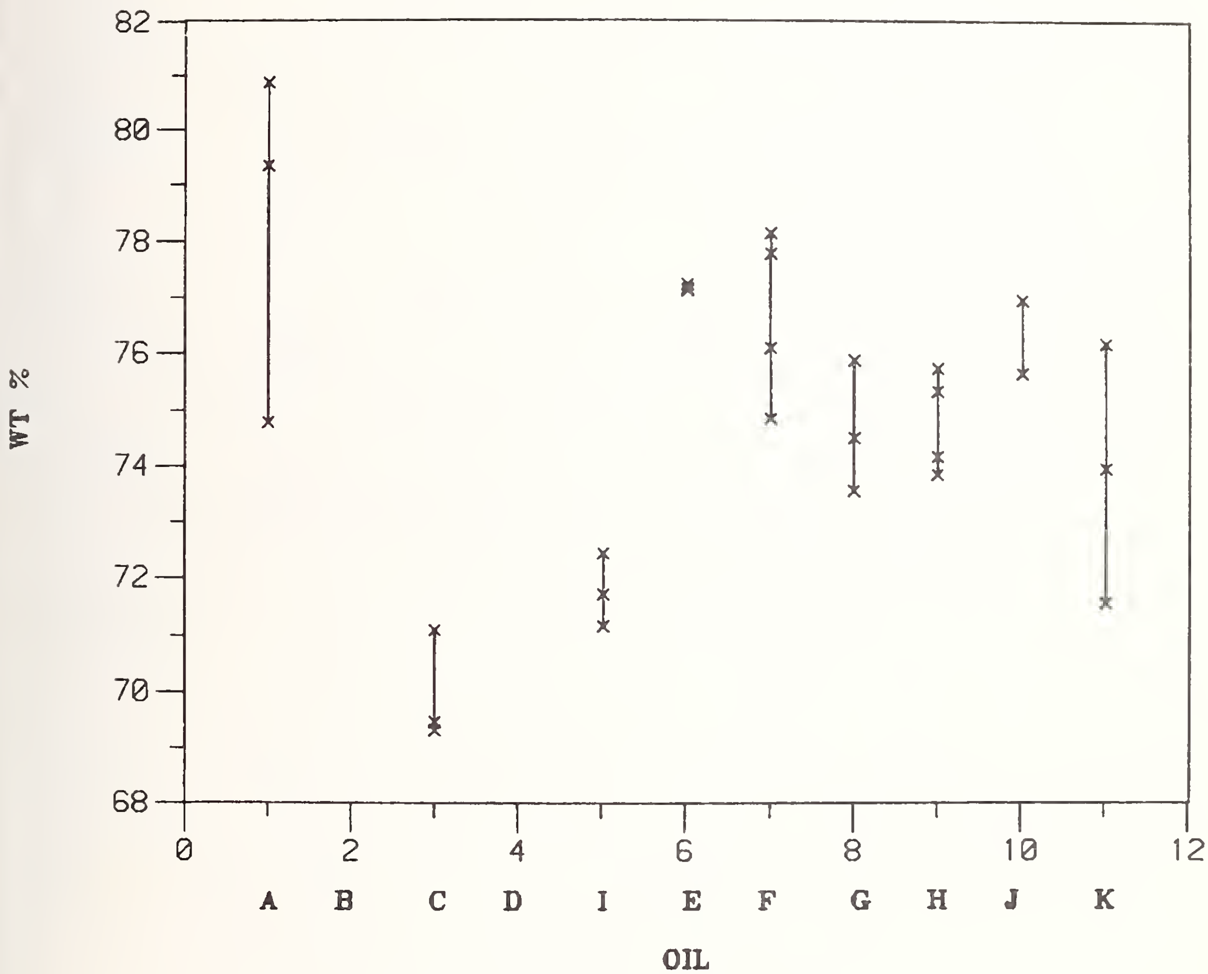
SATURATES BY ASTM D2549



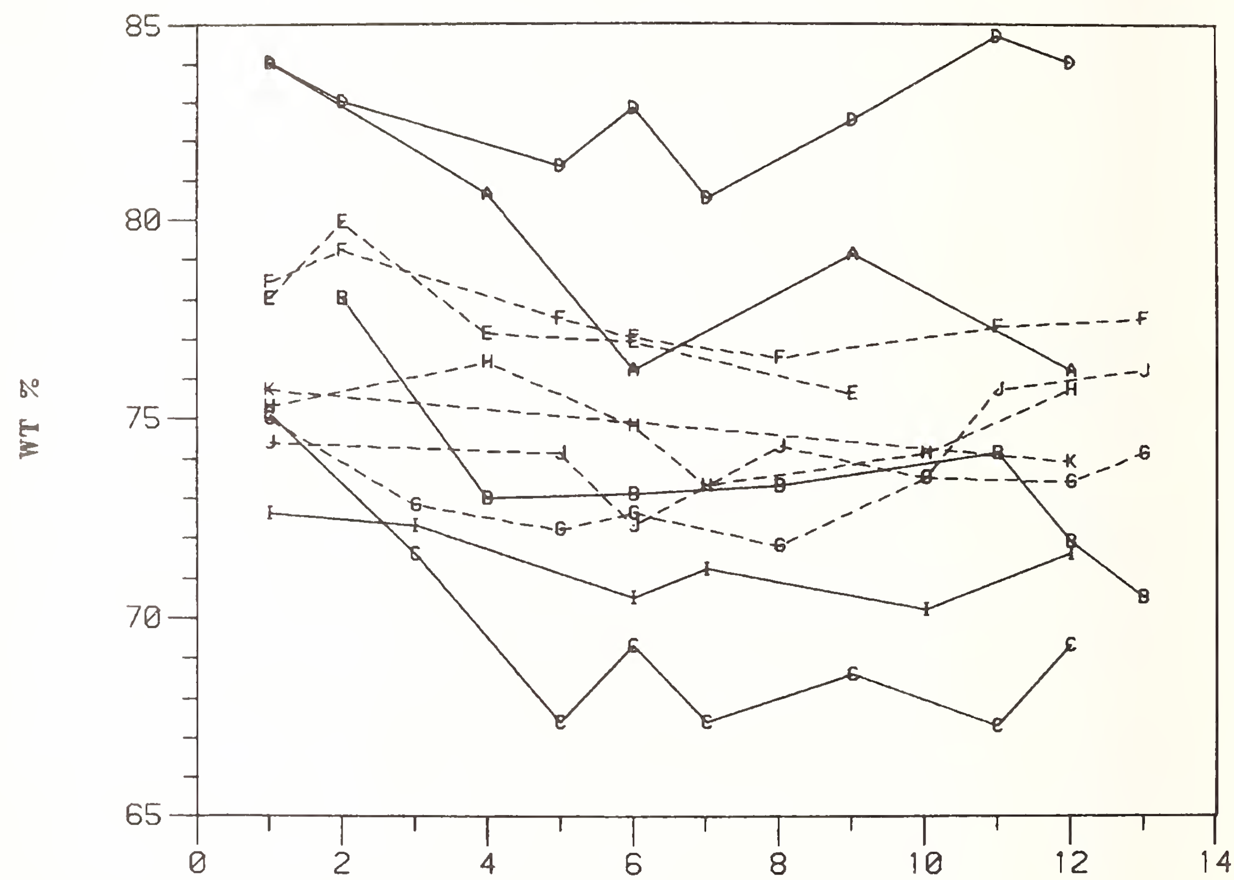
SATURATE HYDROCARBONS BY TLC/FID



SATURATES BY HPLC



SATURATES BY ASTM D2007



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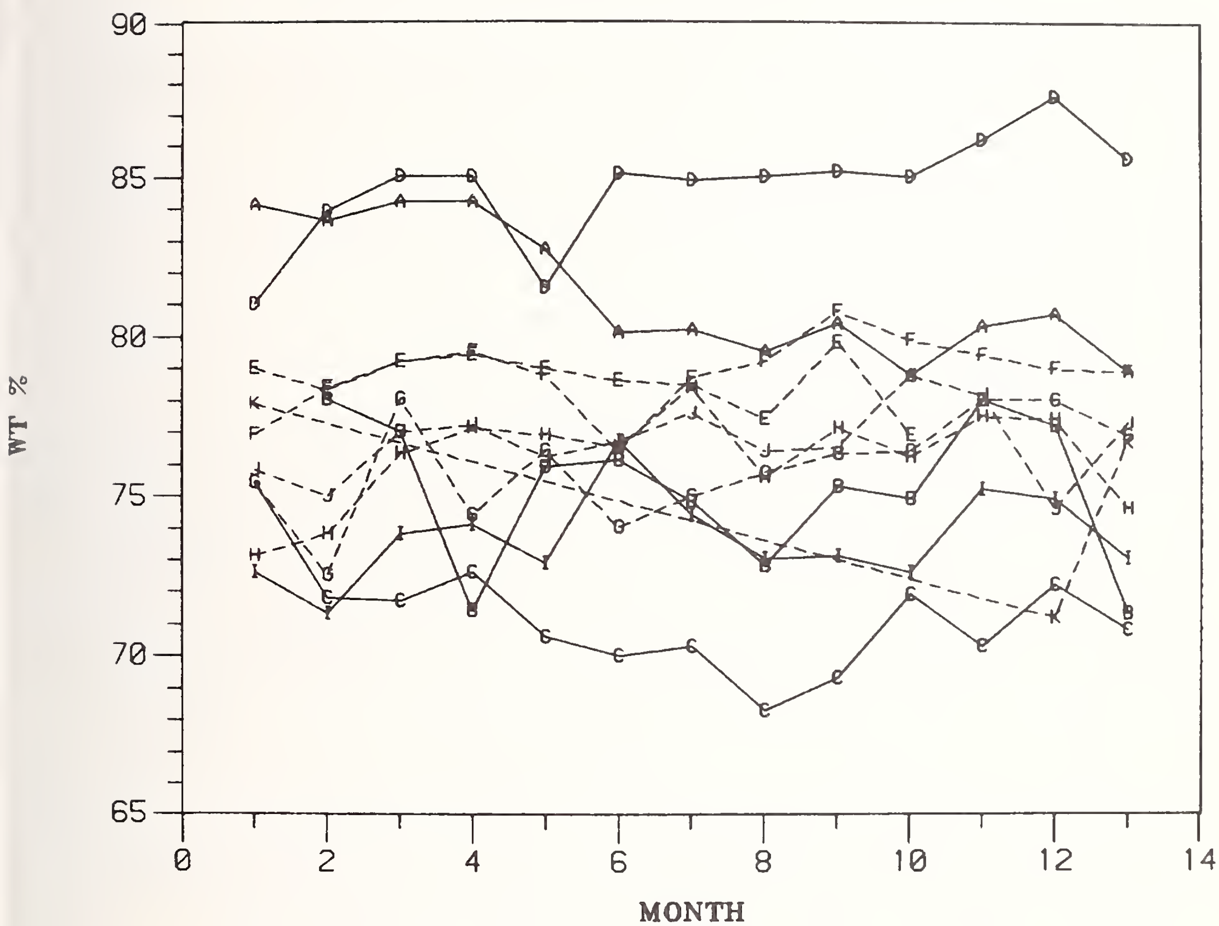
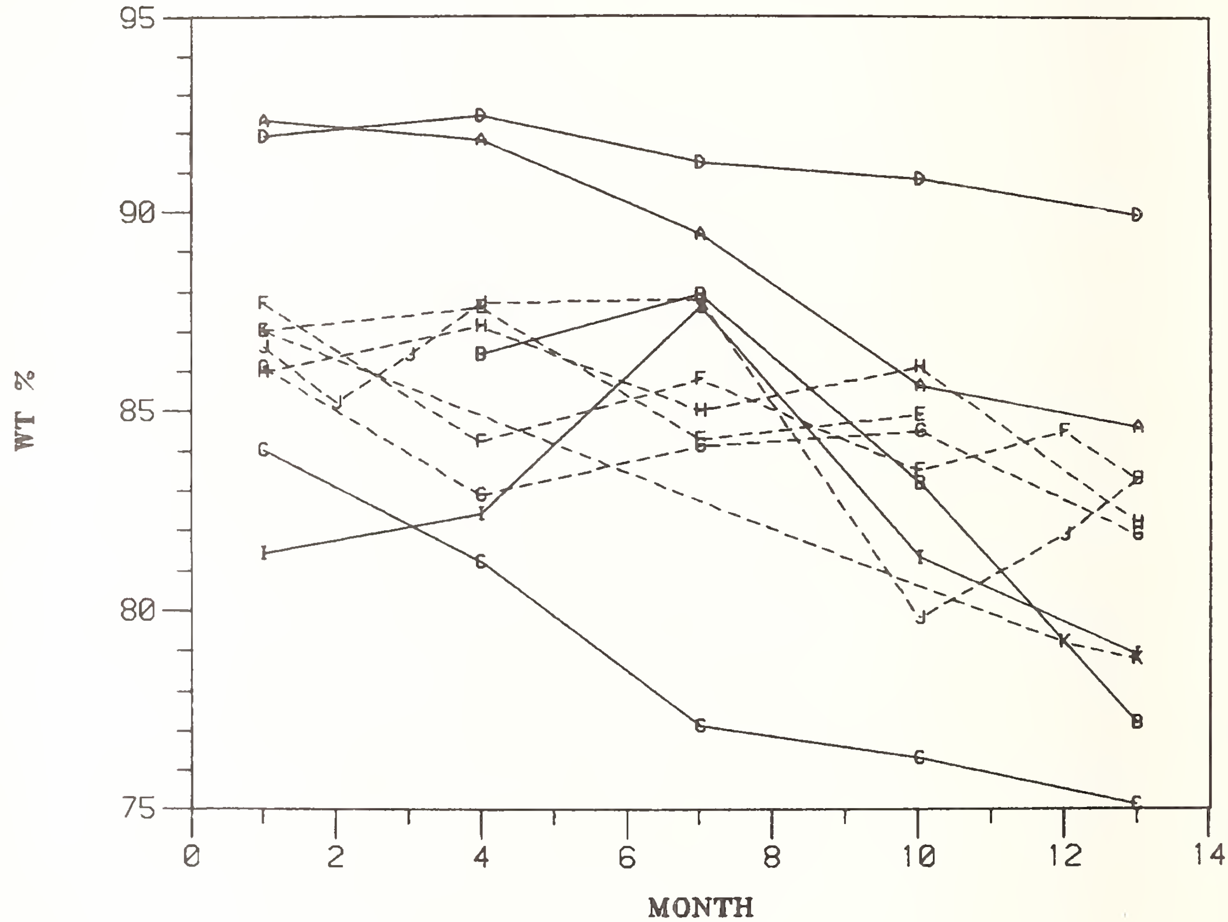
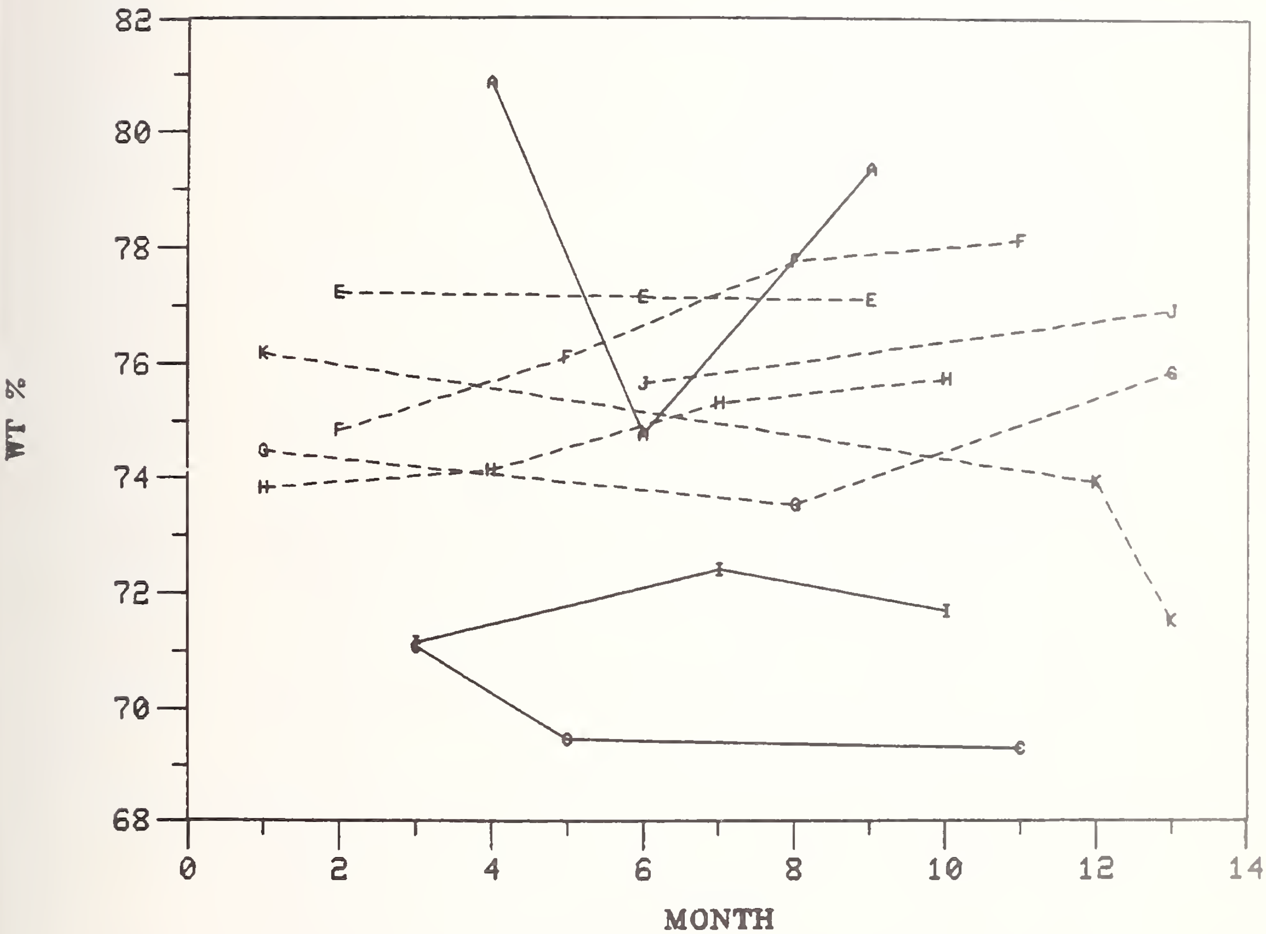


SATURATE HYDROCARBONS BY TLC/FID



SATURATES BY HPLC



ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: ARCMATICS (WT%) ASTM D2007 LABORATORY: M

DATE :	VIRGIN BASESTOCK				: REF :	RE-REFINED BASESTOCKS					
	A	B	C	D	I	E	F	G	H	J	K
MAR 80 :	15.6	-	24.4	15.5	26.9	20.6	20.5	22.8	22.8	24.5	23.8
APR 80 :	--	21.4	--	16.5	--	18.8	19.7	--	--	--	-
MAY 80 :	--	--	28.0	--	27.3	--	--	24.9	--	--	-
JUN 80 :	19.0	26.3	--	--	--	21.5	--	--	21.8	--	-
JUL 80 :	--	--	32.1	18.2	--	--	21.6	25.4	--	24.9	-
AUG 80 :	23.1	26.2	30.3	16.6	29.1	21.8	21.7	24.5	23.1	26.4	-
SEP 80 :	--	--	31.9	18.9	28.3	--	--	--	24.8	--	-
OCT 80 :	--	--	--	--	--	--	22.3	25.7	--	24.4	-
NOV 80 :	20.3	26.2	31.0	17.0	--	23.1	--	--	--	--	-
DEC 80 :	--	--	--	--	29.4	--	--	24.5	24.0	25.2	-
JAN 81 :	--	25.2	31.2	14.8	--	-	21.8	--	--	23.0	-
FEB 81 :	23.3	27.3	30.1	15.4	27.9	-	--	24.3	22.5	--	25.0
MAR 81 :	--	28.0	--	--	--	-	21.6	24.3	--	22.8	-
MEAN :	20.26	25.80	29.87	16.61	28.15	21.16	21.31	24.55	23.17	24.46	24.40
STD.DEV. :	3.19	2.14	2.56	1.41	.98	1.59	.89	.88	1.08	1.25	.85
MIN :	15.6	21.4	24.4	14.8	26.9	18.8	19.7	22.8	21.8	22.8	23.8
MAX :	23.3	28.0	32.1	18.9	29.4	23.1	22.3	25.7	24.8	26.4	25.0

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: AROMATICS, RUN 2 (WT%) ASTM D2007

LABORATORY: M

DATE	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	26.3	--	--	--	--	--	--
APR 80	--	--	--	15.6	--	--	19.9	--	--	--	-
MAY 80	--	--	--	--	27.0	--	--	26.4	--	--	-
JUN 80	17.3	--	--	--	--	--	--	--	--	--	-
JUL 80	--	--	--	--	--	--	21.4	--	--	24.3	-
AUG 80	22.8	25.9	--	--	--	--	--	--	--	--	-
SEP 80	--	--	32.8	--	28.6	--	--	--	--	--	-
OCT 80	--	27.3	--	--	--	--	21.8	26.2	--	--	-
NOV 80	--	--	--	17.0	--	23.4	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	23.8	23.4	26.4	-
JAN 81	--	--	30.1	--	--	-	--	--	--	--	-
FEB 81	--	--	--	15.1	--	-	--	24.4	22.8	--	--
MAR 81	--	--	--	--	--	-	--	--	--	22.7	--
MEAN	20.05	26.60	31.45	15.90	27.30	23.40	21.03	25.20	23.10	24.47	.00
STD.DEV.	3.89	.99	1.91	.98	1.18	.00	1.00	1.30	.42	1.86	.00
MIN	17.3	25.9	30.1	15.1	26.3	23.4	19.9	23.8	22.8	22.7	.0
MAX	22.8	27.3	32.8	17.0	28.6	23.4	21.8	26.4	23.4	26.4	.0

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: ARCMATICS (WT %) ASTM D2549 LABORATORY: V

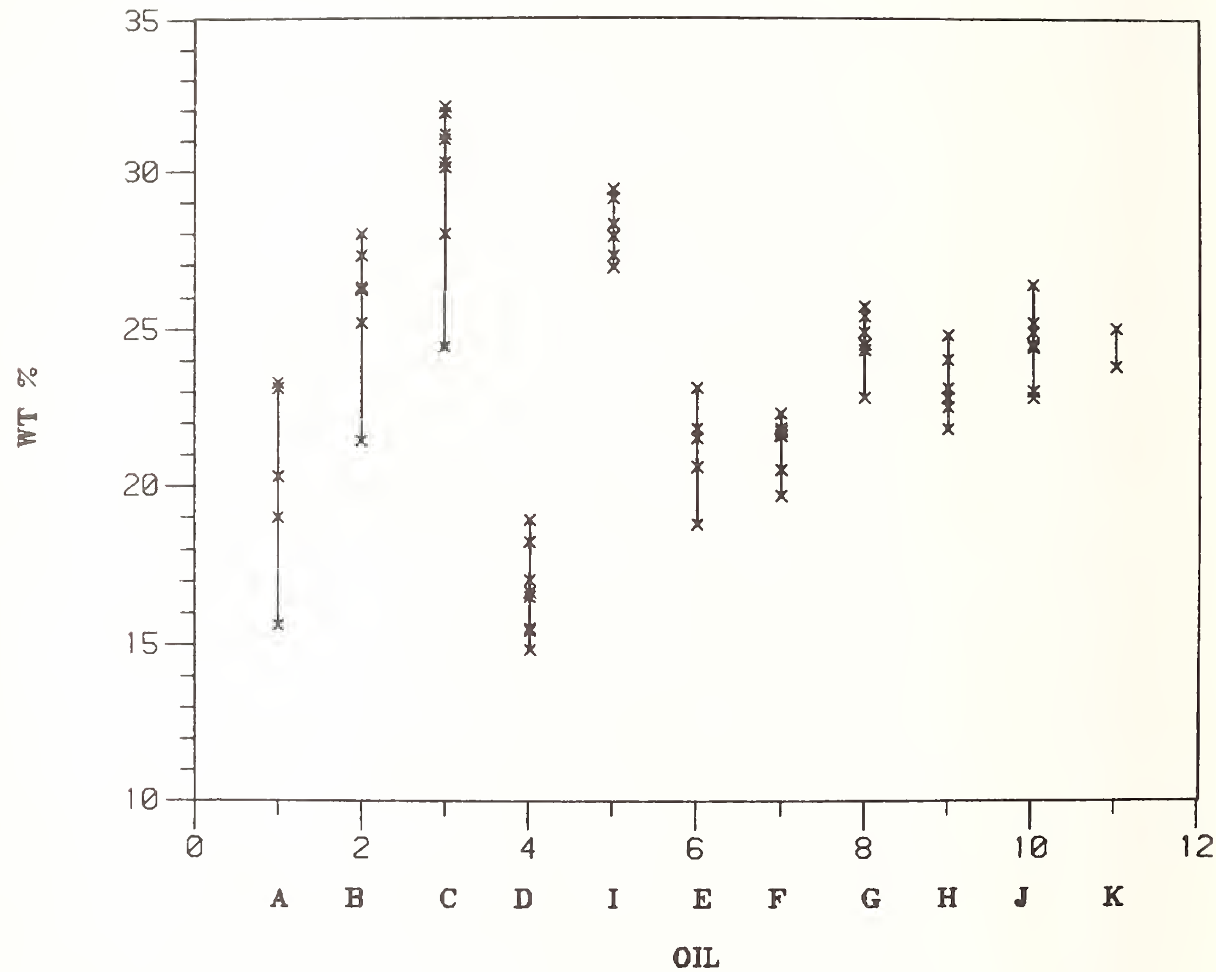
DATE	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
	A	B	C	D	I	E	F	G	H	J	K
MAR 80	15.9	-	24.6	19.0	27.4	21.0	23.1	24.6	26.9	24.2	22.1
APR 80	16.4	22.0	28.2	16.1	28.7	21.7	21.6	27.5	26.2	25.0	-
MAY 80	15.8	23.0	28.3	15.0	26.2	20.8	20.8	22.0	23.7	23.0	-
JUN 80	15.8	28.6	27.4	15.0	25.9	20.6	20.5	25.6	22.9	22.8	-
JUL 80	17.3	24.1	29.4	18.5	27.1	21.0	21.2	23.6	23.1	23.8	-
AUG 80	19.9	23.9	30.0	14.9	23.3	21.4	23.6	26.0	23.5	23.3	-
SEP 80	19.8	25.2	29.7	15.1	25.6	21.5	21.3	25.0	21.6	22.4	-
OCT 80	20.5	27.2	31.7	15.0	27.0	22.6	20.8	24.3	24.4	23.6	-
NOV 80	19.6	24.7	30.7	14.8	26.9	20.2	19.2	23.7	22.9	23.5	-
DEC 80	21.2	25.1	28.1	14.0	27.4	23.1	20.1	23.6	23.8	21.2	-
JAN 81	19.7	22.0	29.7	13.8	24.8	-	20.6	22.0	22.5	21.8	-
FEB 81	19.3	22.8	27.8	12.4	25.1	-	21.0	22.0	22.6	25.4	28.8
MAR 81	21.1	28.7	29.2	14.4	27.0	-	21.1	23.1	25.4	22.7	23.3
MEAN	18.64	24.77	28.83	15.23	26.34	21.39	21.15	24.08	23.81	23.28	24.73
STD.DEV.	2.08	2.33	1.76	1.79	1.40	.89	1.15	1.67	1.54	1.18	3.57
MIN	15.8	22.0	24.6	12.4	23.3	20.2	19.2	22.0	21.6	21.2	22.1
MAX	21.2	28.7	31.7	19.0	28.7	23.1	23.6	27.5	26.9	25.4	28.8

ASTM/NBS BASESTOCK CONSISTENCY STUDY

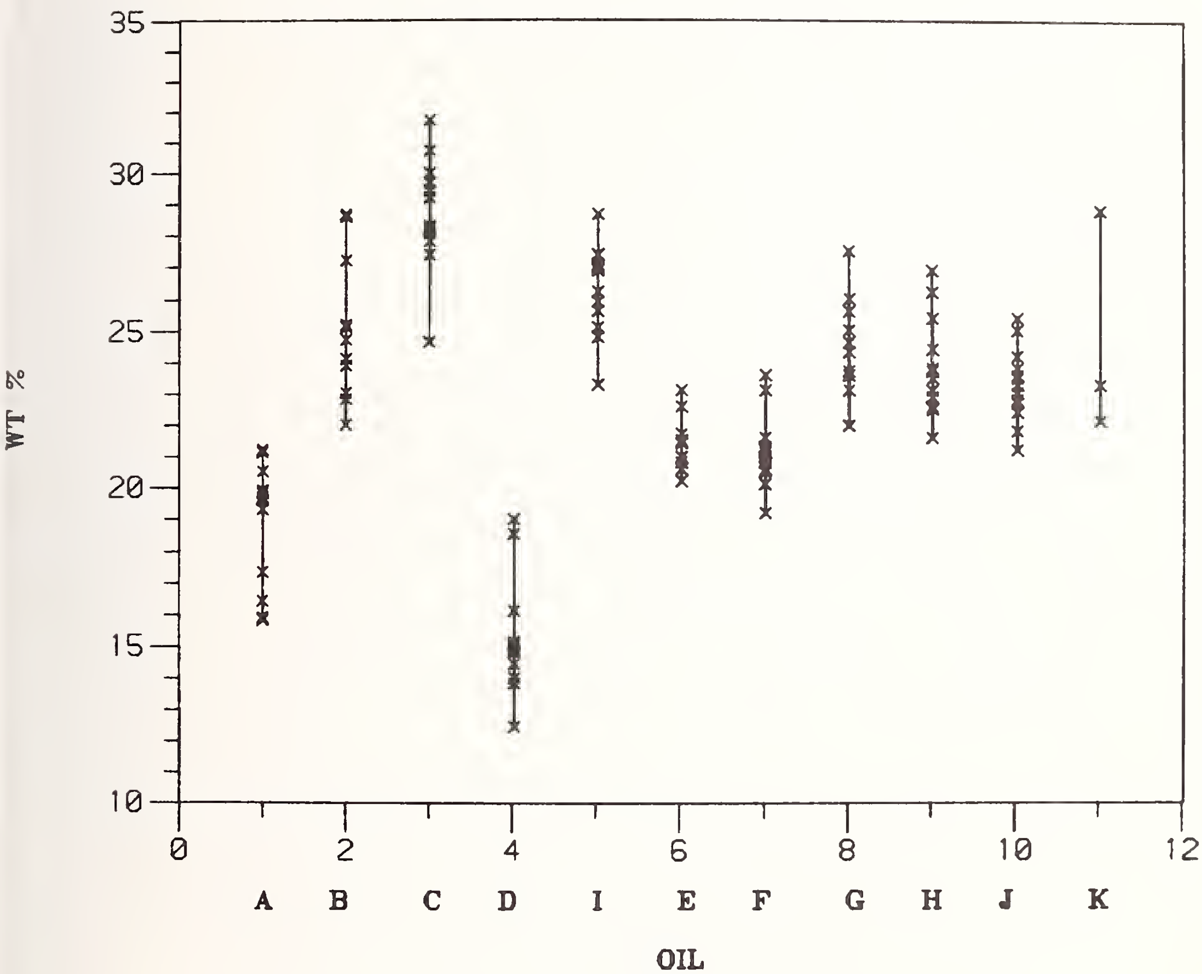
TEST: AROMATIC HYDROCARBONS (WT %) TLC/FID LABORATORY: U

DATE	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
	A	B	C	D	I	E	F	G	H	J	K
MAR 80	6.8	-	15.3	7.7	17.0	11.6	11.8	12.1	12.8	11.2	12.6
APR 80	--	--	--	--	--	--	--	--	--	13.8	-
MAY 80	--	--	--	--	--	--	--	--	--	12.7	-
JUN 80	7.3	12.3	17.6	7.0	16.9	11.2	14.3	15.2	12.0	11.3	-
JUL 80	--	--	--	--	--	--	--	--	--	--	-
AUG 80	--	--	--	--	--	--	--	--	--	--	-
SEP 80	8.4	10.0	21.6	7.5	10.0	12.4	12.0	12.4	12.6	11.7	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	13.2	15.9	23.3	8.4	18.2	14.7	15.5	13.4	12.4	18.6	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	14.4	--	--	16.5	19.6
MAR 81	14.0	21.2	24.1	9.3	19.6	-	15.3	16.1	16.3	15.8	20.3
MEAN	9.94	14.85	20.38	7.98	16.34	12.48	14.30	13.84	13.22	3.955	17.50
STD.DEV.	3.40	4.88	3.79	.89	3.71	1.56	1.39	1.75	1.75	2.74	4.26
MIN	6.8	12.3	15.3	7.0	10.0	11.2	11.8	12.1	12.0	11.2	12.6
MAX	14.0	21.2	24.1	9.3	19.6	14.7	15.5	16.1	16.3	18.6	20.3

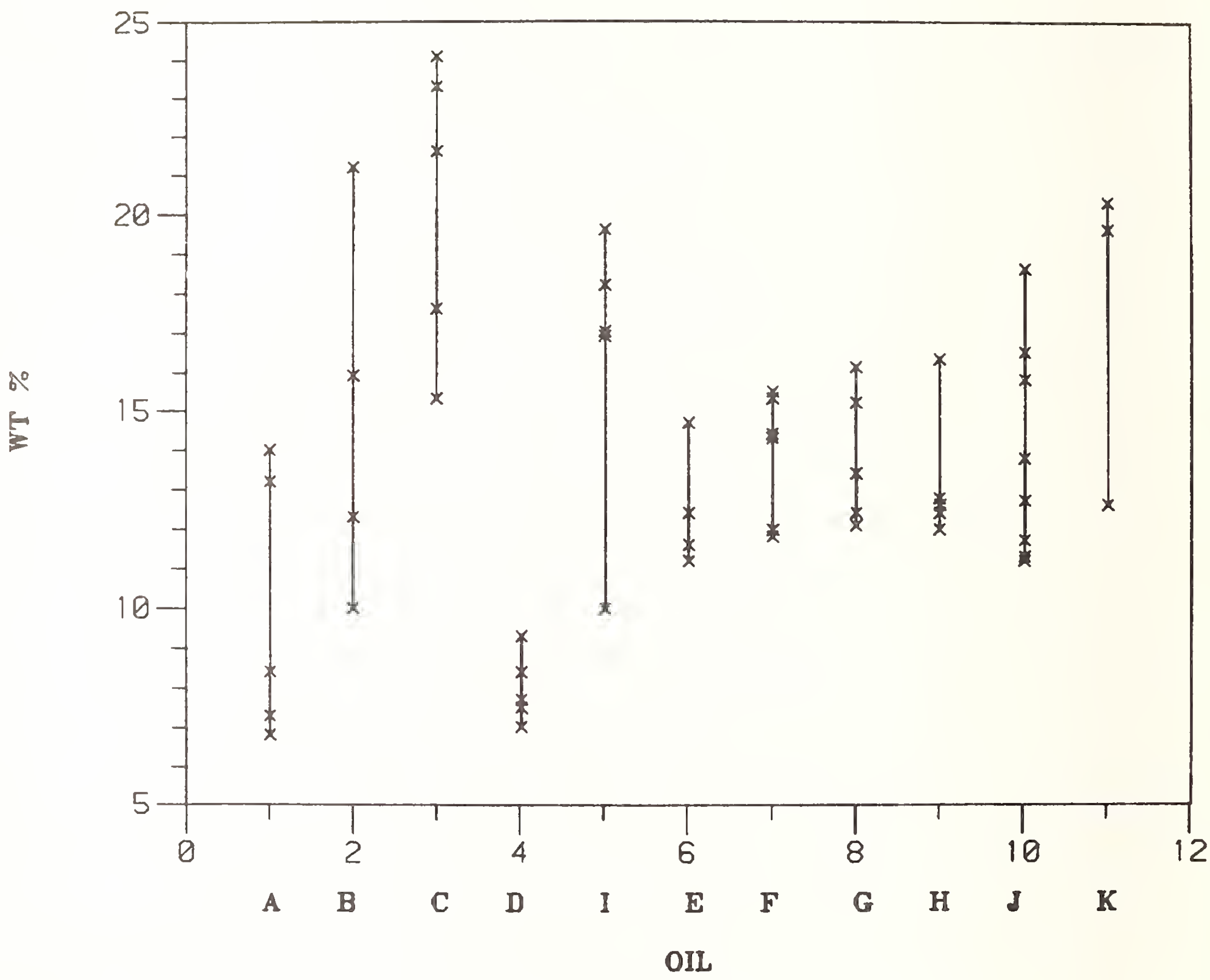
AROMATICS BY ASTM D2007



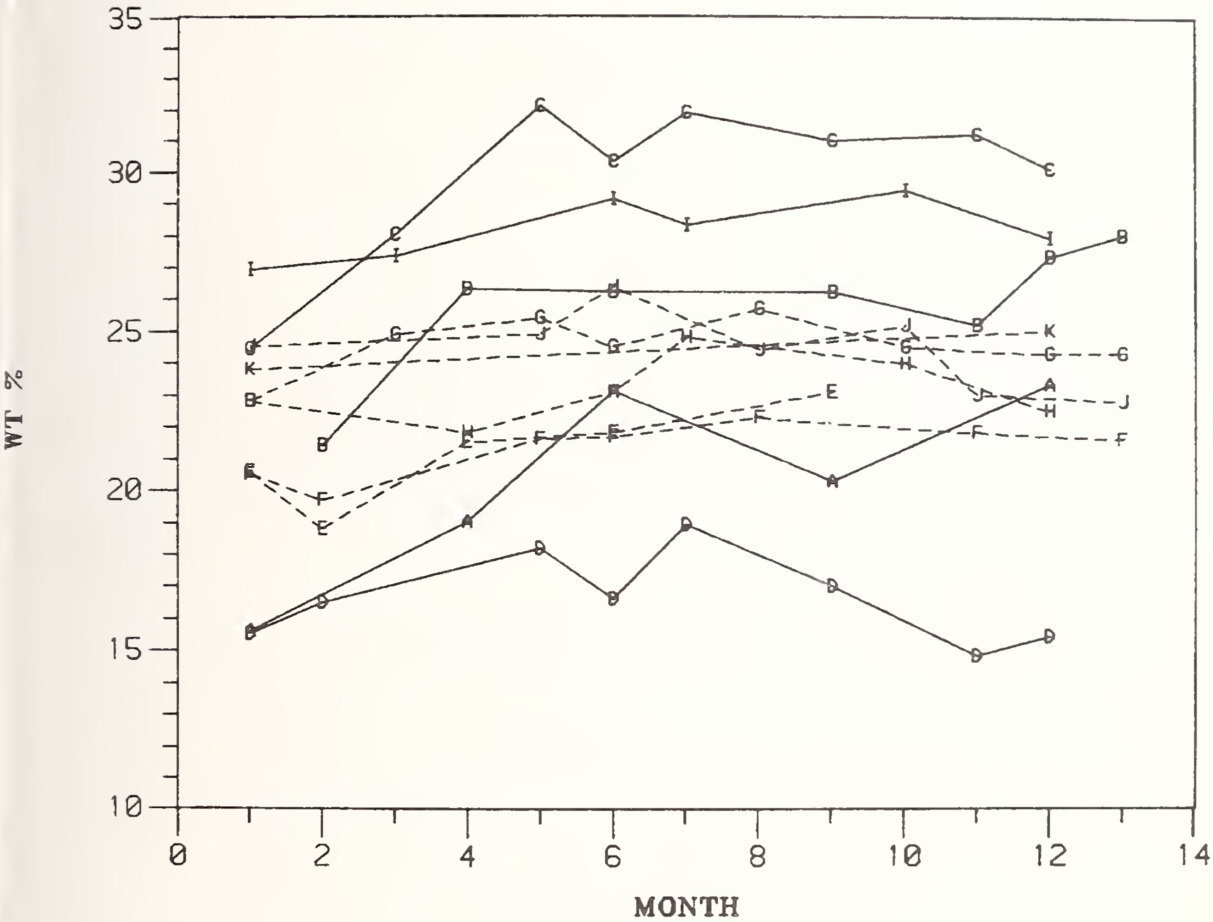
AROMATICS BY ASTM D2549



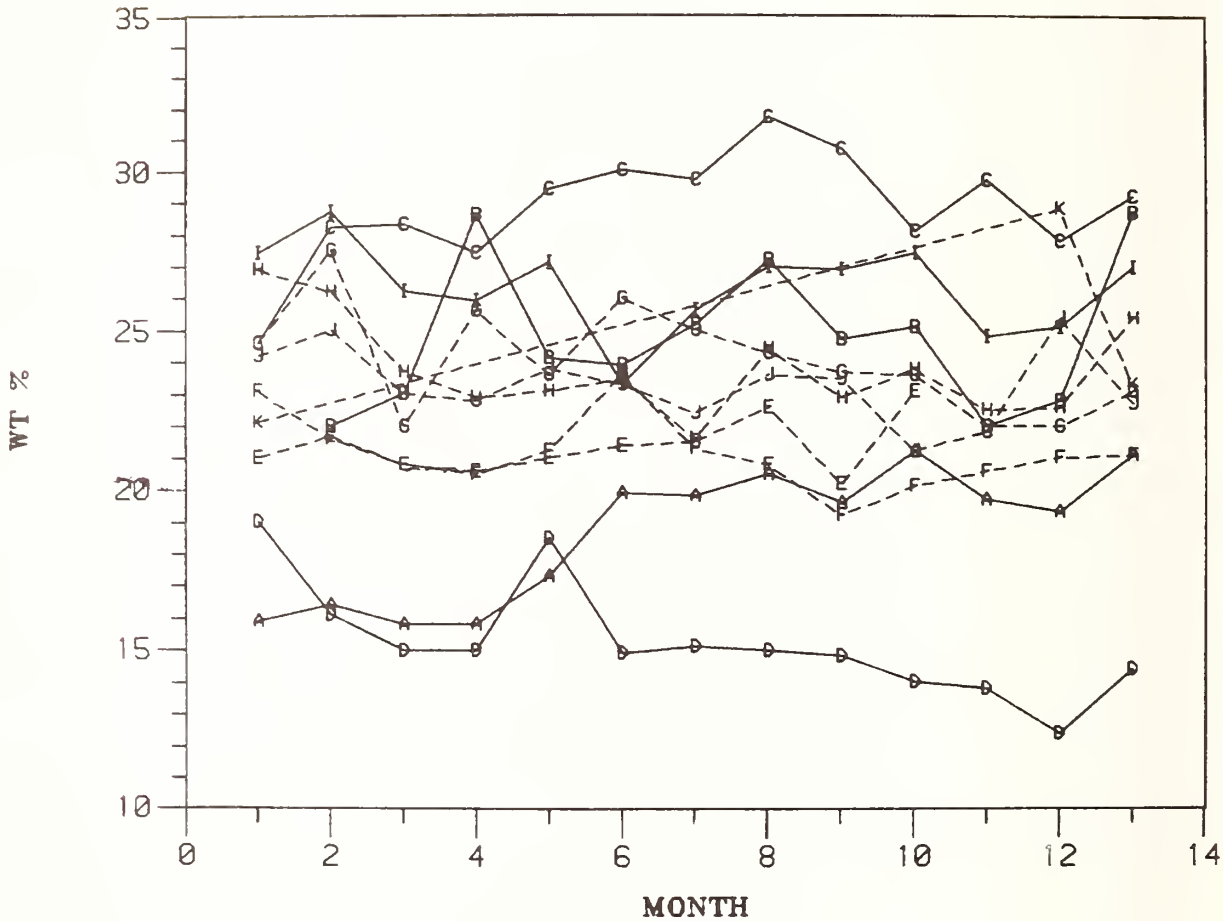
AROMATIC HYDROCARBONS BY TLC/FID



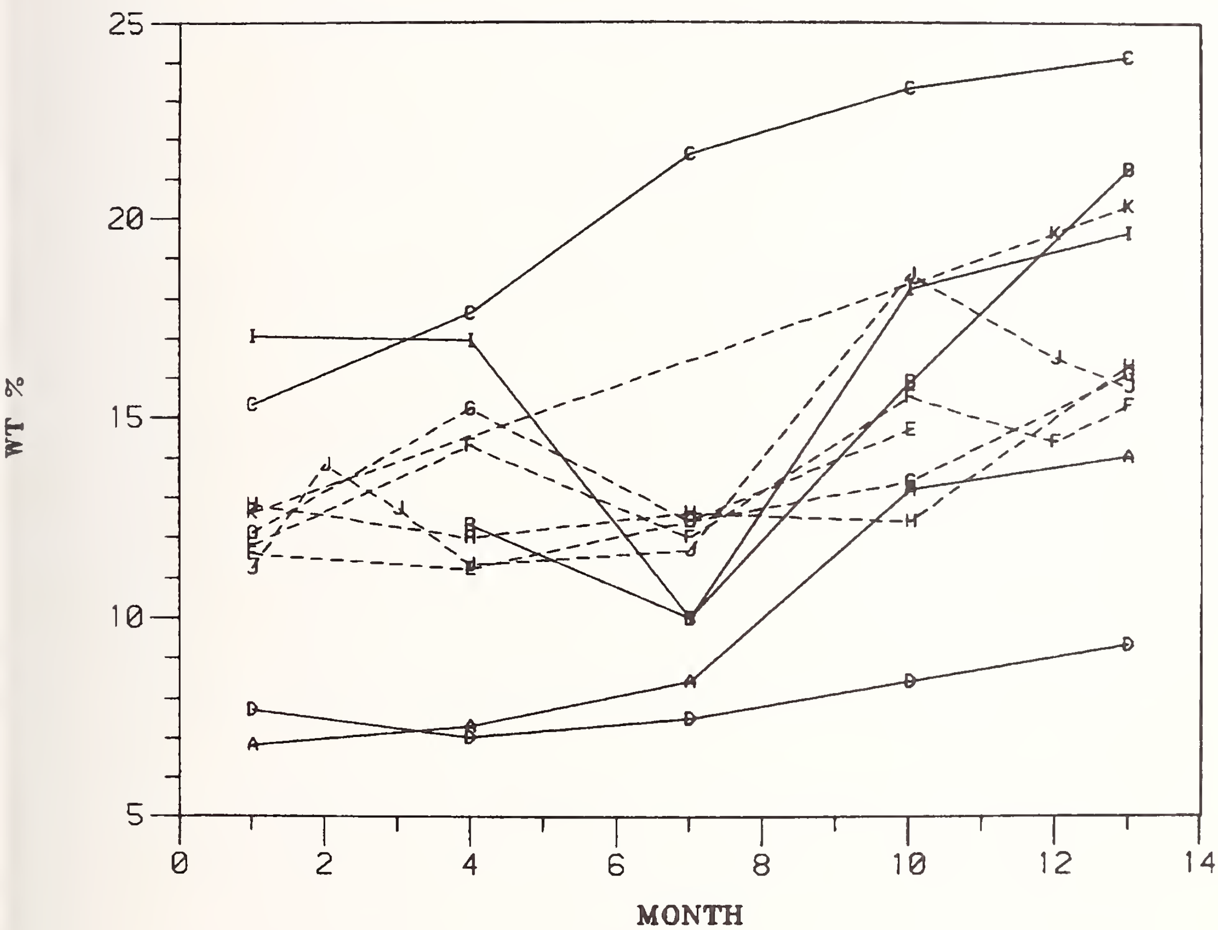
AROMATICS BY ASTM D2007



AROMATICS BY ASTM D2549



AROMATIC HYDROCARBONS BY TLC/FID



ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: AROMATICITY, MONO-RING CARBON (WT%) UV SPECTROPHOTOMETRY LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	3.2	-	4.3	2.7	4.1	4.0	3.3	4.2	3.9	3.6	3.8
APR 80	3.0	3.1	4.4	2.6	3.9	3.6	3.2	4.2	3.5	3.9	-
MAY 80	3.0	3.2	4.5	2.7	4.0	3.7	3.1	4.1	3.5	3.8	-
JUN 80	2.9	3.2	4.2	2.2	3.9	4.8	2.1	3.4	3.4	3.6	-
JUL 80	3.0	3.3	4.7	2.8	3.9	3.7	3.3	4.0	3.5	3.8	-
AUG 80	3.9	3.5	5.1	2.6	4.1	3.9	3.4	4.2	3.6	4.0	-
SEP 80	3.8	4.0	5.0	2.8	4.0	4.0	3.3	4.6	3.6	3.5	-
OCT 80	3.7	3.3	4.9	2.5	4.0	3.8	3.0	3.9	3.6	3.9	-
NOV 80	3.5	3.5	4.8	2.4	3.9	3.8	3.5	3.8	3.6	4.0	-
DEC 80	3.9	3.4	4.9	2.6	3.9	3.9	3.3	4.0	3.6	3.7	-
JAN 81	3.9	3.4	4.9	2.4	4.0	-	3.2	4.1	3.6	3.7	-
FEB 81	3.8	3.6	4.5	2.6	4.1	-	3.1	4.1	3.6	3.7	3.9
MAR 81	3.8	3.6	4.7	2.5	3.9	-	1.6	2.1	3.7	3.5	2.1
MEAN	3.49	3.42	4.68	2.57	3.98	3.92	3.03	3.90	3.59	3.75	3.27
STD.DEV.	.41	.24	.28	.17	.08	.34	.55	.61	.12	.17	1.01
MIN	2.9	3.1	4.2	2.2	3.9	3.6	1.6	2.1	3.4	3.5	2.1
MAX	3.9	4.0	5.1	2.8	4.1	4.8	3.5	4.6	3.9	4.0	3.9

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: MCNOAROMATICS (WT%) HPLC/MS

LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	15.16	15.83	--	18.50
APR 80	--	--	--	--	--	14.45	12.64	--	--	--	-
MAY 80	--	--	21.57	--	16.90	--	--	--	--	--	-
JUN 80	13.32	--	--	--	--	--	--	--	14.92	--	-
JUL 80	--	--	22.62	--	--	--	14.38	--	--	--	-
AUG 80	19.15	--	--	--	-	15.48	--	--	--	16.23	-
SEP 80	--	--	--	--	18.03	--	--	--	15.84	--	-
OCT 80	--	--	--	--	--	--	13.67	15.52	--	--	-
NOV 80	15.38	--	--	--	--	16.06	--	--	--	--	-
DEC 80	--	--	--	--	18.49	--	--	--	16.16	--	-
JAN 81	--	--	24.66	--	--	-	14.22	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	19.20
MAR 81	--	--	--	--	--	-	--	15.88	--	15.12	21.45
MEAN	15.950	.000	22.950	.000	17.807	15.330	13.727	15.520	15.687	15.675	19.717
STD.DEV.	2.957	.000	1.571	.000	.818	.815	.786	.360	.534	.785	1.541
MIN	13.32	.00	21.57	.00	16.90	14.45	12.64	15.16	14.92	15.12	18.50
MAX	19.15	.00	24.66	.00	18.49	16.06	14.38	15.88	16.16	16.23	21.45

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: MCNOAROMATICS, -6 MASS Z SERIES (WT%) HPLC/MS

LABORATORY: T

		VIRGIN BASESTOCK			REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	2.8913	2.9657	--	--
APR 80	--	--	--	--	--	2.9828	3.1817	--	--	--	-
MAY 80	--	--	5.4535	--	4.0356	--	--	--	--	--	-
JUN 80	2.3101	--	--	--	--	--	--	--	2.9815	--	-
JUL 80	--	--	5.6498	--	--	--	3.4847	--	--	--	-
AUG 80	3.2989	--	--	--	--	3.1879	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	2.80450	.00000	5.55165	.00000	4.03560	3.08535	3.33320	2.89130	2.97360	.00000	.00000
STD.DEV.	.69919	.00000	.13881	.00000	.00000	.14503	.21425	.00000	.01117	.00000	.00000
MIN	2.3101	.0000	5.4535	.0000	4.0356	2.9828	3.1817	2.8913	2.9657	.0000	.0000
MAX	3.2989	.0000	5.6498	.0000	4.0356	3.1879	3.4847	2.8913	2.9815	.0000	.0000

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: MCNOAROMATICS, -8 MASS Z SERIES (WT%) HPLC/MS — LABORATORY: T

DATE	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	3.0336	3.1972	--	--
APR 80	--	--	--	--	--	3.3013	3.4659	--	--	--	-
MAY 80	--	--	4.7502	--	3.8450	--	--	--	--	--	-
JUN 80	2.3196	--	--	--	--	--	--	--	3.2321	--	-
JUL 80	--	--	4.7728	--	--	--	3.4659	--	--	--	-
AUG 80	3.5157	--	--	--	--	3.3845	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	2.91765	.00000	4.76150	.00000	3.84500	3.34290	3.46590	3.03360	3.21465	.00000	.00000
STD.DEV.	.84577	.00000	.01598	.00000	.00000	.05883	.00000	.00000	.02468	.00000	.00000
MIN	2.3196	.0000	4.7502	.0000	3.8450	3.3013	3.4659	3.0336	3.1972	.0000	.0000
MAX	3.5157	.0000	4.7728	.0000	3.8450	3.3845	3.4659	3.0336	3.2321	.0000	.0000

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: MONOAROMATICS. -10 MASS Z SERIES (WT%) HPLC/MS

LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	3.0142	3.0857	--	--
APR 80	--	--	--	--	--	3.1658	2.6923	--	--	--	-
MAY 80	--	--	4.2020	--	3.4987	--	--	--	--	--	-
JUN 80	2.2815	--	--	--	--	--	--	--	3.0138	--	-
JUL 80	--	--	4.1931	--	--	--	2.8562	--	--	--	-
AUG 80	3.3814	--	--	--	--	3.2241	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	2.83145	.00000	4.19755	.00000	3.49870	3.19495	2.77425	3.01420	3.04975	.00000	.00000
STD.DEV.	.77775	.00000	.00629	.00000	.00000	.04122	.11589	.00000	.05084	.00000	.00000
MIN	2.2815	.0000	4.1931	.0000	3.4987	3.1658	2.6923	3.0142	3.0138	.0000	.0000
MAX	3.3814	.0000	4.2020	.0000	3.4987	3.2241	2.8562	3.0142	3.0857	.0000	.0000

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: MCNCAROMATICS, -12 MASS Z SERIES (WT%) HPLC/MS

LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	2.5919	2.6849	--	--
APR 80	--	--	--	--	--	2.3856	1.6998	--	--	--	-
MAY 80	--	--	3.1706	--	2.4688	--	--	--	--	--	-
JUN 80	2.2623	--	--	--	--	--	--	--	2.4726	--	-
JUL 80	--	--	3.3272	--	--	--	1.9734	--	--	--	-
AUG 80	3.2640	--	--	--	--	2.5231	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	2.76315	.00000	3.24890	.00000	2.46880	2.45435	1.83660	2.59190	2.57875	.00000	.00000
STD.DEV.	.70831	.00000	.11073	.00000	.00000	.09723	.19346	.00000	.15012	.00000	.00000
MIN	2.2623	.0000	3.1706	.0000	2.4688	2.3856	1.6998	2.5919	2.4726	.0000	.0000
MAX	3.2640	.0000	3.3272	.0000	2.4688	2.5231	1.9734	2.5919	2.6849	.0000	.0000

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: MCNOAROMATICS, -14 MASS Z SERIES (WT%) HPLC/MS

LABORATORY: T

		VIRGIN BASESTOCK			REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	1.8961	1.9480	--	--
APR 80	--	--	--	--	--	1.3999	.8288	--	--	--	-
MAY 80	--	--	1.9524	--	1.5747	--	--	--	--	--	-
JUN 80	1.8085	---	--	--	--	--	--	--	1.6251	--	-
JUL 80	--	--	2.1660	--	--	--	1.2538	--	--	--	-
AUG 80	2.4921	---	--	--	--	1.6033	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	2.15030	.00000	2.05920	.00000	1.57470	1.50160	1.04130	1.89610	1.78655	.00000	.00000
STD.DEV.	.48338	.00000	.15104	.00000	.00000	.14383	.30052	.00000	.22832	.00000	.00000
MIN	1.8085	.0000	1.9524	.0000	1.5747	1.3999	.8288	1.8961	1.6251	.0000	.0000
MAX	2.4921	.0000	2.1660	.0000	1.5747	1.6033	1.2538	1.8961	1.9480	.0000	.0000

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: MCNCAROMATICS, -16 MASS Z SERIES (WT%) HPLC/MS LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	1.0358	1.1546	--	--
APR 80	--	--	--	--	--	.7016	.4479	--	--	--	-
MAY 80	--	--	1.1302	--	.7923	--	--	--	--	--	-
JUN 80	1.3046	--	--	--	--	--	--	--	.9664	--	-
JUL 80	--	--	1.3788	--	--	--	.7997	--	--	--	-
AUG 80	1.8361	--	--	--	--	.9044	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	1.57035	.00000	1.25450	.00000	.79230	.80300	.62380	1.03580	1.06050	.00000	.00000
STD.DEV.	.37583	.00000	.17579	.00000	.00000	.14340	.24876	.00000	.13308	.00000	.00000
MIN	1.3046	.0000	1.1302	.0000	.7923	.7016	.4479	1.0358	.9664	.0000	.0000
MAX	1.8361	.0000	1.3788	.0000	.7923	.9044	.7997	1.0358	1.1546	.0000	.0000

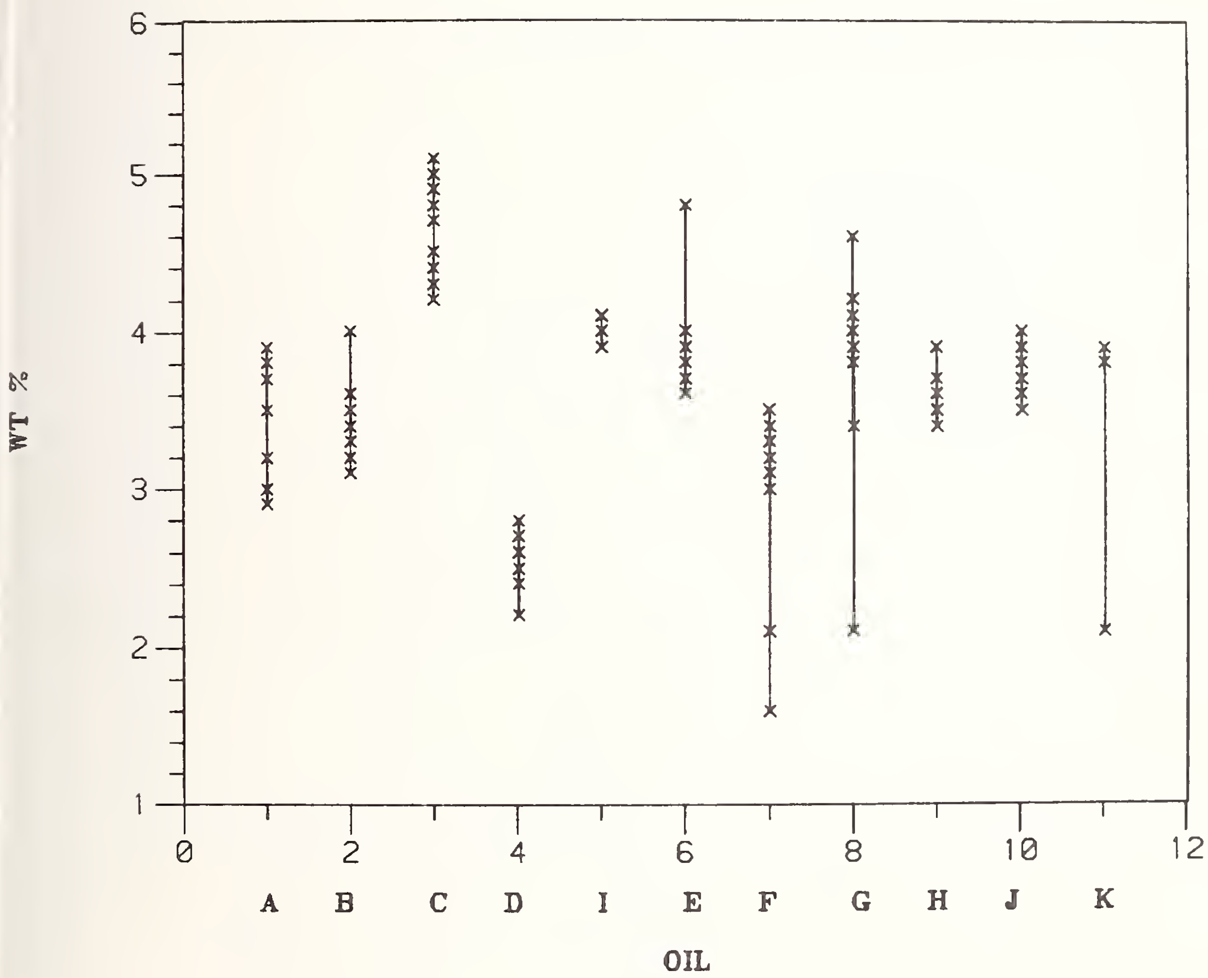
ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: MCNCAROMATICS, -18 MASS Z SERIES (WT%) HPLC/MS

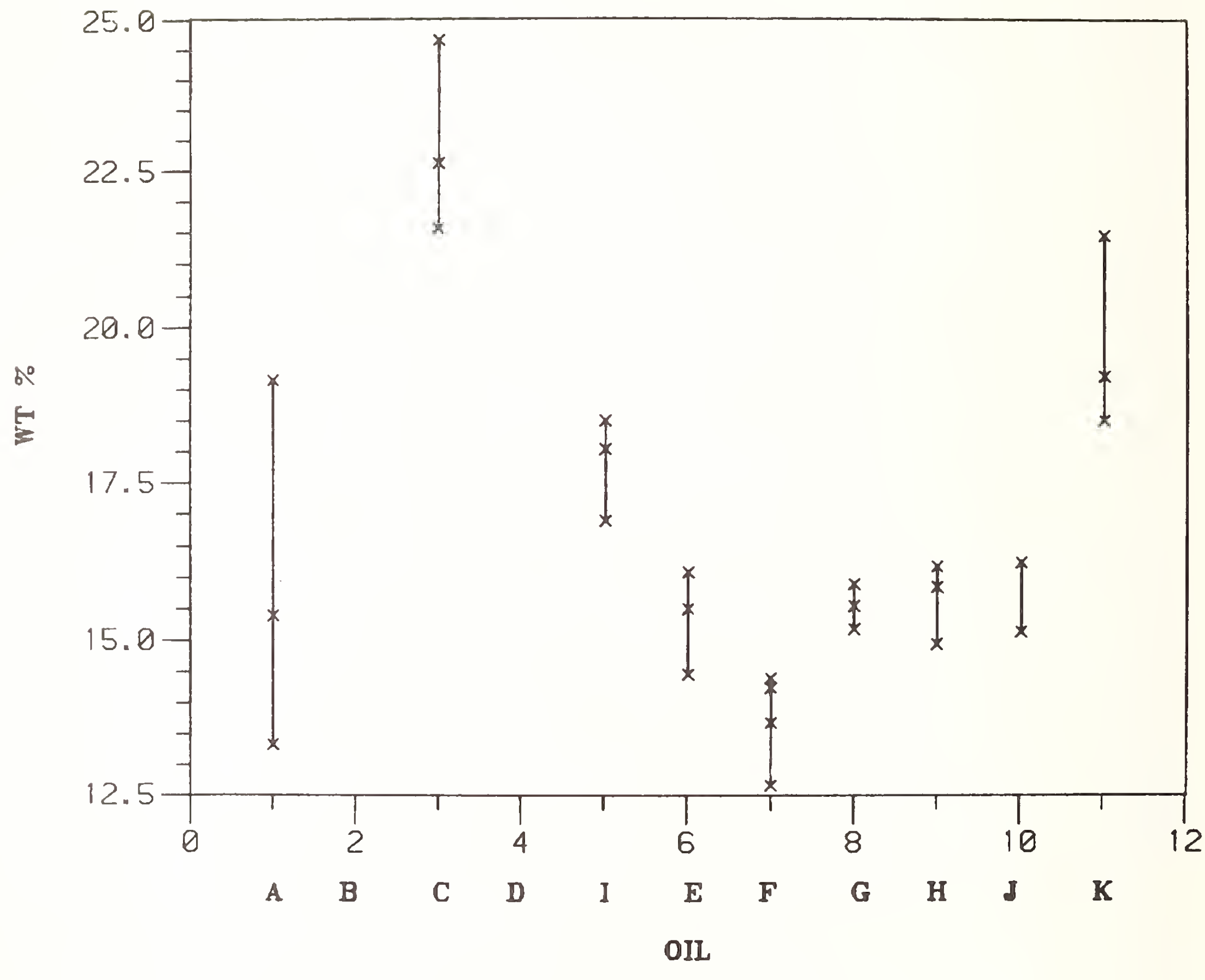
LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	.6971	.7938	--	--
APR 80	--	--	--	--	--	.5131	.3237	--	--	--	-
MAY 80	--	--	.9111	--	.6850	--	--	--	--	--	-
JUN 80	.9334	--	--	--	--	--	--	--	.6284	--	-
JUL 80	--	--	1.1323	--	--	--	.5464	--	--	--	-
AUG 80	1.3617	--	--	--	--	.6527	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	1.14755	.00000	1.02170	.00000	.68500	.58290	.43505	.69710	.71110	.00000	.00000
STD.DEV.	.30285	.00000	.15641	.00000	.00000	.09871	.15747	.00000	.11696	.00000	.00000
MIN	.9334	.0000	.9111	.0000	.6850	.5131	.3237	.6971	.6284	.0000	.0000
MAX	1.3617	.0000	1.1323	.0000	.6850	.6527	.5464	.6971	.7938	.0000	.0000

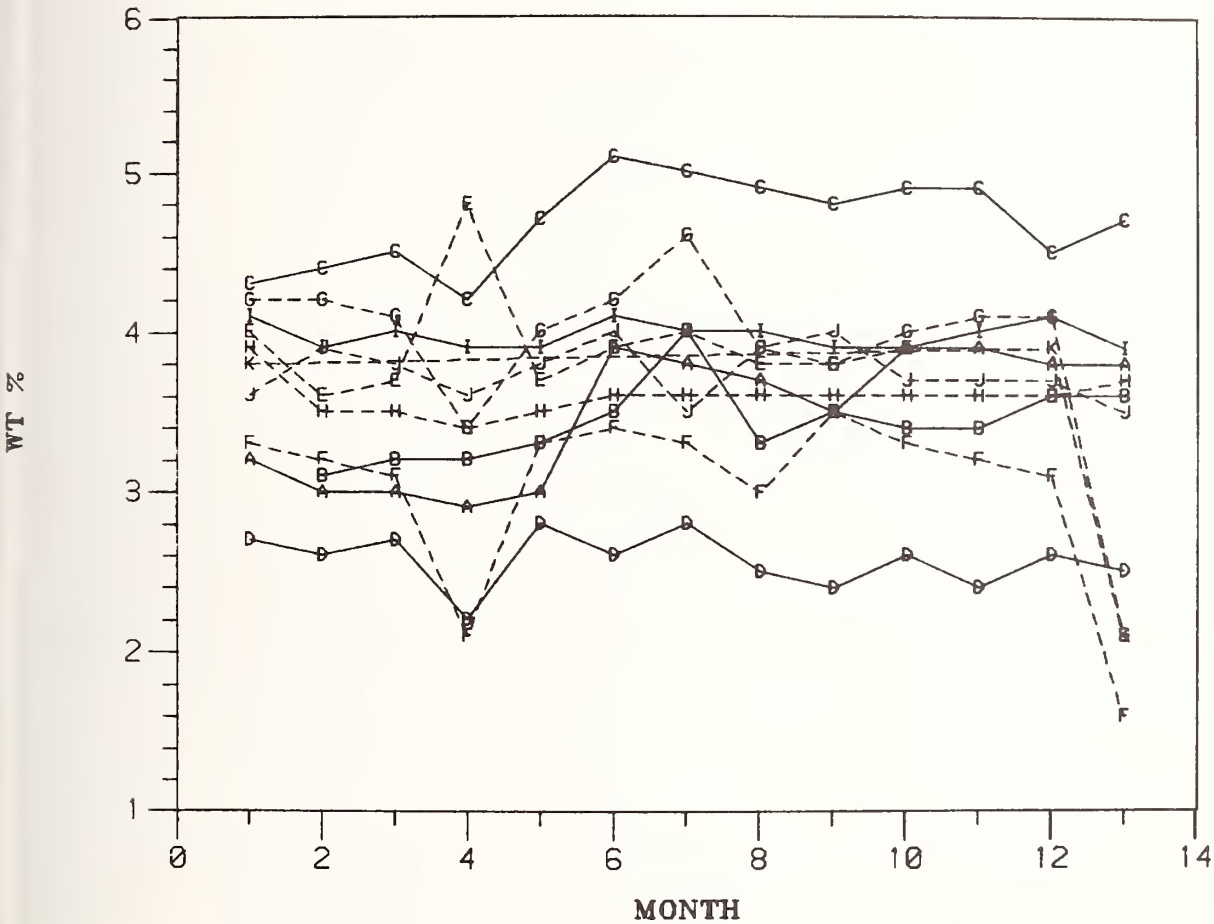
AROMATICITY (MONO-RING) BY UV



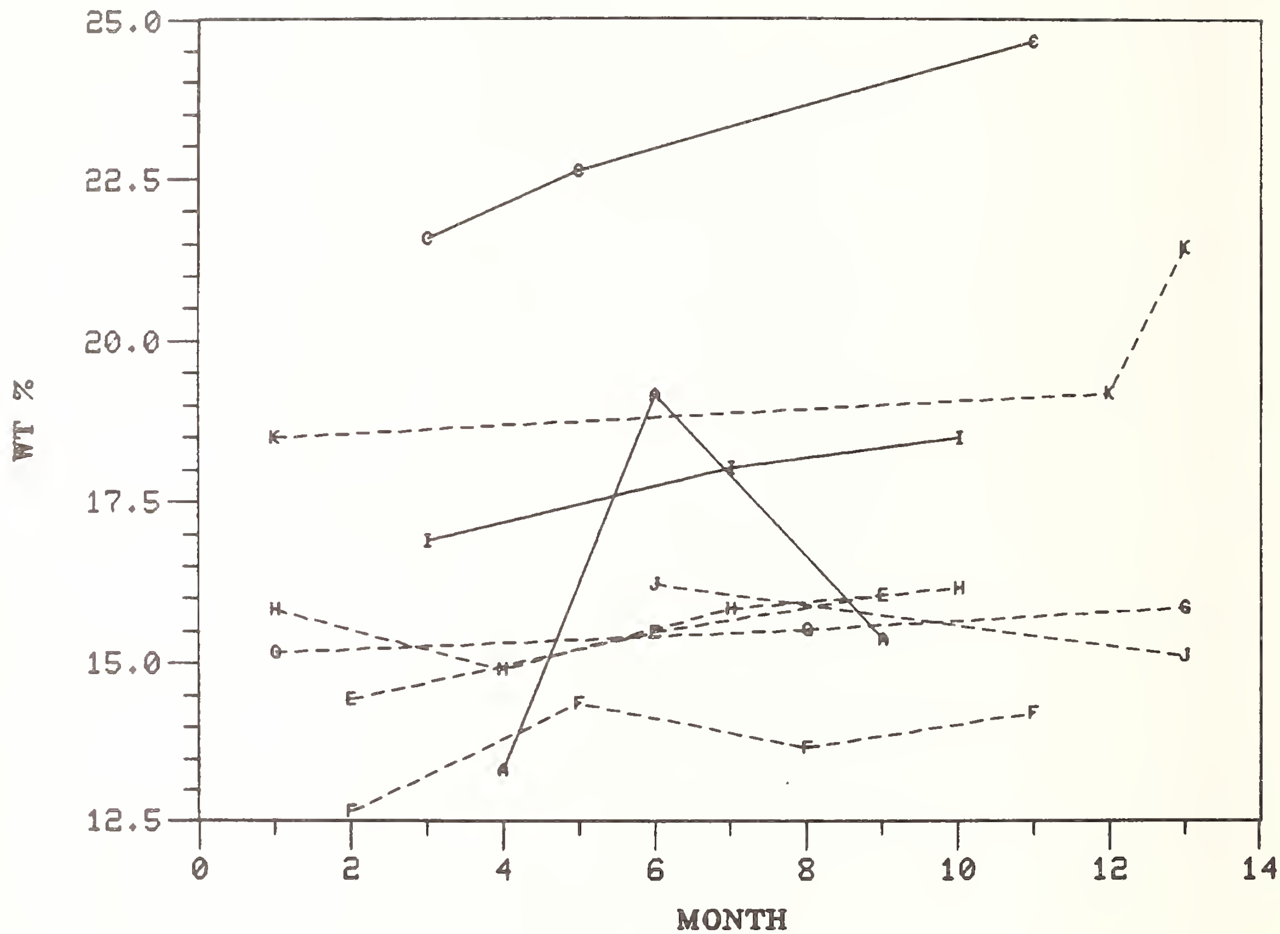
MONOAROMATICS BY HPLC



AROMATICITY (MONO-RING) BY UV



MONOAROMATICS BY HPLC



ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: AROMATICITY, DI-RING CARBON (WT%) UV SPECTROPHOTOMETRY — LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	1.2	-	1.1	.7	1.7	1.6	1.7	2.3	1.7	2.1	1.2
APR 80	1.1	1.0	1.2	.7	1.6	1.4	1.6	2.1	1.6	2.0	-
MAY 80	1.2	1.1	1.2	.7	1.6	1.4	1.5	2.2	1.6	1.6	-
JUN 80	1.1	1.1	1.2	.6	1.6	2.0	1.2	2.6	1.4	1.8	-
JUL 80	1.2	1.1	1.6	.7	1.5	1.5	1.6	2.1	1.5	2.0	-
AUG 80	1.5	1.3	1.7	.7	1.7	1.6	1.6	2.3	1.6	1.9	-
SEP 80	1.5	1.4	1.8	.7	1.6	1.6	1.6	2.3	1.5	1.8	-
OCT 80	1.5	1.2	1.7	.6	1.6	1.4	1.4	2.1	1.6	1.8	-
NOV 80	1.4	1.2	1.6	.6	1.6	1.4	1.7	1.9	1.6	2.1	-
DEC 80	1.7	1.3	1.6	.7	1.6	1.7	1.6	2.0	1.6	1.7	-
JAN 81	1.6	1.2	1.6	.3	1.6	-	1.5	2.2	1.6	1.7	-
FEB 81	1.6	1.3	1.3	.6	1.7	-	1.5	1.9	1.7	1.9	1.4
MAR 81	1.6	1.4	1.4	.6	1.6	-	.8	1.0	1.6	1.8	.8
MEAN	1.40	1.22	1.46	.63	1.62	1.56	1.48	2.08	1.58	1.86	1.13
STD.DEV.	.21	.13	.24	.11	.06	.19	.24	.37	.08	.16	.31
MIN	1.1	1.0	1.1	.3	1.5	1.4	.8	1.0	1.4	1.6	.8
MAX	1.7	1.4	1.8	.7	1.7	2.0	1.7	2.6	1.7	2.1	1.4

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: DIAROMATICS (WT%) HPLC/MS

LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	6.07	6.46	--	3.84
APR 80	--	--	--	--	--	4.49	7.15	--	--	--	-
MAY 80	--	--	5.14	--	8.00	--	--	--	--	--	-
JUN 80	3.31	--	--	--	--	--	--	--	6.23	--	-
JUL 80	--	--	6.26	--	--	--	6.55	--	--	--	-
AUG 80	4.14	--	--	--	--	4.14	--	--	--	5.30	-
SEP 80	--	--	--	--	7.21	--	--	--	5.56	--	-
OCT 80	--	--	--	--	--	--	5.73	5.94	--	--	-
NOV 80	3.75	--	--	--	--	4.02	--	--	--	--	-
DEC 80	--	--	--	--	7.51	--	--	--	5.43	--	-
JAN 81	--	--	4.98	--	--	-	5.36	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	4.61
MAR 81	--	--	--	--	--	-	--	4.76	--	5.27	4.65
MEAN	3.733	.000	5.460	.000	7.573	4.217	6.197	5.590	5.920	5.285	4.367
STD.DEV.	.415	.000	.697	.000	.399	.244	.807	.722	.502	.021	.457
MIN	3.31	.00	4.98	.00	7.21	4.02	5.36	4.76	5.43	5.27	3.84
MAX	4.14	.00	6.26	.00	8.00	4.49	7.15	6.07	6.46	5.30	4.65

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: DIAROMATICS, -12 MASS Z SERIES (WT%) HPLC/MS LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	1.3155	.9521	--	--
APR 80	--	--	--	--	--	.7296	1.4773	--	--	--	-
MAY 80	--	--	.6127	--	.9553	--	--	--	--	--	-
JUN 80	.5445	--	--	--	--	--	--	--	1.0006	--	-
JUL 80	--	--	.7915	--	--	--	1.3231	--	--	--	-
AUG 80	.5559	--	--	--	--	.7311	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	.55020	.00000	.70210	.00000	.95530	.73035	1.40020	1.31550	.97635	.00000	.00000
STD.DEV.	.00806	.00000	.12643	.00000	.00000	.00106	.10904	.00000	.03429	.00000	.00000
MIN	.5445	.0000	.6127	.0000	.9553	.7296	1.3231	1.3155	.9521	.0000	.0000
MAX	.5559	.0000	.7915	.0000	.9553	.7311	1.4773	1.3155	1.0006	.0000	.0000

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: DIAROMATICS, -14 MASS Z SERIES (WT%) HPLC/MS

LABORATORY: T

DATE	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	1.2634	1.2570	--	--
APR 80	--	--	--	--	--	.9978	1.9760	--	--	--	-
MAY 80	--	--	.7368	--	1.0265	--	--	--	--	--	-
JUN 80	.6217	--	--	--	--	--	--	--	1.3327	--	-
JUL 80	--	--	.9164	--	--	--	1.6693	--	--	--	-
AUG 80	.8632	--	--	--	--	.9610	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	.74247	.00000	.82660	.00000	1.02650	.97940	1.82265	1.26340	1.29485	.00000	.00000
STD.DEV.	.17073	.00000	.12700	.00000	.00000	.02602	.21687	.00000	.05353	.00000	.00000
MIN	.6217	.0000	.7368	.0000	1.0265	.9610	1.6693	1.2634	1.2570	.0000	.0000
MAX	.8632	.0000	.9164	.0000	1.0265	.9978	1.9760	1.2634	1.3327	.0000	.0000

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: DIAROMATICS, -16 MASS Z SERIES (WT%) HPLC/MS

LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	.9433	1.2020	--	--
APR 80	--	--	--	--	--	.7771	1.2511	--	--	--	-
MAY 80	--	--	.7175	--	.9145	--	--	--	--	--	-
JUN 80	.6262	--	--	--	--	--	--	--	1.1487	--	-
JUL 80	--	--	.8991	--	--	--	1.1602	--	--	--	-
AUG 80	.9655	--	--	--	--	.7094	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	.79585	.00000	.80830	.00000	.91450	.74325	1.20565	.94330	1.17535	.00000	.00000
STD.DEV.	.23992	.00000	.12841	.00000	.00000	.04787	.06428	.00000	.03769	.00000	.00000
MIN	.6262	.0000	.7175	.0000	.9145	.7094	1.1602	.9433	1.1487	.0000	.0000
MAX	.9655	.0000	.8991	.0000	.9145	.7771	1.2511	.9433	1.2020	.0000	.0000

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: DIARCMATICS. -18 MASS Z SERIES (WT%) HPLC/MS

LABORATORY: T

		VIRGIN BASESTOCK			: REF :	RE-REFINED BASESTOCKS					
DATE :	A	B	C	D	I	E	F	G	H	J	K
MAR 80 :	--	-	--	--	--	--	--	.7078	.9620	--	--
APR 80 :	--	--	--	--	--	.5320	.6611	--	--	--	-
MAY 80 :	--	--	.7342	--	.9111	--	--	--	--	--	-
JUN 80 :	.4911	--	--	--	--	--	--	--	.8225	--	-
JUL 80 :	--	--	.9189	--	--	--	.7097	--	--	--	-
AUG 80 :	.7313	--	--	--	--	.4712	--	--	--	--	-
SEP 80 :	--	--	--	--	--	--	--	--	--	--	-
OCT 80 :	--	--	--	--	--	--	--	--	--	--	-
NOV 80 :	--	--	--	--	--	--	--	--	--	--	-
DEC 80 :	--	--	--	--	--	--	--	--	--	--	-
JAN 81 :	--	--	--	--	--	-	--	--	--	--	-
FEB 81 :	--	--	--	--	--	-	--	--	--	--	--
MAR 81 :	--	--	--	--	--	-	--	--	--	--	--
MEAN :	.€1120	.00000	.82655	.00000	.91110	.50160	.68540	.70780	.89225	.00000	.00000
STD.DEV. :	.16985	.00000	.13060	.00000	.00000	.04299	.03437	.00000	.09864	.00000	.00000
MIN :	.4911	.0000	.7342	.0000	.9111	.4712	.€611	.7078	.8225	.0000	.0000
MAX :	.7313	.0000	.9189	.0000	.9111	.5320	.7097	.7078	.9620	.0000	.0000

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: DIAROMATICS, -20 MASS Z SERIES (WT%) HPLC/MS

LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	.9208	1.0262	--	--
APR 80	--	--	--	--	--	.8066	1.0963	--	--	--	-
MAY 80	--	--	1.3017	--	2.4448	--	--	--	--	--	-
JUN 80	.6176	--	--	--	--	--	--	--	1.0165	--	-
JUL 80	--	--	1.5269	--	--	--	1.0110	--	--	--	-
AUG 80	.4952	--	--	--	--	.7319	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	.55640	.00000	1.41430	.00000	2.44480	.76925	1.05365	.92080	1.02135	.00000	.00000
STD.DEV.	.08655	.00000	.15924	.00000	.00000	.05282	.06032	.00000	.00686	.00000	.00000
MIN	.4952	.0000	1.3017	.0000	2.4448	.7319	1.0110	.9208	1.0165	.0000	.0000
MAX	.6176	.0000	1.5269	.0000	2.4448	.8066	1.0963	.9208	1.0262	.0000	.0000

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: DIAROMATICS, -22 MASS Z SERIES (WT%) HPLC/MS

LABORATORY: T

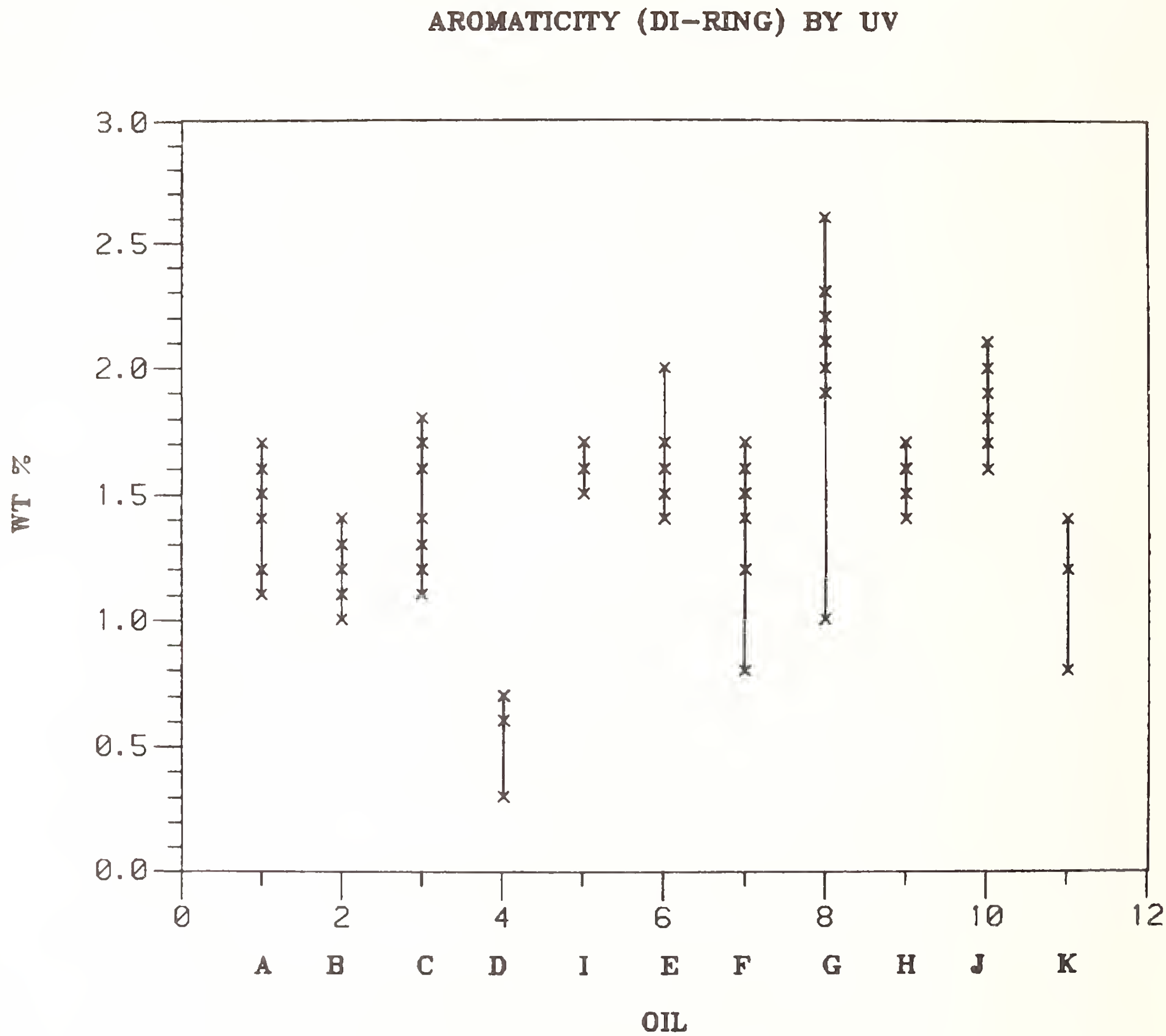
DATE	VIRGIN BASESTOCK A	B	C	D	REF I	RE-REFINED BASESTOCKS E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	.4781	.6169	--	--
APR 80	--	--	--	--	--	.3962	.4472	--	--	--	-
MAY 80	--	--	.6563	--	1.1170	--	--	--	--	--	-
JUN 80	.2396	--	--	--	--	--	--	--	.5507	--	-
JUL 80	--	--	.7506	--	--	--	.4348	--	--	--	-
AUG 80	.3249	--	--	--	--	.3380	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	.28225	.00000	.70345	.00000	1.11700	.36710	.44100	.47810	.58380	.00000	.00000
STD.DEV.	.06032	.00000	.06668	.00000	.00000	.04115	.00877	.00000	.04681	.00000	.00000
MIN	.2396	.0000	.6563	.0000	1.1170	.3380	.4348	.4781	.5507	.0000	.0000
MAX	.3249	.0000	.7506	.0000	1.1170	.3962	.4472	.4781	.6169	.0000	.0000

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: DIAROMATICS, -24 MASS Z SERIES (WT%) HPLC/MS

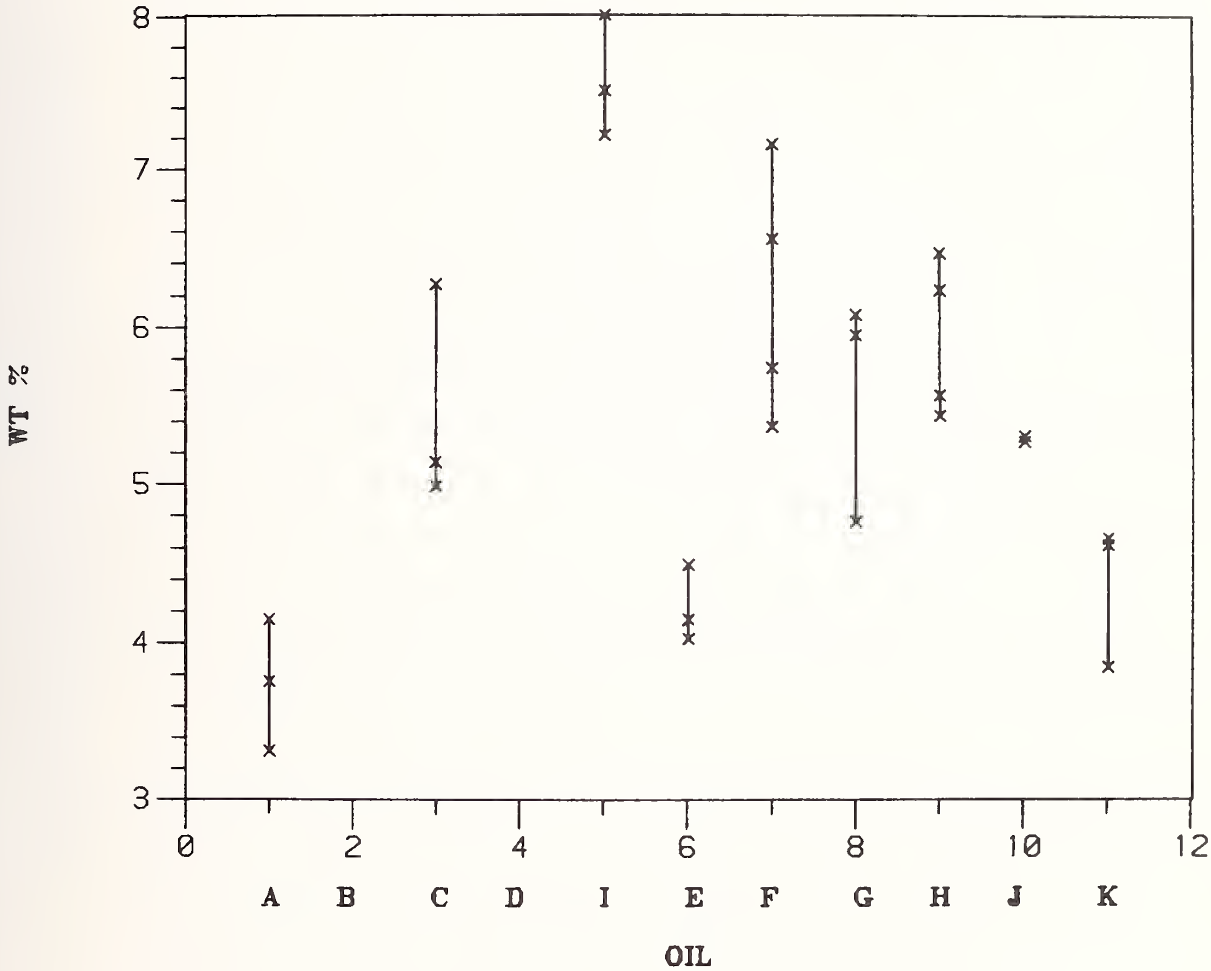
LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	.4410	.4438	--	--
APR 80	--	--	--	--	--	.2506	.2411	--	--	--	-
MAY 80	--	--	.3807	--	.6309	--	--	--	--	--	-
JUN 80	.1694	--	--	--	--	--	--	--	.3584	--	-
JUL 80	--	--	.4567	--	--	--	.2418	--	--	--	-
AUG 80	.2421	--	--	--	--	.1974	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	.20575	.00000	.41870	.00000	.63090	.22400	.24145	.44100	.40110	.00000	.00000
STD.DEV.	.05141	.00000	.05374	.00000	.00000	.03762	.00049	.00000	.06039	.00000	.00000
MIN	.1694	.0000	.3807	.0000	.6309	.1974	.2411	.4410	.3584	.0000	.0000
MAX	.2421	.0000	.4567	.0000	.6309	.2506	.2418	.4410	.4438	.0000	.0000

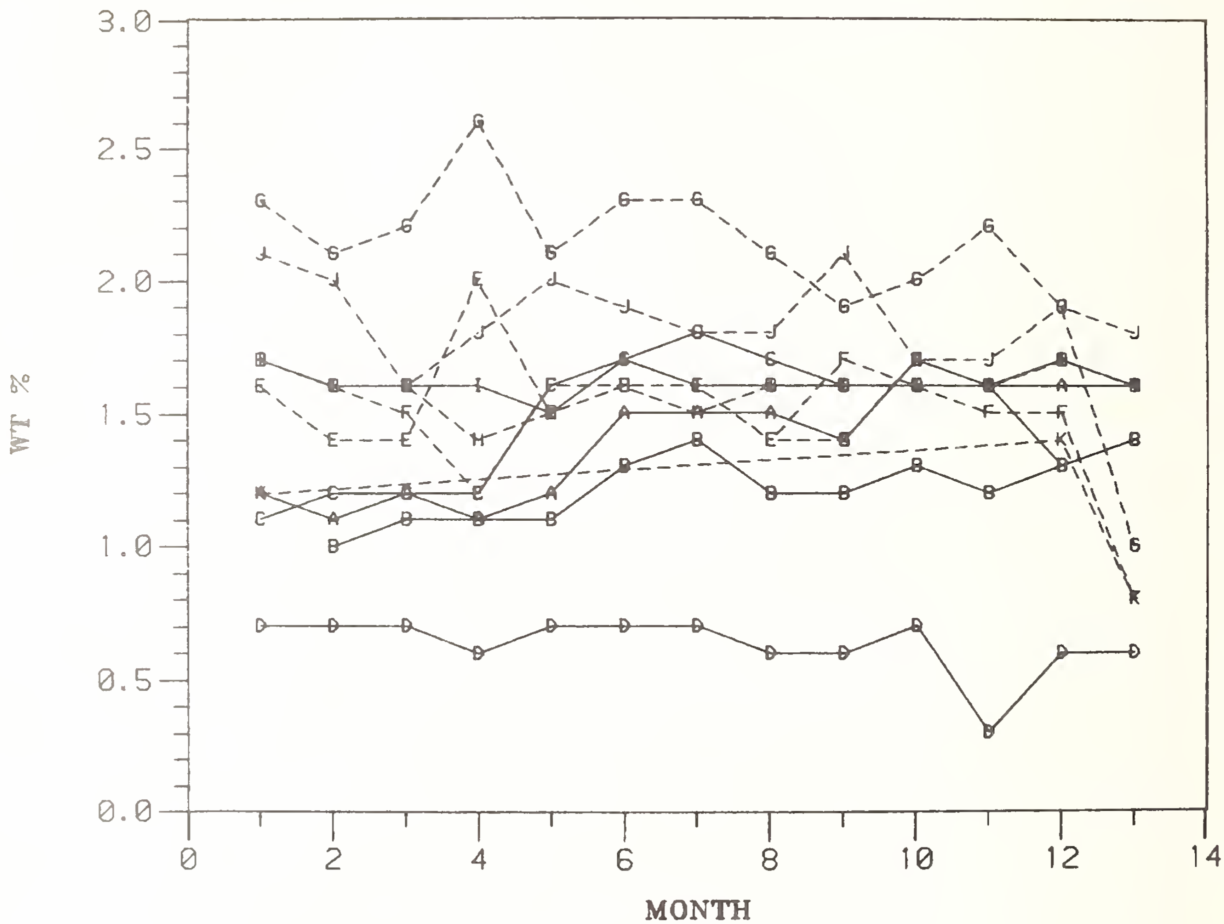


AROMATICITY (DI-RING) BY UV
WT %
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
2
4
6
8
10
12
A
B
C
D
I
E
F
G
H
J
K
OIL

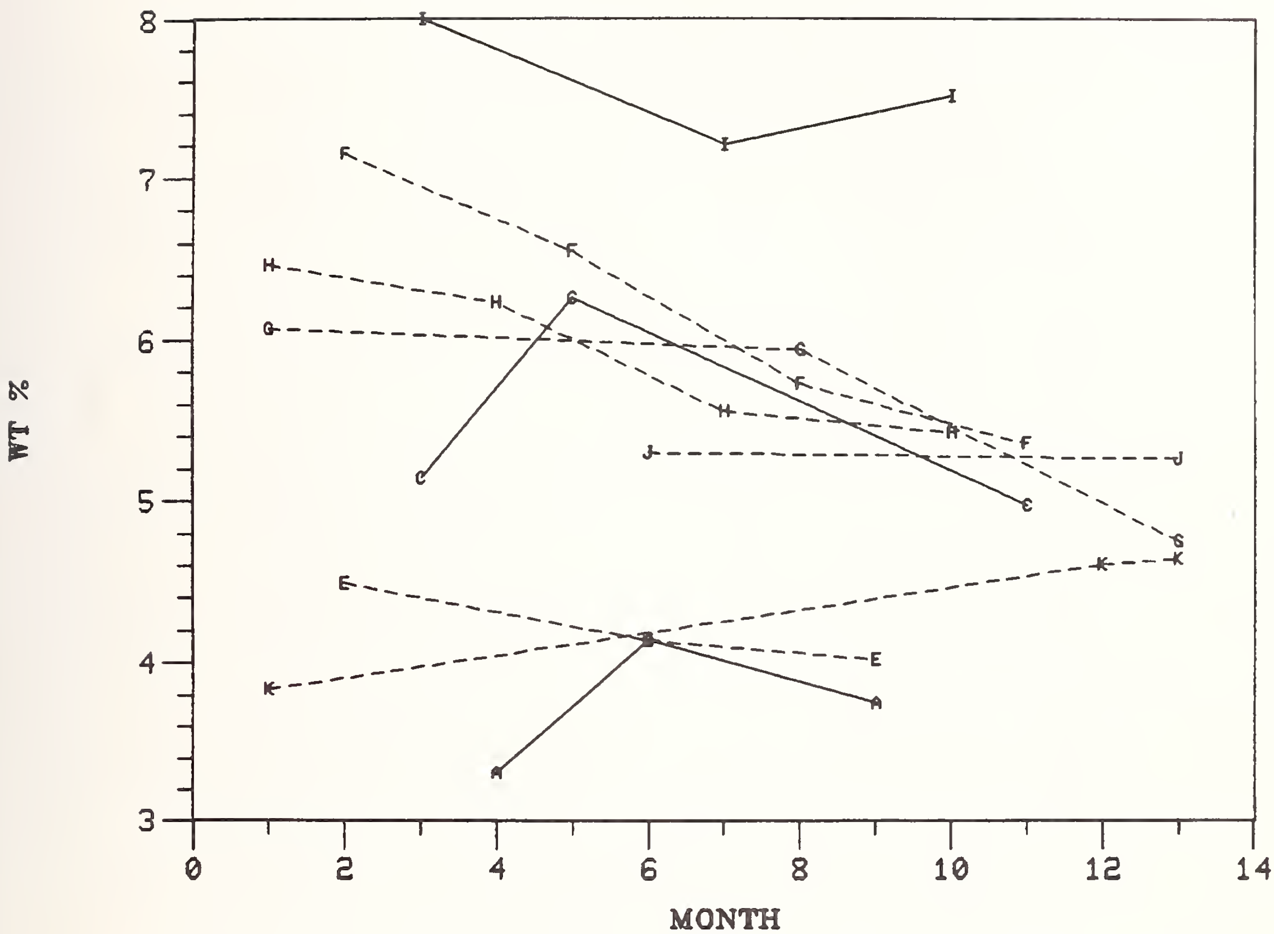
DIAROMATICS BY HPLC



AROMATICITY (DI-RING) BY UV



DIAROMATICS BY HPLC



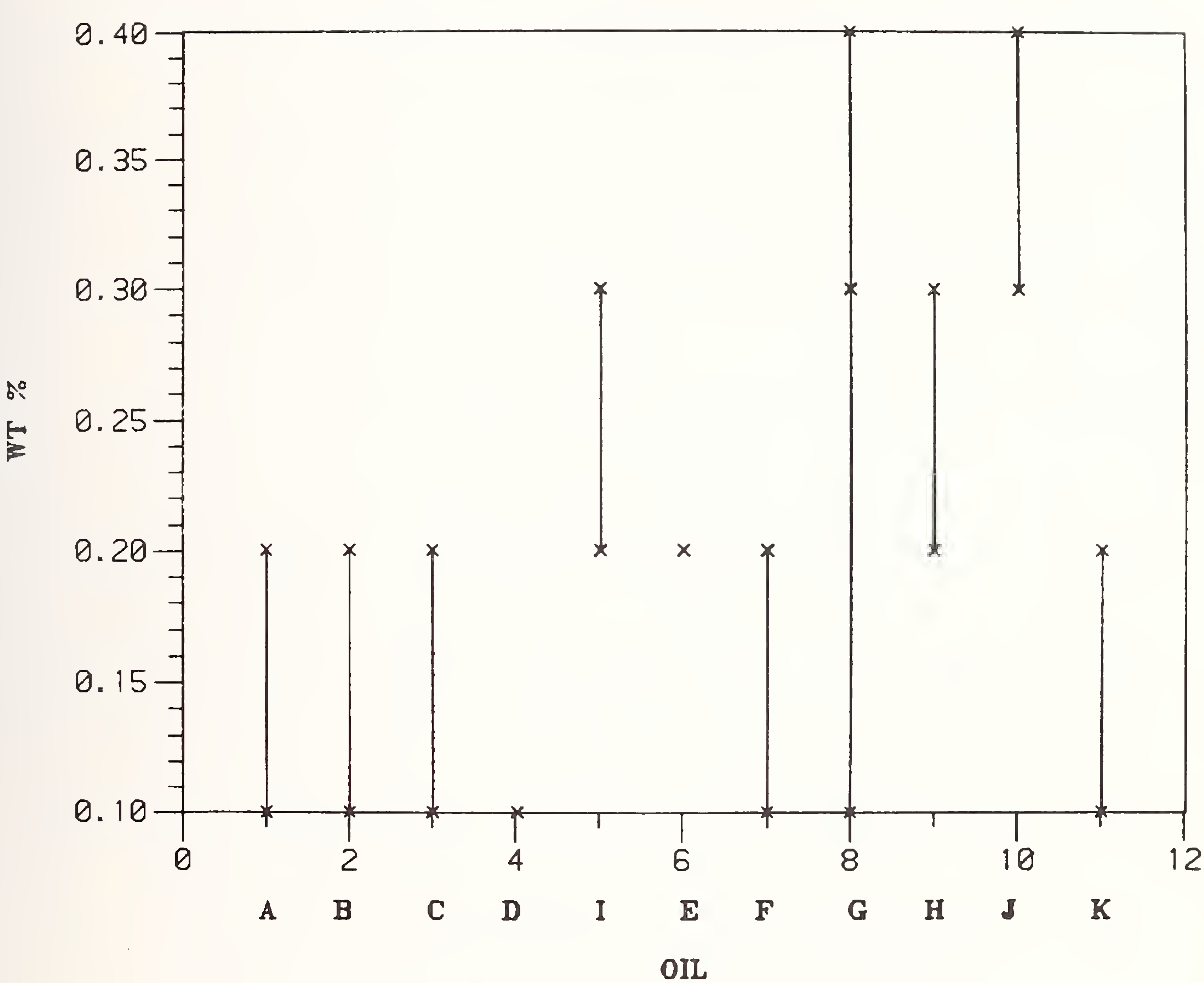
ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: ARCMATICITY, TRI-RING CARBON (WT%) UV SPECTROPHOTOMETRY

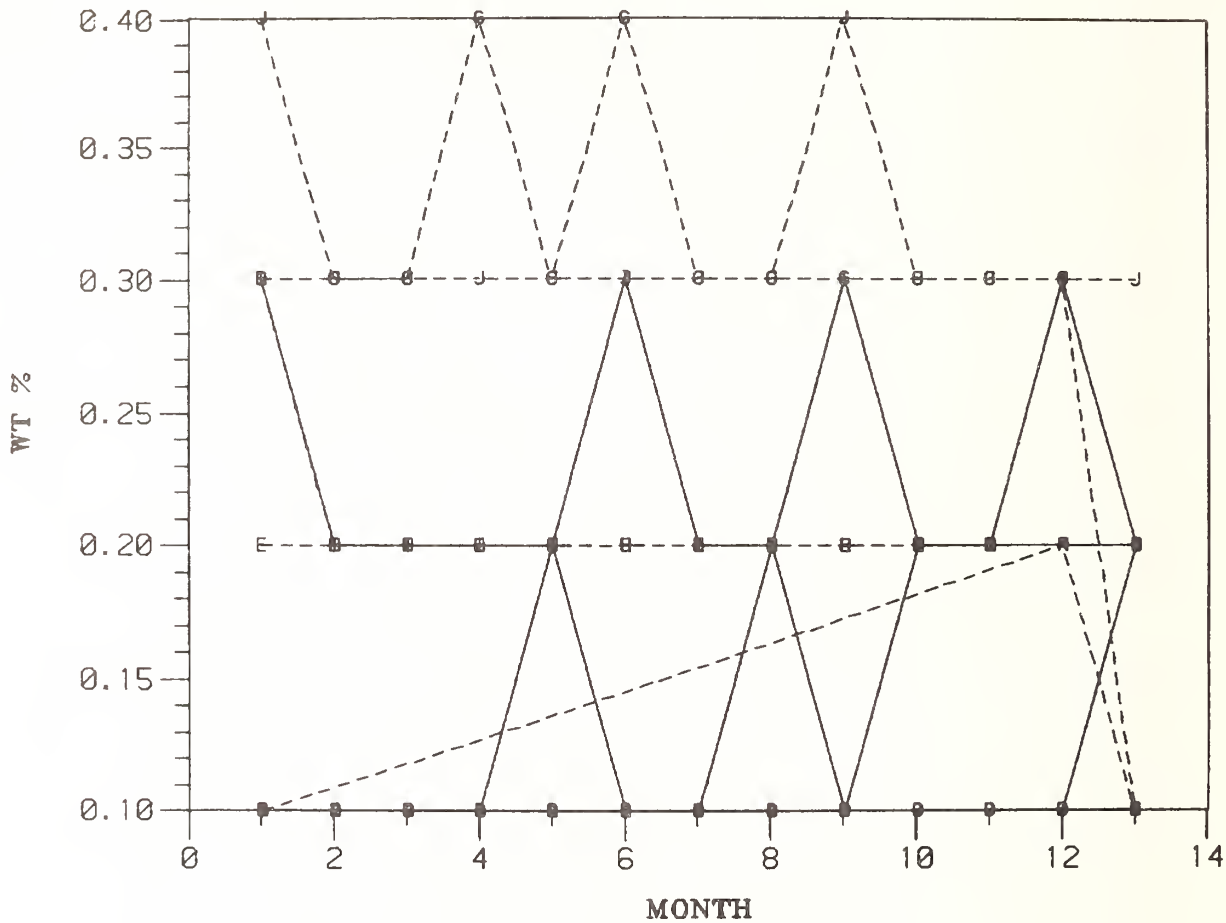
LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.1	-	.1	.1	.3	.2	.2	.3	.3	.4	.1
APR 80	.1	.1	.1	.1	.2	.2	.2	.3	.2	.3	-
MAY 80	.1	.1	.1	.1	.2	.2	.2	.3	.2	.3	-
JUN 80	.1	.1	.1	.1	.2	.2	.2	.4	.2	.3	-
JUL 80	.1	.1	.2	.1	.2	.2	.2	.3	.2	.3	-
AUG 80	.1	.1	.1	.1	.3	.2	.2	.4	.2	.3	-
SEP 80	.1	.1	.1	.1	.2	.2	.2	.3	.2	.3	-
OCT 80	.1	.1	.2	.1	.2	.2	.2	.3	.2	.3	-
NOV 80	.1	.1	.1	.1	.3	.2	.2	.3	.2	.4	-
DEC 80	.2	.1	.1	.1	.2	.2	.2	.3	.2	.3	-
JAN 81	.2	.1	.1	.1	.2	-	.2	.3	.2	.3	-
FEB 81	.2	.1	.1	.1	.3	-	.2	.3	.2	.3	.2
MAR 81	.2	.2	.1	.1	.2	-	.1	.1	.2	.3	.1
MEAN	.13	.11	.12	.10	.23	.20	.19	.30	.21	.32	.13
STD.DEV.	.05	.03	.04	.00	.05	.00	.03	.07	.03	.04	.06
MIN	.1	.1	.1	.1	.2	.2	.1	.1	.2	.3	.1
MAX	.2	.2	.2	.1	.3	.2	.2	.4	.3	.4	.2

AROMATICITY (TRI-RING) BY UV



AROMATICITY (TRI-RING) BY UV



ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: POLYCYCLIC AROMATIC CONTENT (WT%) IP 346

LABORATORY: U

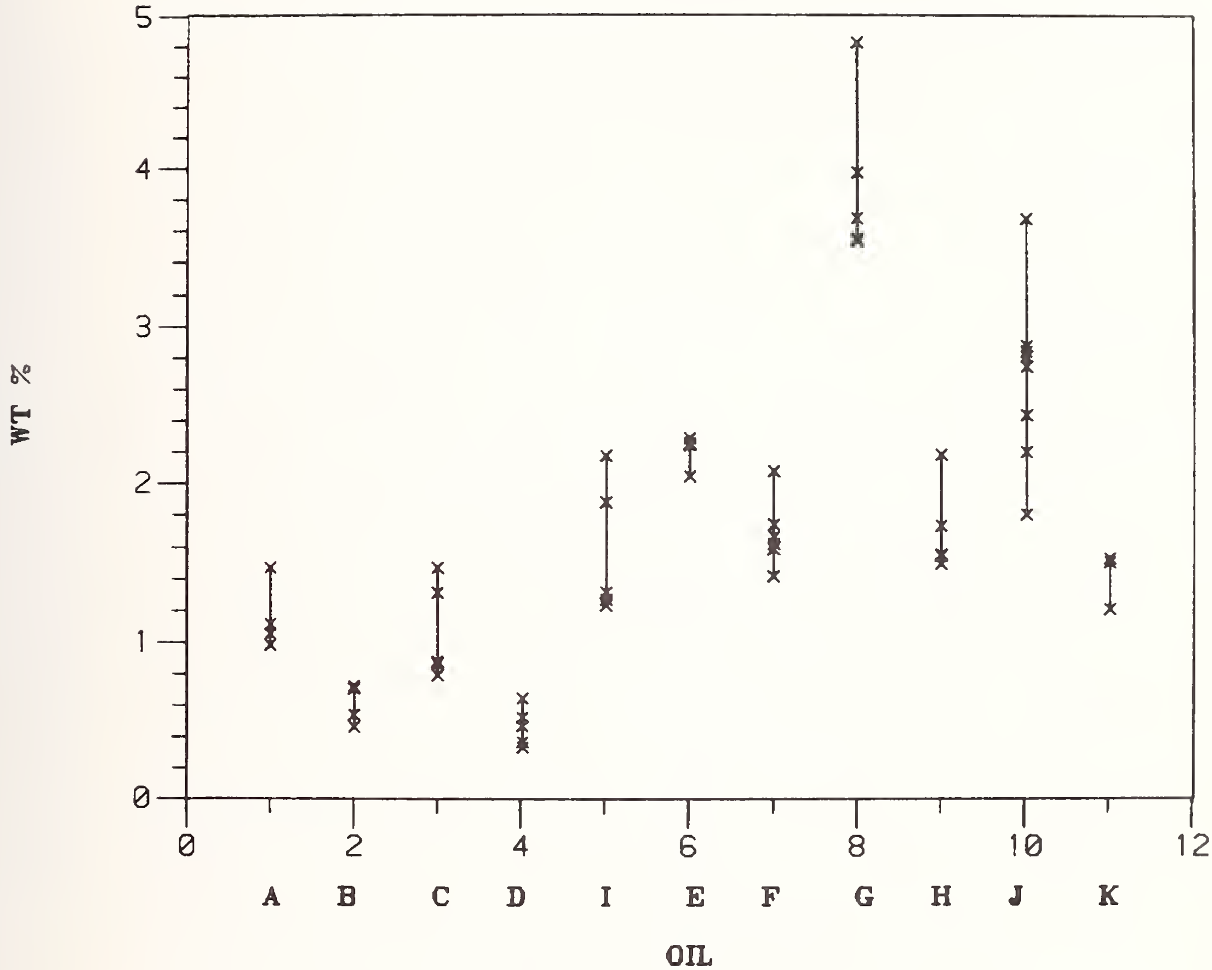
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.98	-	.87	.33	1.26	2.25	1.62	3.68	1.55	3.68	1.20
APR 80	--	--	--	--	--	--	--	--	--	2.80	-
MAY 80	--	--	--	--	--	--	--	--	--	2.84	-
JUN 80	.98	.46	.79	.36	1.31	2.04	2.08	4.82	1.73	2.43	-
JUL 80	--	--	--	--	--	--	--	--	--	--	-
AUG 80	--	--	--	--	--	--	--	--	--	--	-
SEP 80	1.05	.72	1.31	.47	2.17	2.24	1.58	3.55	1.54	2.20	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	1.11	.54	.86	.52	1.23	2.28	1.74	3.53	1.49	1.80	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	1.41	--	--	2.74	1.52
MAR 81	1.46	.70	1.46	.64	1.88	-	1.66	3.97	2.18	2.87	1.50
MEAN	1.116	.605	1.058	.464	1.570	2.203	1.682	3.910	1.698	2.670	1.407
STD.DEV.	.200	.126	.305	.125	.429	.110	.224	.538	.284	.554	.179
MIN	.98	.46	.79	.33	1.23	2.04	1.41	3.53	1.49	1.80	1.20
MAX	1.46	.72	1.46	.64	2.17	2.28	2.08	4.82	2.18	3.68	1.52

ASTM/NBS BASESTOCK CONSISTENCY STUDY

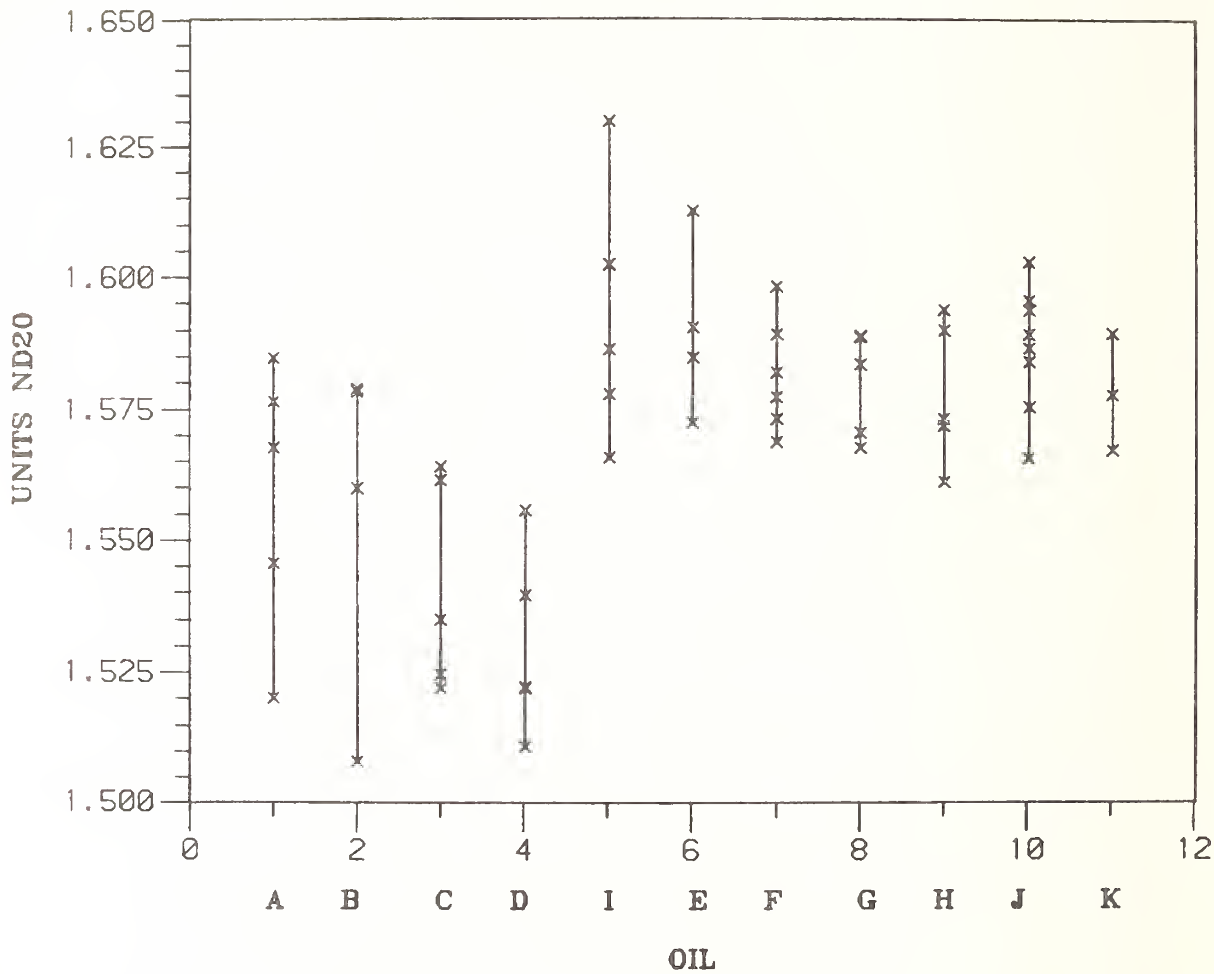
TEST: REFRACTIVE INDEX OF POLYCYCLIC AROMATIC EXTRACT (UNITS) IP 346 LABORATORY: U

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	1.5847	-	1.5245	1.5555	1.6297	1.6123	1.5729	1.5675	1.5730	1.5890	1.5670
APR 80	--	--	--	--	--	--	--	--	--	1.5655	-
MAY 80	--	--	--	--	--	--	--	--	--	1.5865	-
JUN 80	1.5200	1.5787	1.5349	1.5220	1.5775	1.5722	1.5818	1.5884	1.5715	1.5956	-
JUL 80	--	--	--	--	--	--	--	--	--	--	-
AUG 80	--	--	--	--	--	--	--	--	--	--	-
SEP 80	1.5675	1.5782	1.5639	1.5395	1.5862	1.5904	1.5980	1.5887	1.5938	1.6027	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	1.5762	1.5596	1.5612	1.5217	1.6022	1.5847	1.5772	1.5832	1.5897	1.5937	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	1.5685	--	--	1.5837	1.5892
MAR 81	1.5455	1.5077	1.5217	1.5107	1.5657	-	1.5891	1.5702	1.5609	1.5752	1.5777
MEAN	1.55878	1.55605	1.54124	1.52988	1.59226	1.58990	1.58125	1.57960	1.57778	1.58649	1.57797
STD.DEV.	.02613	.03344	.02009	.01765	.02480	.01676	.01087	.01010	.01366	.01183	.01110
MIN	1.5200	1.5077	1.5217	1.5107	1.5657	1.5722	1.5685	1.5675	1.5609	1.5655	1.5670
MAX	1.5847	1.5787	1.5639	1.5555	1.6297	1.6123	1.5980	1.5887	1.5938	1.6027	1.5892

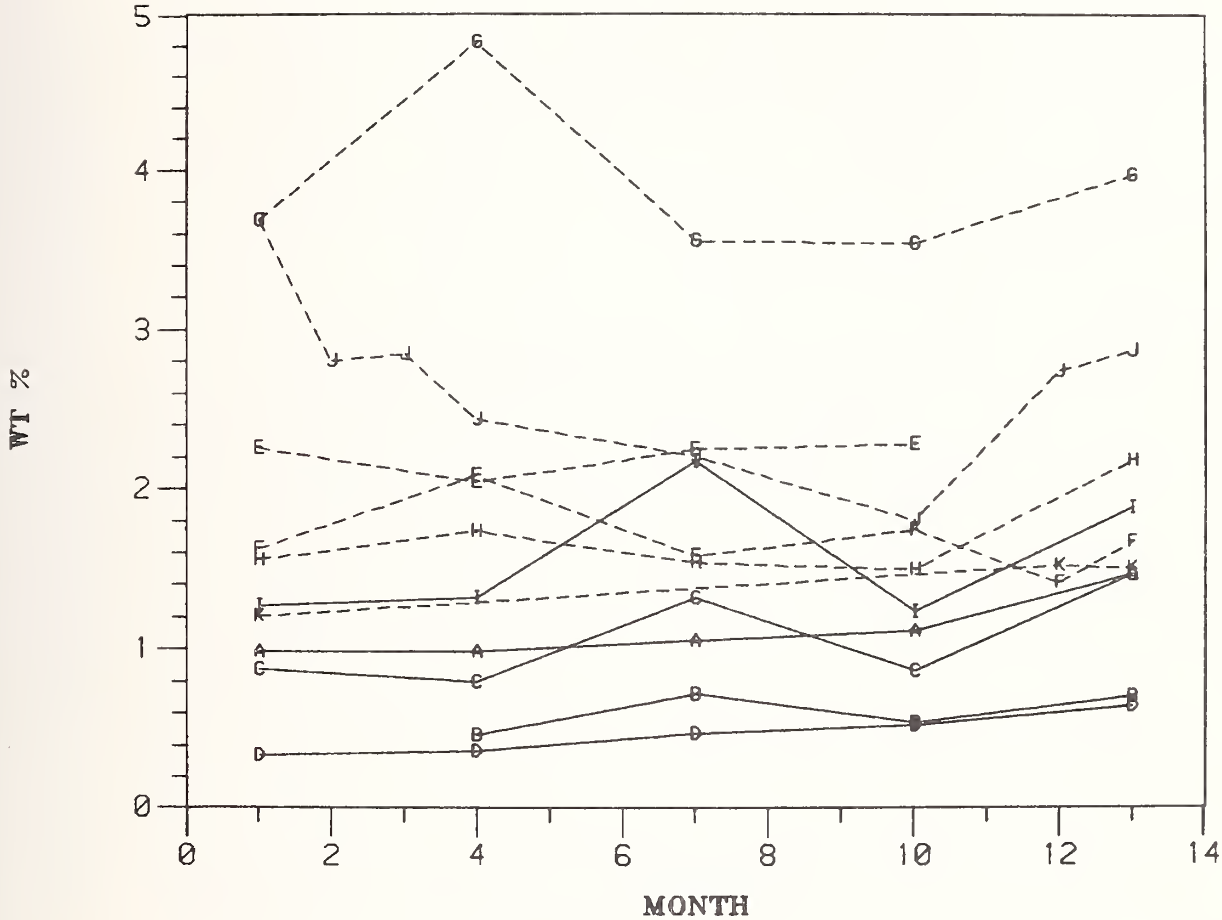
POLYCYCLIC AROMATIC CONTENT BY IP346



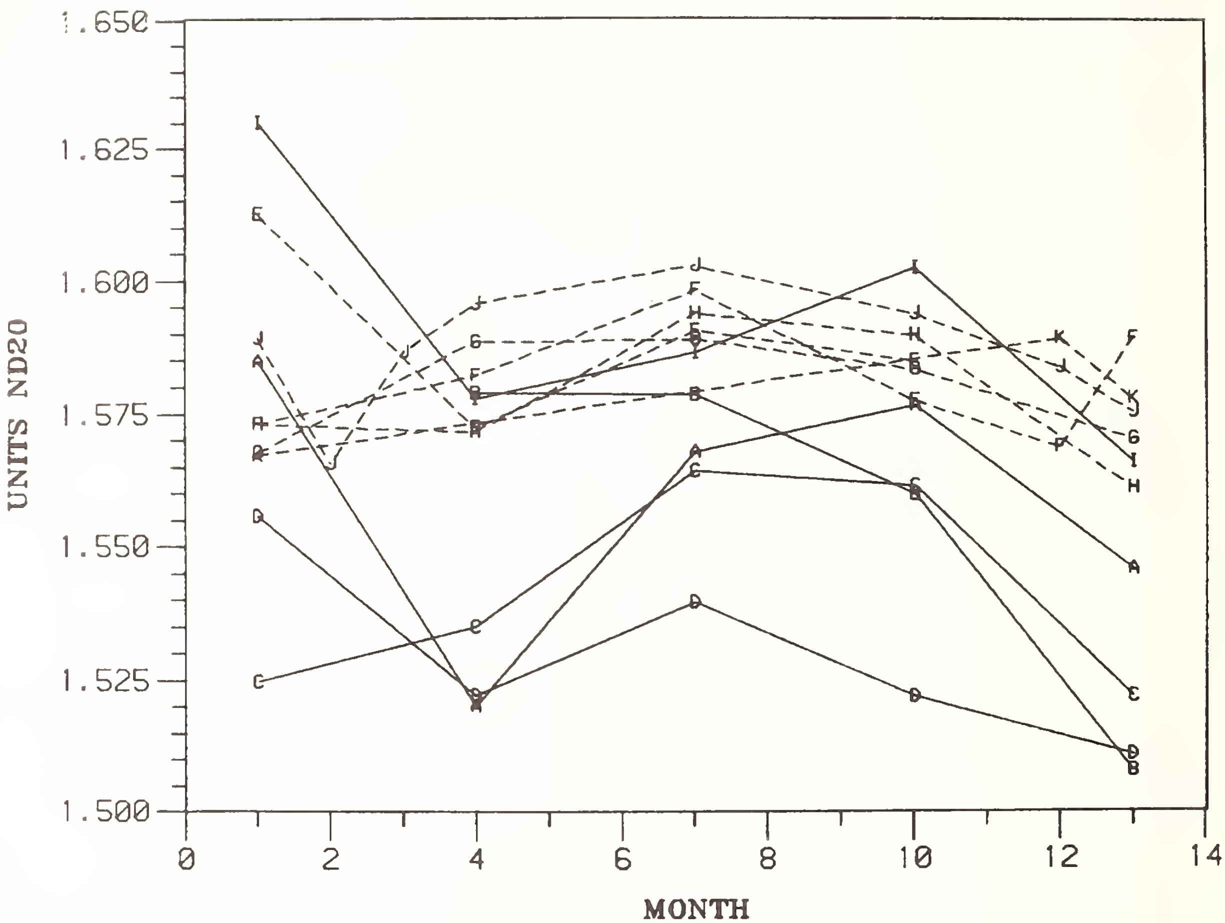
REFRACTIVE INDEX PCA EXTRACT



POLYCYCLIC AROMATIC CONTENT BY IP346



REFRACTIVE INDEX PCA EXTRACT



ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: POLYAROMATICS & POLARS (WT%) HPLC/MS

LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	4.29	3.88	--	1.49
APR 80	--	--	--	--	--	3.85	5.37	--	--	--	-
MAY 80	--	--	2.22	--	3.94	--	--	--	--	--	-
JUN 80	2.61	--	--	--	--	--	--	--	4.69	--	-
JUL 80	--	--	1.67	--	--	--	2.97	--	--	--	-
AUG 80	1.94	--	--	--	--	3.24	--	--	--	2.81	-
SEP 80	--	--	--	--	2.33	--	--	--	3.27	--	-
OCT 80	--	--	--	--	--	--	2.83	4.98	--	--	-
NOV 80	1.53	--	--	--	--	2.81	--	--	--	--	-
DEC 80	--	--	--	--	2.30	--	--	--	2.68	--	-
JAN 81	--	--	1.06	--	--	-	2.29	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	2.25
MAR 81	--	--	--	--	--	-	--	3.50	--	2.68	2.36
MEAN	2.027	.000	1.650	.000	2.857	3.300	3.365	4.257	3.630	2.745	2.033
STD.DEV.	.545	.000	.580	.000	.938	.523	1.368	.741	.860	.092	.474
MIN	1.53	.00	1.06	.00	2.30	2.81	2.29	3.50	2.68	2.68	1.49
MAX	2.61	.00	2.22	.00	3.94	3.85	5.37	4.98	4.69	2.81	2.36

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: PCLYAROMATICS AND POLARS, -16,-30 MASS Z SERIES (WT%) HPLC/MS

LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	.6506	.4980	--	--
APR 80	--	--	--	--	--	.5636	.6568	--	--	--	-
MAY 80	--	--	.4102	--	.5113	--	--	--	--	--	-
JUN 80	.4689	--	--	--	--	--	--	--	.5982	--	-
JUL 80	--	--	.2750	--	--	--	.3362	--	--	--	-
AUG 80	.2810	--	--	--	--	.4857	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	.37495	.C0000	.34260	.00000	.51130	.52465	.49650	.65060	.54810	.00000	.00000
STD.DEV.	.13287	.00000	.09560	.00000	.00000	.05508	.22670	.00000	.07085	.00000	.00000
MIN	.2810	.0000	.2750	.0000	.5113	.4857	.3362	.6506	.4980	.0000	.0000
MAX	.4689	.0000	.4102	.0000	.5113	.5636	.6568	.6506	.5982	.0000	.0000

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: POLYAROMATICS AND POLARS, -18,-32 MASS Z SERIES (WT%) HPLC/MS LABORATORY: T

		VIRGIN BASESTOCK			REF	RE-REFINED BASESTOCKS					
DATE :	A	B	C	D	I	E	F	G	H	J	K
MAR 80 :	--	-	--	--	--	--	--	1.0010	.8454	--	--
APR 80 :	--	--	--	--	--	.9039	1.0939	--	--	--	-
MAY 80 :	--	--	.3426	--	.6504	--	--	--	--	--	-
JUN 80 :	.7531	--	--	--	--	--	--	--	1.1269	--	-
JUL 80 :	--	--	.2677	--	--	--	.6323	--	--	--	-
AUG 80 :	.4831	--	--	--	--	.9174	--	--	--	--	-
SEP 80 :	--	--	--	--	--	--	--	--	--	--	-
OCT 80 :	--	--	--	--	--	--	--	--	--	--	-
NOV 80 :	--	--	--	--	--	--	--	--	--	--	-
DEC 80 :	--	--	--	--	--	--	--	--	--	--	-
JAN 81 :	--	--	--	--	--	-	--	--	--	--	-
FEB 81 :	--	--	--	--	--	-	--	--	--	--	--
MAR 81 :	--	--	--	--	--	-	--	--	--	--	--
MEAN :	.61810	.00000	.30515	.00000	.65040	.91315	.86310	1.00100	.98615	.00000	.00000
STD.DEV. :	.19092	.00000	.05296	.00000	.00000	.00601	.32640	.00000	.19905	.00000	.00000
MIN :	.4831	.0000	.2677	.0000	.6504	.9089	.6323	1.0010	.8454	.0000	.0000
MAX :	.7531	.0000	.3426	.0000	.6504	.9174	1.0939	1.0010	1.1269	.0000	.0000

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: PCLYAROMATICS AND POLARS, -20,-34 MASS Z SERIES (WT%) HPLC/MS

LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	.5542	.6161	--	--
APR 80	--	--	--	--	--	.6269	1.1021	--	--	--	-
MAY 80	--	--	.3135	--	.5395	--	--	--	--	--	-
JUN 80	.4632	--	--	--	--	--	--	--	.7965	--	-
JUL 80	--	--	.1949	--	--	--	.5668	--	--	--	-
AUG 80	.3943	--	--	--	--	.5788	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	.42875	.00000	.25420	.00000	.53950	.60285	.83445	.55420	.70630	.00000	.00000
STD.DEV.	.04872	.00000	.08386	.00000	.00000	.03401	.37851	.00000	.12756	.00000	.00000
MIN	.3943	.0000	.1949	.0000	.5395	.5788	.5668	.5542	.6161	.0000	.0000
MAX	.4632	.0000	.3135	.0000	.5395	.6269	1.1021	.5542	.7965	.0000	.0000

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: POLYAROMATICS AND POLARS, -22 MASS Z SERIES (WT%) HPLC/MS — LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	.5280	.5735	--	--
APR 80	--	--	--	--	--	.5500	.9257	--	--	--	-
MAY 80	--	--	.2734	--	.3813	--	--	--	--	--	-
JUN 80	.3651	--	--	--	--	--	--	--	.8911	--	-
JUL 80	--	--	.1393	--	--	--	.4629	--	--	--	-
AUG 80	.3018	--	--	--	--	.5694	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	.33345	.00000	.20635	.00000	.38130	.55970	.69430	.52800	.73230	.00000	.00000
STD.DEV.	.04476	.00000	.09482	.00000	.00000	.01372	.32725	.00000	.22458	.00000	.00000
MIN	.3018	.0000	.1393	.0000	.3813	.5500	.4629	.5280	.5735	.0000	.0000
MAX	.3651	.0000	.2734	.0000	.3813	.5694	.9257	.5280	.8911	.0000	.0000

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: POLYAROMATICS AND POLARS, -10,-24,-14S MASS Z SERIES (WT%) HPLC/MS

LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	.3994	.3926	--	--
APR 80	--	--	--	--	--	.2731	.6167	--	--	--	-
MAY 80	--	--	.1757	--	.2713	--	--	--	--	--	-
JUN 80	.2238	--	--	--	--	--	--	--	.4847	--	-
JUL 80	--	--	.1060	--	--	--	.3504	--	--	--	-
AUG 80	.1884	--	--	--	--	.2199	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	.20610	.00000	.14085	.00000	.27130	.24650	.48355	.39940	.43865	.00000	.00000
STD.DEV.	.02503	.00000	.04929	.00000	.00000	.03762	.18830	.00000	.06512	.00000	.00000
MIN	.1884	.0000	.1060	.0000	.2713	.2199	.3504	.3994	.3926	.0000	.0000
MAX	.2238	.0000	.1757	.0000	.2713	.2731	.6167	.3994	.4847	.0000	.0000

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: PCLYAROMATICS AND POLARS, -12,-26,-16S MASS Z SERIES (WT%) HPLC/MS LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	.7119	.5850	--	--
APR 80	--	--	--	--	--	.5693	.4876	--	--	--	-
MAY 80	--	--	.4274	--	1.0510	--	--	--	--	--	-
JUN 80	.1573	--	--	--	--	--	--	--	.4080	--	-
JUL 80	--	--	.4832	--	--	--	.3794	--	--	--	-
AUG 80	.1526	--	--	--	--	.2528	--	--	--	--	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	.15495	.00000	.45530	.00000	1.05100	.41130	.43350	.71190	.49650	.00000	.00000
STD.DEV.	.00332	.00000	.03946	.00000	.00000	.22415	.07651	.00000	.12516	.00000	.00000
MIN	.1526	.0000	.4274	.0000	1.0510	.2528	.3794	.7119	.4080	.0000	.0000
MAX	.1573	.0000	.4832	.0000	1.0510	.5698	.4876	.7119	.5850	.0000	.0000

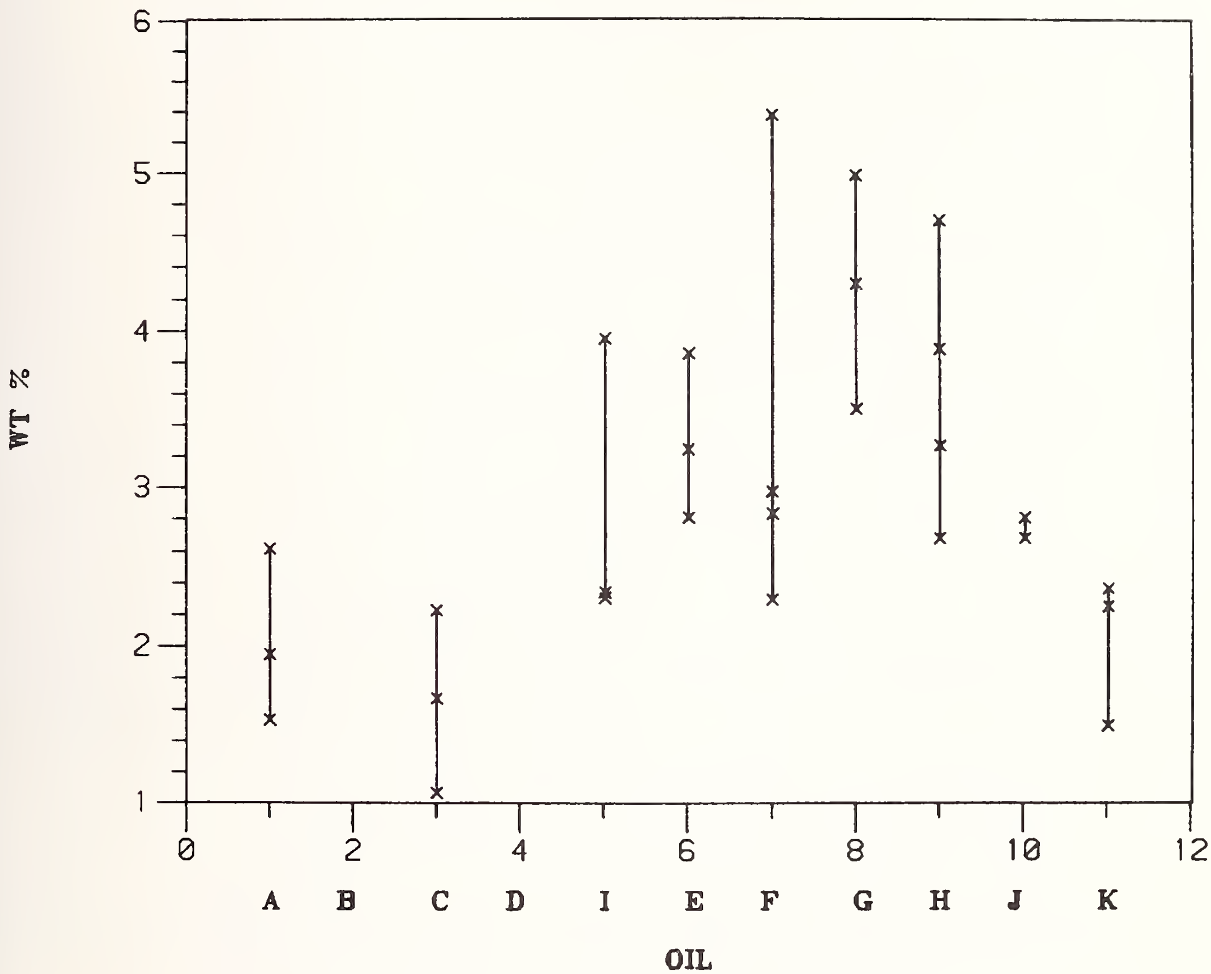
ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: PCLYAROMATICS AND POLARS, -14,-28,-18S MASS Z SERIES (WT%) HPLC/MS

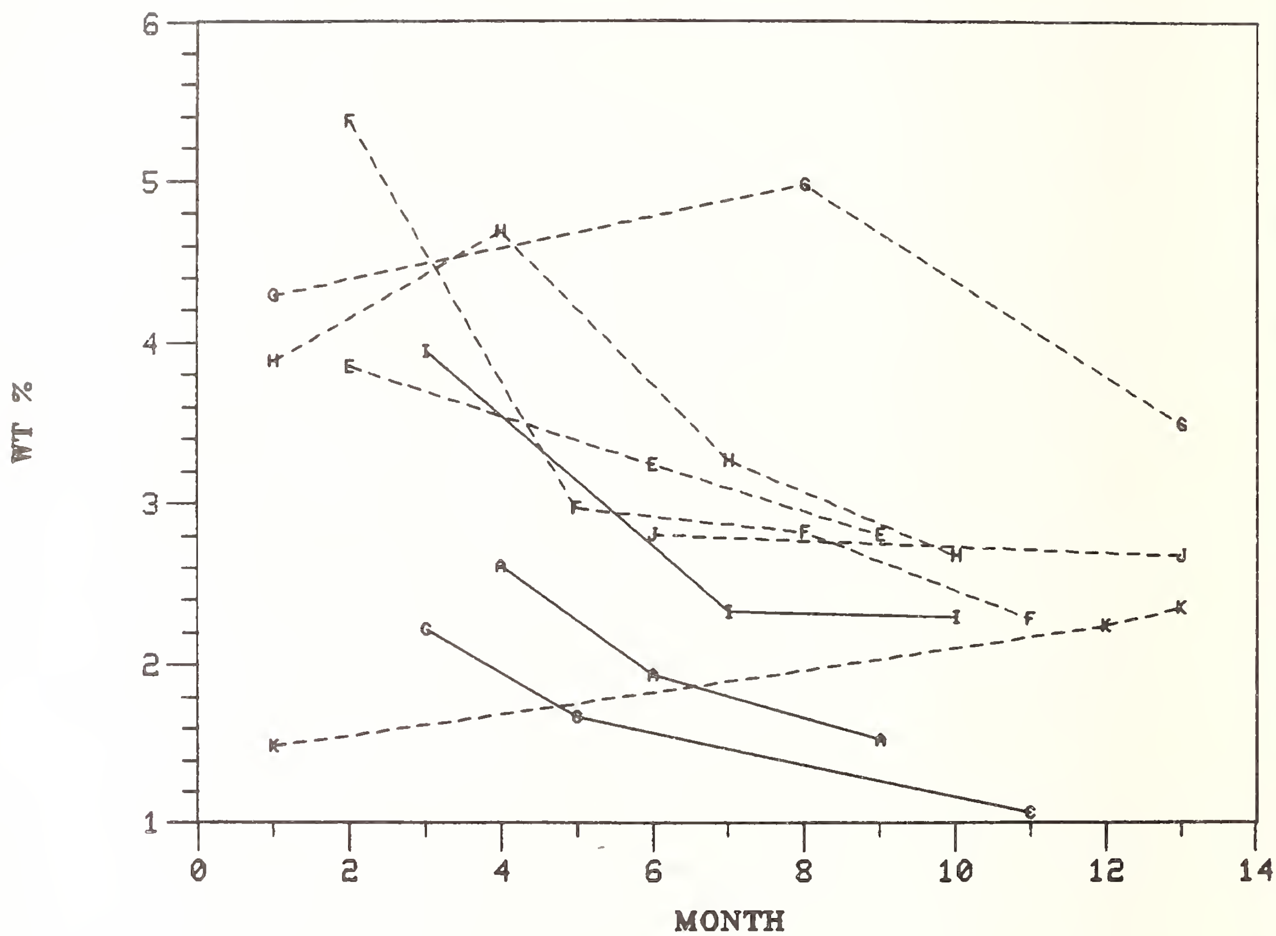
LABORATORY: T

	VIRGIN BASESTOCK				: REF :	RE-REFINED BASESTOCKS					
DATE :	A	B	C	D	I	E	F	G	H	J	K
MAR 80 :	--	-	--	--	--	--	--	.4450	.3693	--	--
APR 80 :	--	--	--	--	--	.3577	.4872	--	--	--	-
MAY 80 :	--	--	.2773	--	.5352	--	--	--	--	--	-
JUN 80 :	.1785	--	--	--	--	--	--	--	.3847	--	-
JUL 80 :	--	--	.2039	--	--	--	.2419	--	--	--	-
AUG 80 :	.1389	--	--	--	--	.2161	--	--	--	--	-
SEP 80 :	--	--	--	--	--	--	--	--	--	--	-
OCT 80 :	--	--	--	--	--	--	--	--	--	--	-
NOV 80 :	--	--	--	--	--	--	--	--	--	--	-
DEC 80 :	--	--	--	--	--	--	--	--	--	--	-
JAN 81 :	--	--	--	--	--	-	--	--	--	--	-
FEB 81 :	--	--	--	--	--	-	--	--	--	--	--
MAR 81 :	--	--	--	--	--	-	--	--	--	--	--
MEAN :	.15870	.00000	.24060	.00000	.53520	.28690	.36455	.44500	.37700	.00000	.00000
STD.DEV. :	.02800	.00000	.05190	.00000	.00000	.10013	.17345	.00000	.01089	.00000	.00000
MIN :	.1389	.0000	.2039	.0000	.5352	.2161	.2419	.4450	.3693	.0000	.0000
MAX :	.1785	.0000	.2773	.0000	.5352	.3577	.4872	.4450	.3847	.0000	.0000

POLYAROMATICS & POLAR BY HPLC



POLYAROMATICS & POLARS BY HPLC



ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: PCLARS (WT%) ASTM D2007

LABORATORY: M

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.4	-	.5	.5	.5	1.4	1.1	2.2	1.9	1.2	.5
APR 80	--	.6	--	.5	--	1.3	1.1	--	--	--	-
MAY 80	--	--	.4	--	.4	--	--	2.3	--	--	-
JUN 80	.4	.7	--	--	--	1.4	--	--	1.8	--	-
JUL 80	--	--	.5	.5	--	--	.9	2.4	--	1.0	-
AUG 80	.7	.7	.4	.6	.4	1.3	1.3	2.9	2.1	1.3	-
SEP 80	--	--	.7	.6	.5	--	--	--	1.9	--	-
OCT 80	--	--	--	--	--	--	1.2	2.5	--	1.3	-
NOV 80	--	--	.4	.5	--	1.3	--	--	--	--	-
DEC 80	.6	--	--	--	.4	--	--	2.0	1.9	1.3	-
JAN 81	--	.7	1.5	.5	--	-	.9	--	--	1.3	-
FEB 81	.5	.8	.6	.6	.5	-	--	2.3	1.8	--	1.1
MAR 81	--	1.5	--	--	--	-	.9	2.6	--	1.0	--
MEAN	.52	.83	.62	.54	.45	1.34	1.06	2.40	1.90	1.20	.80
STD.DEV.	.13	.33	.37	.05	.05	.05	.16	.27	.11	.14	.42
MIN	.4	.6	.4	.5	.4	1.3	.9	2.0	1.8	1.0	.5
MAX	.7	1.5	1.5	.6	.5	1.4	1.3	2.9	2.1	1.3	1.1

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: PCLARS, RUN 2 (WT%) ASTM D2007 LABORATORY: M

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	.5	--	--	2.3	--	--	.5
APR 80	--	--	--	.7	--	--	1.0	--	--	--	-
MAY 80	--	--	--	--	.5	--	--	2.3	--	--	-
JUN 80	.4	--	--	--	--	--	--	--	--	--	-
JUL 80	--	--	--	--	--	--	1.0	--	--	1.0	-
AUG 80	.6	.7	--	--	--	--	--	--	--	--	-
SEP 80	--	--	.7	--	.6	--	--	--	--	--	-
OCT 80	--	.8	--	--	--	--	1.2	2.5	--	--	-
NOV 80	--	--	--	.4	--	1.3	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	2.1	1.8	1.3	-
JAN 81	--	--	1.6	--	--	-	--	--	--	--	-
FEB 81	--	--	--	.6	--	-	--	1.8	1.7	--	--
MAR 81	--	--	--	--	--	-	--	--	--	1.0	--
MEAN	.50	.75	1.15	.55	.54	1.30	1.07	2.20	1.75	1.10	.50
STD.DEV.	.14	.07	.64	.14	.05	.00	.12	.26	.07	.17	.00
MIN	.4	.7	.7	.4	.5	1.3	1.0	1.8	1.7	1.0	.5
MAX	.6	.8	1.6	.7	.6	1.3	1.2	2.5	1.8	1.3	.5

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: POLARS COMPOUNDS (WT%) TLC/FID

LABORATORY: U

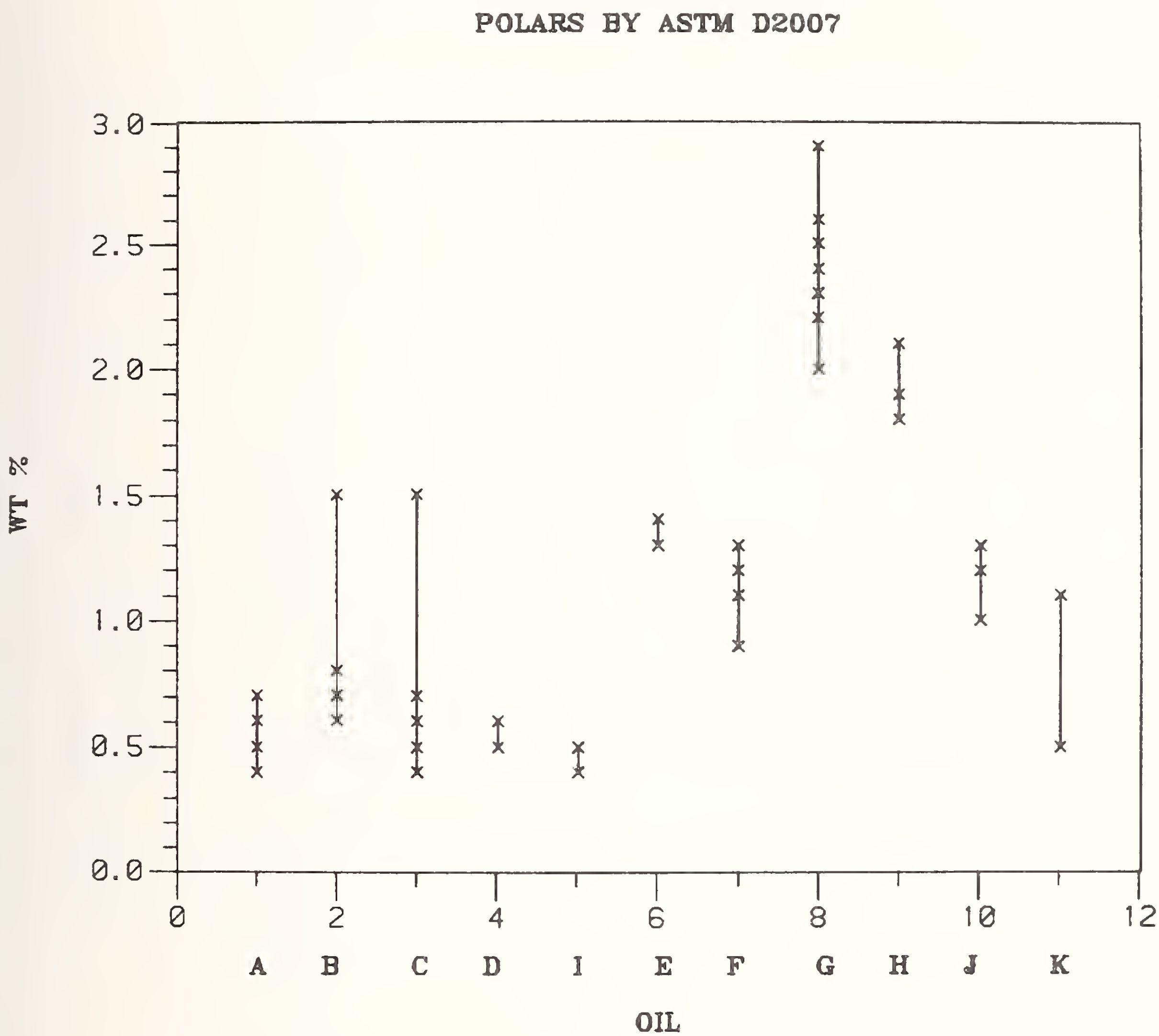
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.7	-	.7	.4	1.6	1.1	.5	1.6	1.1	.6	.25
APR 80	--	--	--	--	--	--	--	--	--	1.0	-
MAY 80	--	--	--	--	--	--	--	--	--	.8	-
JUN 80	.9	1.0	1.2	.6	.7	1.2	1.4	1.5	.9	.8	-
JUL 80	--	--	--	--	--	--	--	--	--	--	-
AUG 80	--	--	--	--	--	--	--	--	--	--	-
SEP 80	2.0	2.0	.9	1.0	2.0	2.8	2.7	3.0	2.0	.5	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	.8	.7	.4	.6	.5	.4	1.0	1.8	1.4	1.6	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	1.1	--	--	1.6	1.2
MAR 81	1.4	1.6	.8	.8	1.5	-	1.4	2.0	1.5	.9	.9
MEAN	1.16	1.33	0.80	0.68	1.26	1.38	1.35	1.98	1.38	1.10	0.78
STD.DEV.	.54	.59	.29	.22	.63	1.01	.74	.60	.42	.44	.49
MIN	.7	.7	.4	.4	.5	.4	.5	1.5	.9	.5	.25
MAX	2.0	2.0	1.2	1.0	2.0	2.8	2.7	3.0	2.0	1.6	1.2

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: HIGHLY POLAR COMPOUNDS (WT%) TLC/FID

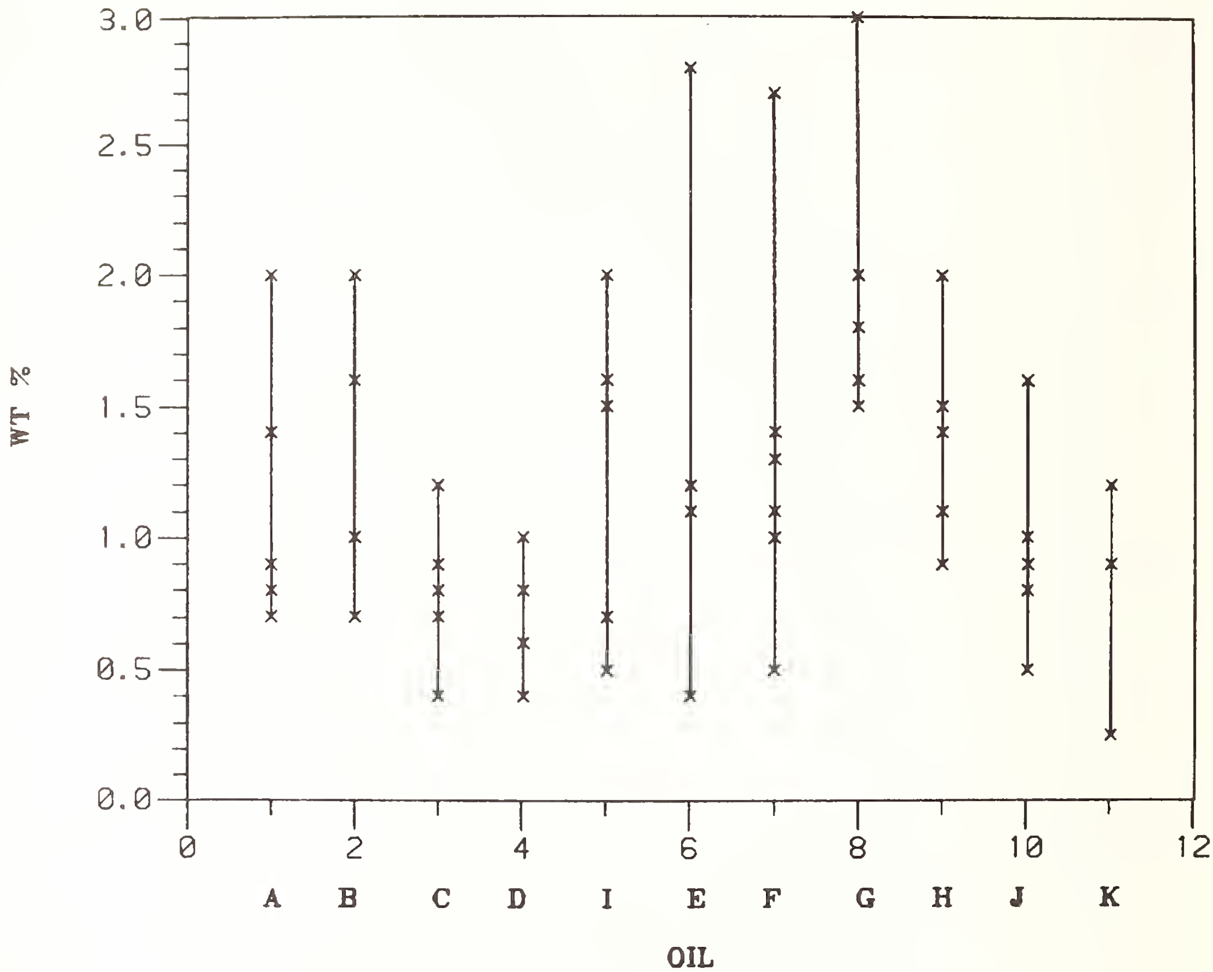
LABORATORY: U

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.2	-	ND	ND	ND	.3	ND	.2	.2	.6	.1
APR 80	--	--	--	--	--	--	--	--	--	ND	-
MAY 80	--	--	--	--	--	--	--	--	--	.1	-
JUN 80	.1	.3	ND	ND	.05	ND	ND	.4	.05	.2	-
JUL 80	--	--	--	--	--	--	--	--	--	--	-
AUG 80	--	--	--	--	--	--	--	--	--	--	-
SEP 80	.2	.1	.4	.3	.4	.5	.5	.5	.4	ND	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	.4	.2	ND	.2	ND	ND	ND	.3	.1	ND	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	ND	--	--	ND	ND
MAR 81	ND	ND	ND	ND	ND	-	ND	ND	ND	ND	ND
MEAN	.23	.20	.40	.25	.45	.40	.50	.35	.19	.30	.10
STD.DEV.	.13	.10	-	.07	.07	.14	-	.13	.16	.26	-
MIN	.10	.10	.40	.20	.05	.30	.50	.20	.05	.10	.10
MAX	.40	.30	.40	.30	.05	.50	.50	.50	.40	.60	.10

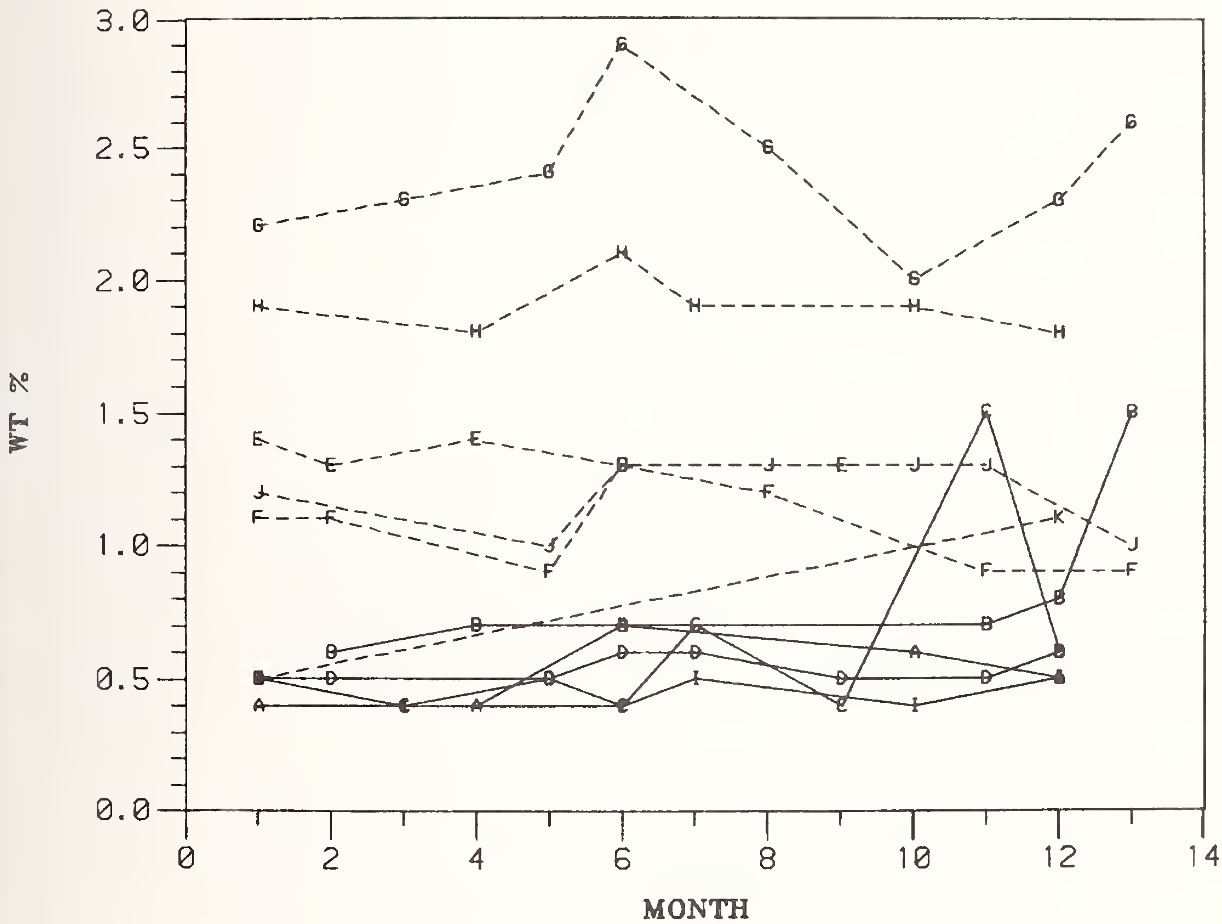


POLARS BY ASTM D2007
WT %
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
2
4
6
8
10
12
A B C D I E F G H J K
OIL

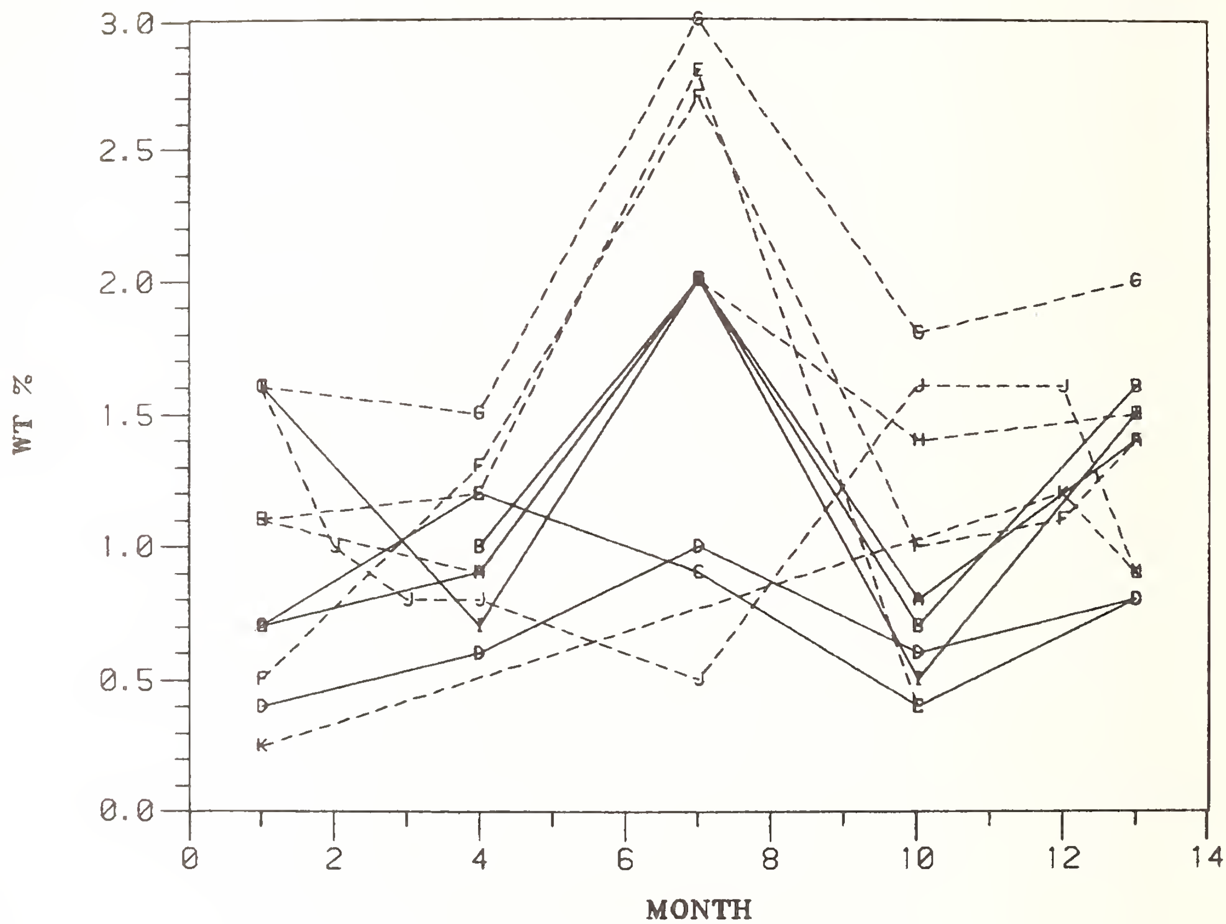
POLAR COMPOUNDS BY TLC/FID



POLARS BY ASTM D2007



POLAR COMPOUNDS BY TLC/FID



ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: SULFUR COMPOUNDS, BENZTHIOPHENES (ppm) MASS SPECTROMETRY LABORATORY: J

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	--	--	--	--
APR 80	--	--	--	--	--	--	--	--	--	--	-
MAY 80	--	--	--	--	--	--	--	--	--	--	-
JUN 80	--	--	--	--	--	--	--	--	--	--	-
JUL 80	--	--	--	--	--	--	--	--	--	--	-
AUG 80	--	--	--	--	--	--	--	--	--	--	-
SEP 80	--	--	480.	--	--	--	--	--	--	400.	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	1300.	--	--	400.	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	400.
MAR 81	--	--	--	--	1100.	-	--	--	--	--	--
MEAN	.00	.00	480.00	.00	1200.00	.00	.00	400.00	.00	400.00	400.00
STD.DEV.	.00	.00	.00	.00	141.42	.00	.00	.00	.00	.00	.00
MIN	.0	.0	480.	.0	1100.	.0	.0	400.	.0	400.	400.
MAX	.0	.0	480.	.0	1300.	.0	.0	400.	.0	400.	400.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

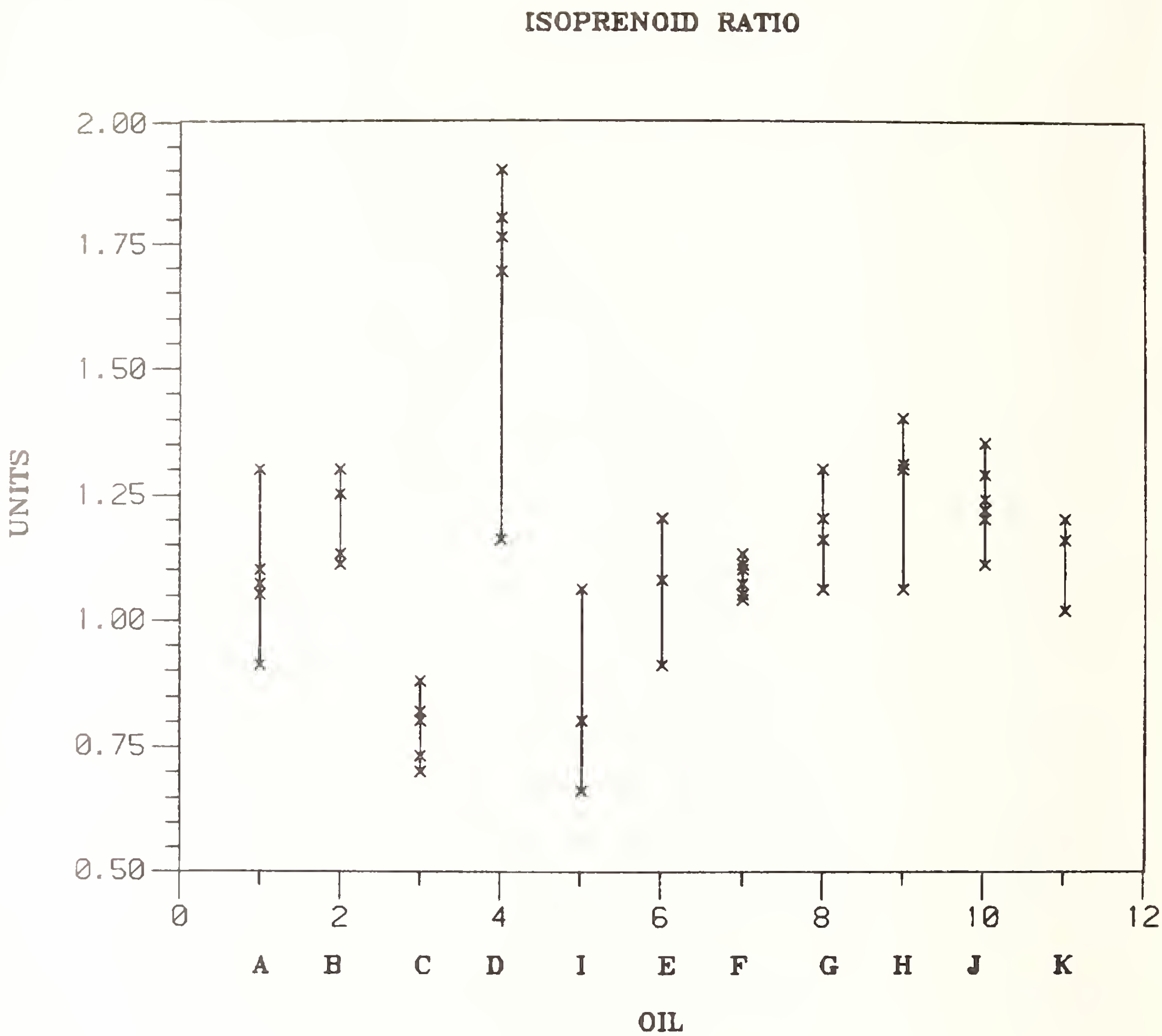
TEST: SULFUR COMPOUNDS. DIBENZTHIOPHENES (ppm) MASS SPECTROMETRY — LABORATORY: U

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	ND	-	ND	ND	ND	ND	ND	NC	ND	ND	ND
APR 80	--	--	--	--	--	--	--	--	--	ND	-
MAY 80	--	--	--	--	--	--	--	--	--	ND	-
JUN 80	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-
JUL 80	--	--	--	--	--	--	--	--	--	--	-
AUG 80	--	--	--	--	--	--	--	--	--	--	-
SEP 80	ND	--	400.	--	--	--	--	--	--	700.	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	ND	--	--	--	450.	--	--	500.	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	ND	--	--	ND	1000.
MAR 81	ND	--	--	--	1250.	-	ND	ND	ND	ND	ND
MEAN	ND	ND	400.0	ND	850.0	ND	ND	500.0	ND	700.0	1000.0
STD.DEV.	ND	ND	.0	ND	565.7	ND	ND	.0	ND	.0	.0
MIN	ND	ND	400.	ND	450.	ND	ND	500.	ND	700.	1000.
MAX	ND	ND	400.	ND	1250.	ND	ND	500.	ND	700.	1000.

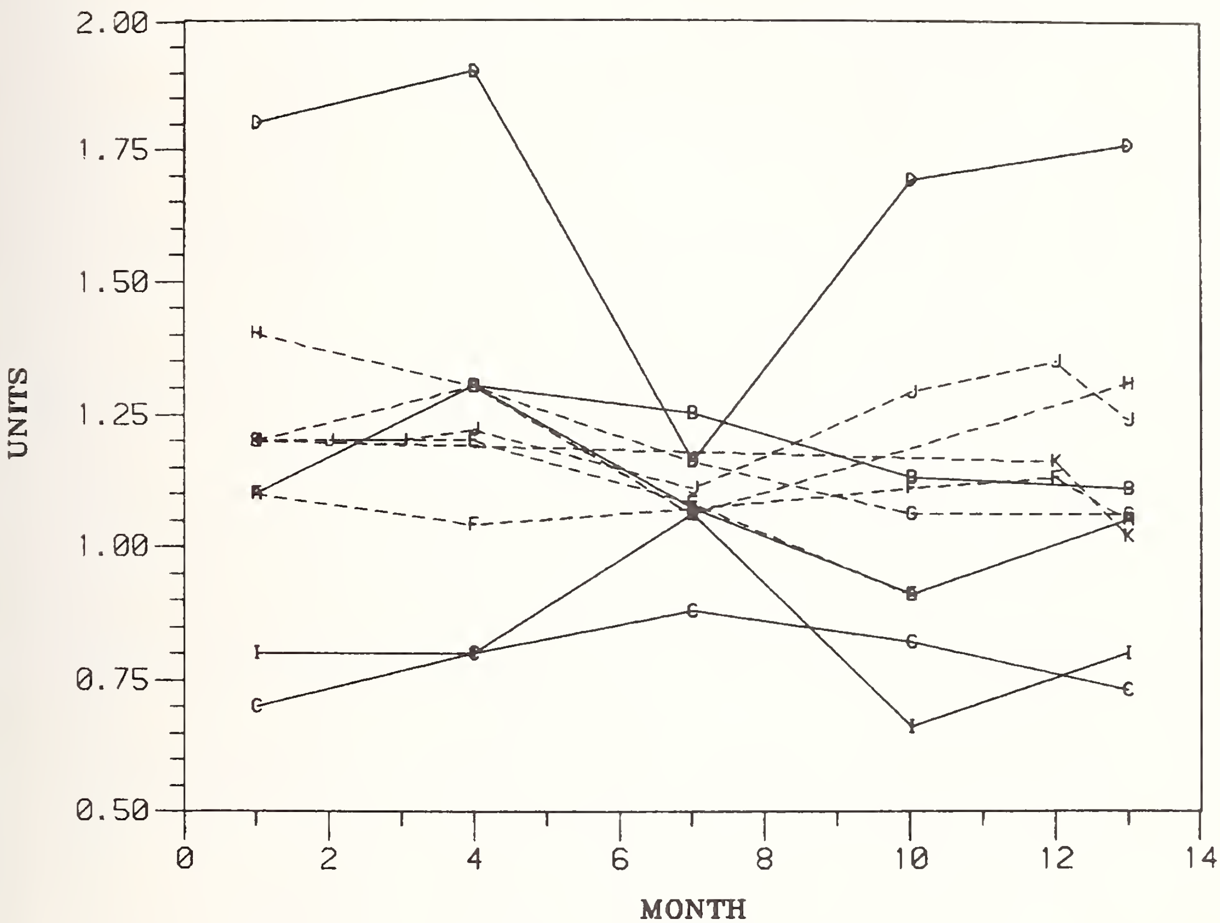
ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: ISOPRENOID RATIO (UNITS) nmr SPECTROMETRY   LABORATORY: U

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	1.10	-	.70	1.80	.80	1.20	1.10	1.20	1.40	1.20	1.20
APR 80	--	--	--	--	--	--	--	--	--	1.20	-
MAY 80	--	--	--	--	--	--	--	--	--	1.20	-
JUN 80	1.30	1.30	.80	1.90	.80	1.20	1.04	1.30	1.30	1.22	-
JUL 80	--	--	--	--	--	--	--	--	--	--	-
AUG 80	--	--	--	--	--	--	--	--	--	--	-
SEP 80	1.07	1.25	.88	1.16	1.06	1.08	1.07	1.16	1.06	1.11	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	.91	1.13	.82	1.69	.66	.91	1.11	1.06	--	1.29	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	1.13	--	--	1.35	1.16
MAR 81	1.05	1.11	.73	1.76	.80	-	1.05	1.06	1.31	1.24	1.02
MEAN	1.086	1.197	.786	1.662	.824	1.097	1.083	1.156	1.267	1.226	1.127
STD.DEV.	.140	.092	.072	.291	.145	.137	.036	.101	.145	.071	.095
MIN	.91	1.11	.70	1.16	.66	.91	1.04	1.06	1.06	1.11	1.02
MAX	1.30	1.30	.88	1.90	1.06	1.20	1.13	1.30	1.40	1.35	1.20


ISOPRENOID RATIO
UNITS
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0
2
4
6
8
10
12
A B C D I E F G H J K
OIL

ISOPRENOID RATIO



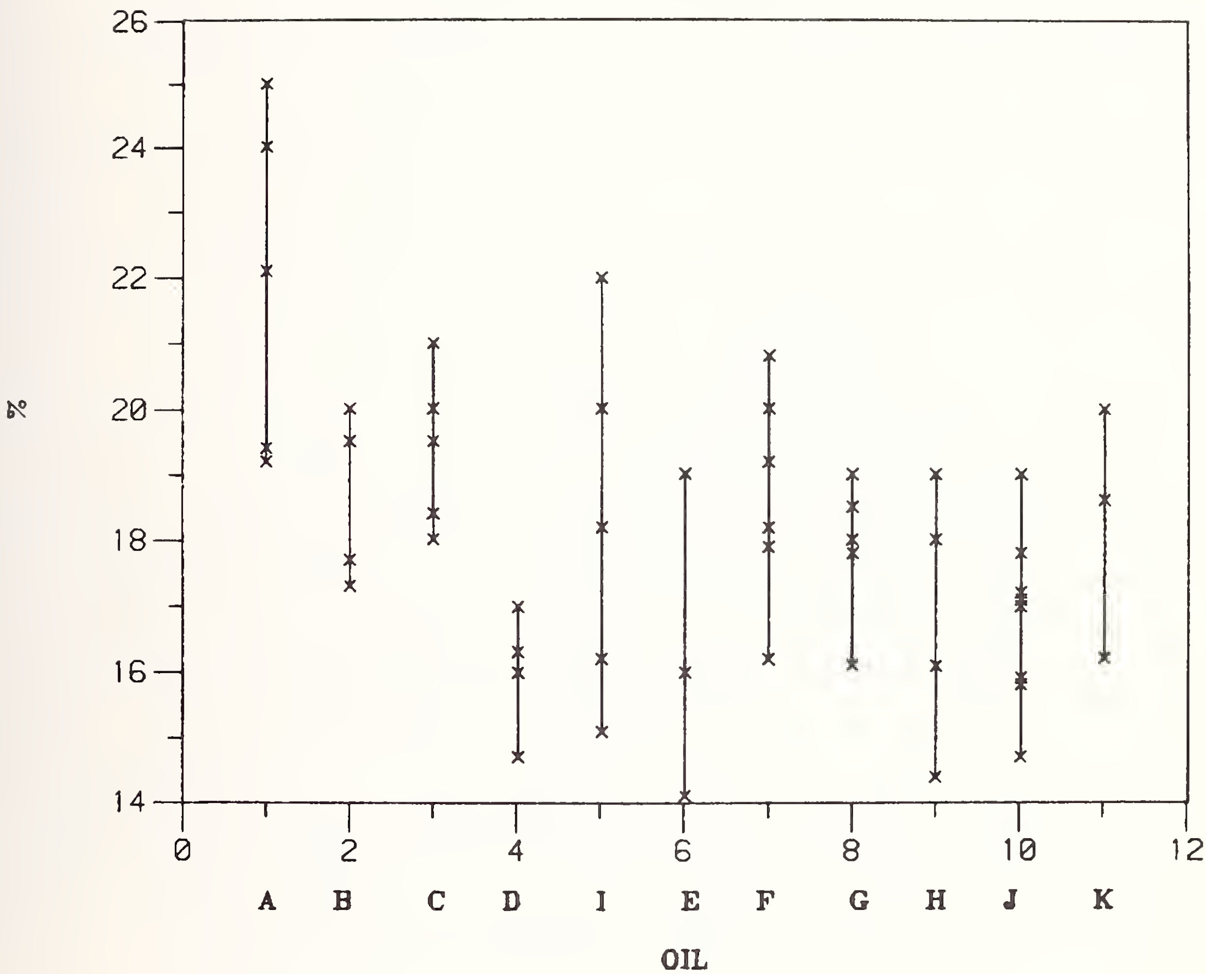
ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: LINEAR/TOTAL HYDROCARBON RATIO (%) nmr SPECTROMETRY

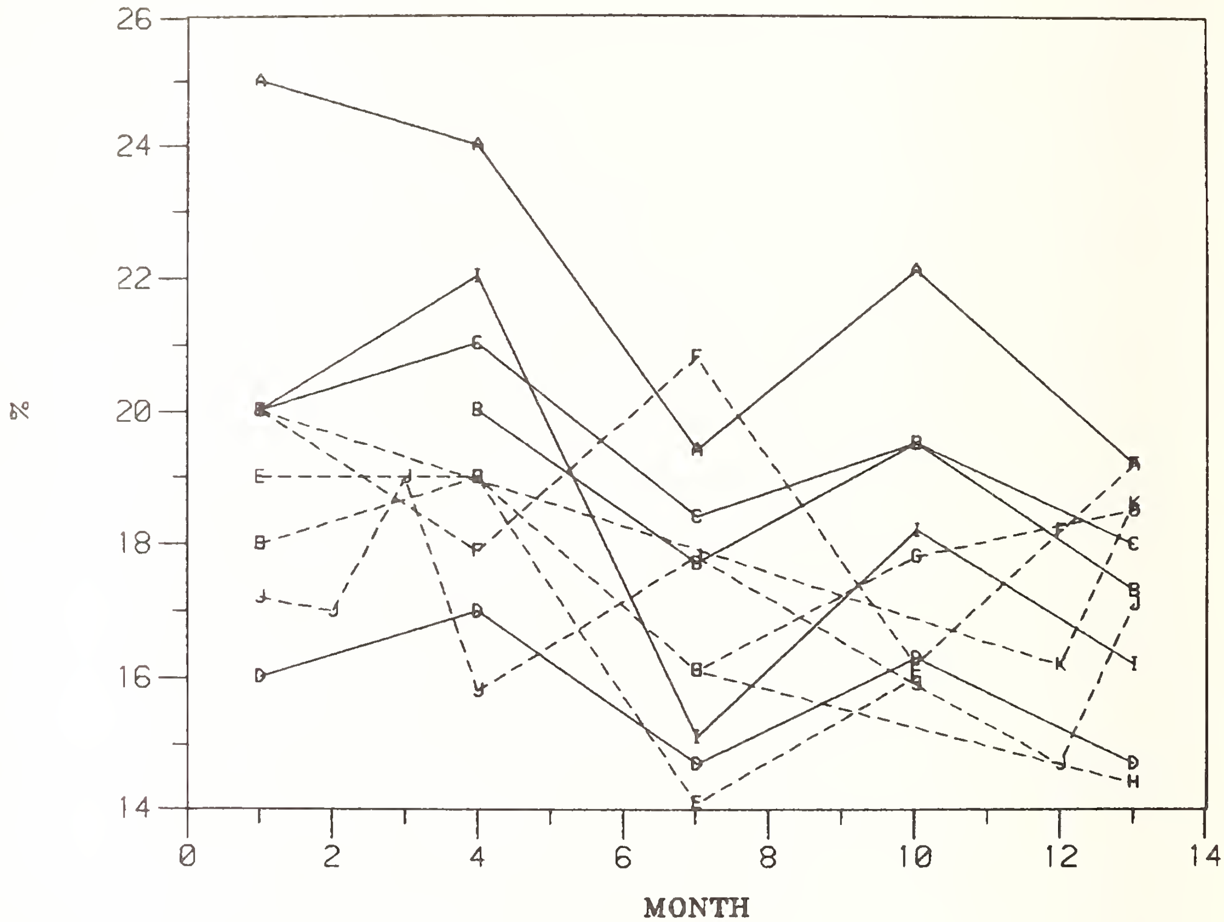
LABORATORY: U

DATE	VIRGIN BASESTOCK A	B	C	D	REF I	RE-REFINED BASESTOCKS E	F	G	H	J	K
MAR 80	25.0	-	20.0	16.0	20.0	19.0	20.0	18.0	18.0	17.2	20.0
APR 80	--	--	--	--	--	--	--	--	--	17.0	-
MAY 80	--	--	--	--	--	--	--	--	--	19.0	-
JUN 80	24.0	20.0	21.0	17.0	22.0	19.0	17.9	19.0	19.0	15.8	-
JUL 80	--	--	--	--	--	--	--	--	--	--	-
AUG 80	--	--	--	--	--	--	--	--	--	--	-
SEP 80	19.4	17.7	18.4	14.7	15.1	14.1	20.8	16.1	16.1	17.8	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	22.1	19.5	19.5	16.3	18.2	16.0	16.2	17.8	--	15.9	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	18.2	--	--	14.7	16.2
MAR 81	19.2	17.3	18.0	14.7	16.2	-	19.2	18.5	14.4	17.1	18.6
MEAN	21.94	18.62	19.38	15.74	18.30	17.02	18.72	17.88	16.87	16.81	18.27
STD.DEV.	2.63	1.33	1.21	1.02	2.79	2.41	1.64	1.10	2.04	1.33	1.92
MIN	19.2	17.3	18.0	14.7	15.1	14.1	16.2	16.1	14.4	14.7	16.2
MAX	25.0	20.0	21.0	17.0	22.0	19.0	20.8	19.0	19.0	19.0	20.0

LINEAR/TOTAL HC RATIO



LINEAR/TOTAL HC RATIO



ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: POLYISOBUTYLENE DERIVATIVES (%W/W) nmr SPECTROMETRY

LABORATORY: U

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	ND	-	ND	ND	ND	ND	.2	ND	.9	--	.4
APR 80	--	--	--	--	--	--	--	--	--	ND	-
MAY 80	--	--	--	--	--	--	--	--	--	ND	-
JUN 80	ND	ND	ND	ND	ND	ND	.3	ND	.9	--	-
JUL 80	--	--	--	--	--	--	--	--	--	--	-
AUG 80	--	--	--	--	--	--	--	--	--	--	-
SEP 80	ND	ND	ND	.4	ND	ND	ND	ND	1.1	ND	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	ND	ND	ND	ND	ND	ND	.05	ND	2.27	ND	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	ND	--	--	ND	.4
MAR 81	ND	ND	ND	ND	ND	-	.2	ND	1.6	ND	1.25
MEAN	ND	ND	ND	.40	ND	ND	.19	ND	1.35	ND	.68
STD.DEV.	ND	ND	ND	-	ND	ND	.10	ND	.59	ND	.49
MIN	ND	ND	ND	.40	ND	ND	.05	ND	.90	ND	.40
MAX	ND	ND	ND	.40	ND	ND	.30	ND	2.27	ND	1.25

VI

GENERAL PERFORMANCE TESTS

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: DEMULSIBILITY, TUBE 1 (MIN TO 3 mL EMULSION) ASTM D1401

LABORATORY: W

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	4.	-	7.	4.	>60.	>60.	>60.	7.	>60.	12.	>60.
APR 80	4.	8.	>60.	6.	>60.	>60.	>60.	>60.	>60.	12.	-
MAY 80	2.	12.	2.	26.	>60.	>60.	>60.	>60.	>60.	32.	-
JUN 80	5.	14.	3.	5.	>60.	>60.	>60.	>60.	>60.	6.	-
JUL 80	3.	18.	3.	5.	>60.	40.	>60.	13.	>60.	6.	-
AUG 80	7.	13.	2.	4.	>60.	25.	>60.	>60.	18.	45.	-
SEP 80	4.	10.	2.	6.	>60.	40.	>60.	>60.	18.	7.	-
OCT 80	4.	12.	6.	7.	>60.	7.	>60.	>60.	>60.	18.	-
NOV 80	3.	24.	5.	4.	>60.	5.	>60.	12.	>60.	>60.	-
DEC 80	10.	16.	5.	7.	>60.	>60.	>60.	>60.	>60.	13.	-
JAN 81	3.	12.	6.	6.	>60.	-	>60.	22.	>60.	7.	-
FEB 81	3.	22.	4.	5.	>60.	-	>60.	>60.	>60.	>60.	>60.
MAR 81	2.	>60.	7.	17.	>60.	-	>60.	>60.	>60.	11.	>60.
MEAN	4.2	18.4	8.6	7.8	>60.0	41.7	>60.0	45.7	53.5	22.2	>60.0
STD.DEV.	2.2	13.9	15.5	6.4	.0	22.4	.0	22.6	15.8	20.2	.0
MIN	2.	8.	2.	4.	>60.	5.	>60.	7.	18.	6.	>60.
MAX	10.	>60.	>60.	26.	>60.	>60.	>60.	>60.	>60.	>60.	>60.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: DEMULSIBILITY, TUBE 2 (MIN TO 3 mL OF EMULSION) ASTM D1401 LABORATORY: W

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	2.	-	7.	4.	>60.	>60.	>60.	8.	>60.	12.	>60.
APR 80	4.	14.	>60.	6.	>60.	>60.	>60.	>60.	>60.	14.	-
MAY 80	3.	12.	3.	26.	>60.	>60.	>60.	>60.	>60.	>60.	-
JUN 80	4.	17.	3.	7.	>60.	>60.	>60.	>60.	>60.	6.	-
JUL 80	3.	18.	7.	4.	>60.	42.	>60.	12.	>60.	6.	-
AUG 80	7.	14.	2.	4.	>60.	25.	>60.	>60.	>60.	45.	-
SEP 80	5.	8.	2.	8.	>60.	44.	>60.	>60.	18.	8.	-
OCT 80	3.	12.	6.	9.	>60.	8.	>60.	>60.	>60.	18.	-
NOV 80	4.	33.	5.	4.	>60.	5.	>60.	12.	>60.	>60.	-
DEC 80	9.	16.	5.	8.	>60.	>60.	>60.	>60.	>60.	13.	-
JAN 81	2.	17.	6.	10.	>60.	-	>60.	20.	>60.	8.	-
FEB 81	2.	24.	5.	5.	>60.	-	>60.	>60.	>60.	>60.	>60.
MAR 81	3.	>60.	8.	15.	>60.	-	>60.	>60.	>60.	11.	>60.
MEAN	3.9	20.4	9.2	8.5	>60.0	42.4	>60.0	45.5	56.8	24.7	>60.0
STD.DEV.	2.1	14.0	15.4	6.1	.0	22.2	.0	22.7	11.6	22.5	.0
MIN	2.	8.	2.	4.	>60.	5.	>60.	8.	18.	6.	>60.
MAX	9.	>60.	>60.	26.	>60.	>60.	>60.	>60.	>60.	>60.	>60.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: DEMULSIBILITY, TUBE 3 (MIN TO 3 mL OF EMULSION) ASTM D1401 LABORATORY: W

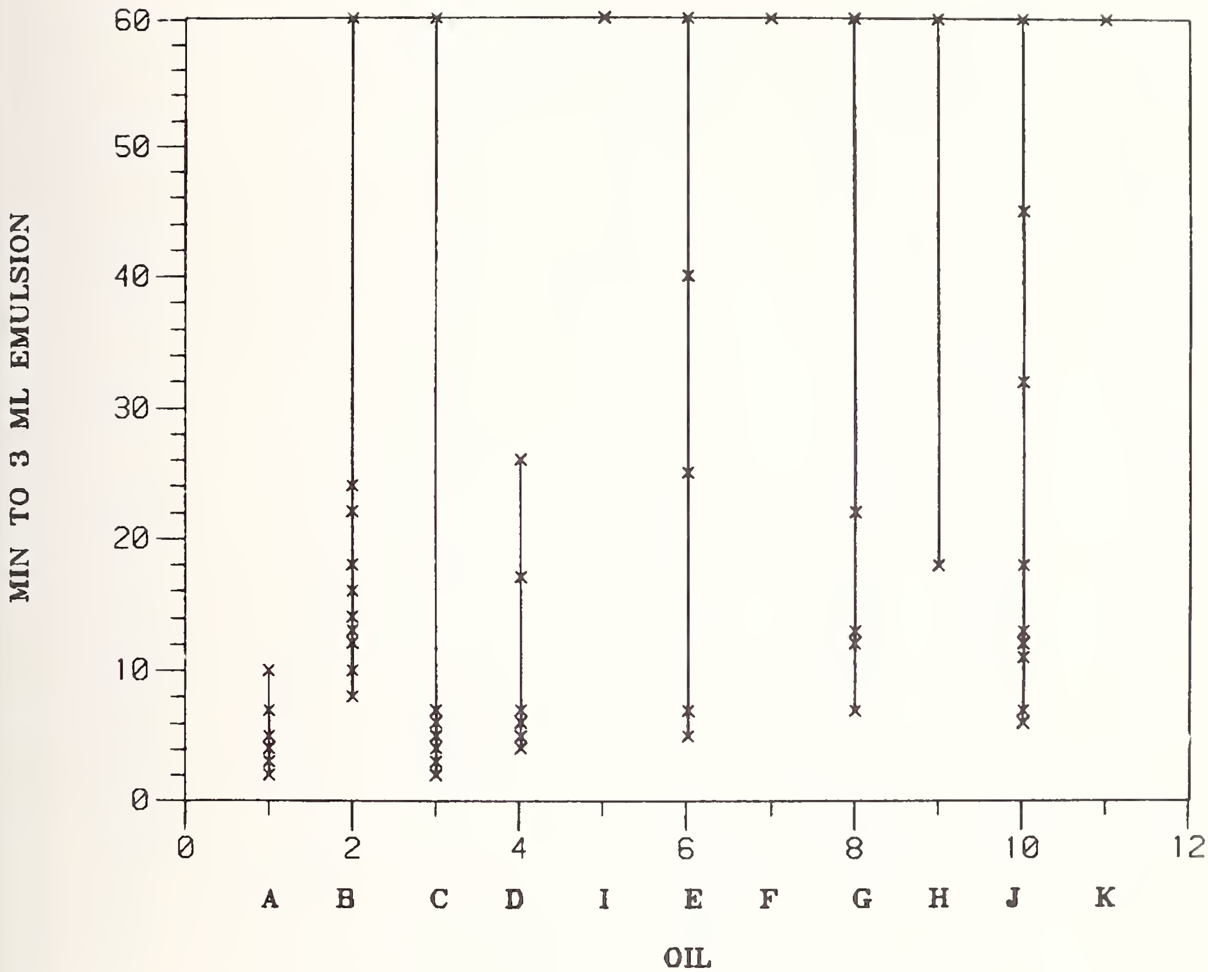
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	3.	-	9.	5.	>60.	>60.	>60.	6.	>60.	12.	>60.
APR 80	5.	12.	>60.	5.	>60.	>60.	>60.	>60.	>60.	13.	-
MAY 80	3.	12.	3.	26.	>60.	>60.	>60.	>60.	>60.	>60.	-
JUN 80	4.	16.	17.	5.	>60.	>60.	>60.	>60.	>60.	8.	-
JUL 80	4.	13.	4.	5.	>60.	48.	>60.	13.	>60.	8.	-
AUG 80	4.	16.	3.	6.	>60.	28.	>60.	>60.	>60.	42.	-
SEP 80	4.	10.	2.	8.	>60.	50.	>60.	>60.	20.	9.	-
OCT 80	4.	13.	7.	8.	>60.	7.	>60.	>60.	>60.	18.	-
NOV 80	4.	32.	5.	4.	>60.	5.	>60.	12.	>60.	>60.	-
DEC 80	9.	18.	5.	8.	>60.	>60.	>60.	>60.	>60.	13.	-
JAN 81	3.	14.	6.	6.	>60.	-	>60.	22.	>60.	8.	-
FEB 81	2.	26.	5.	5.	>60.	-	>60.	>60.	>60.	>60.	>60.
MAR 81	3.	>60.	7.	15.	>60.	-	>60.	>60.	>60.	11.	>60.
MEAN	4.0	20.2	10.2	8.2	>60.0	43.8	>60.0	45.6	56.9	24.8	>60.0
STD.DEV.	1.7	14.1	15.4	6.1	.0	22.3	.0	22.7	11.1	22.0	.0
MIN	2.	10.	2.	4.	>60.	5.	>60.	6.	20.	8.	>60.
MAX	9.	>60.	>60.	26.	>60.	>60.	>60.	>60.	>60.	>60.	>60.

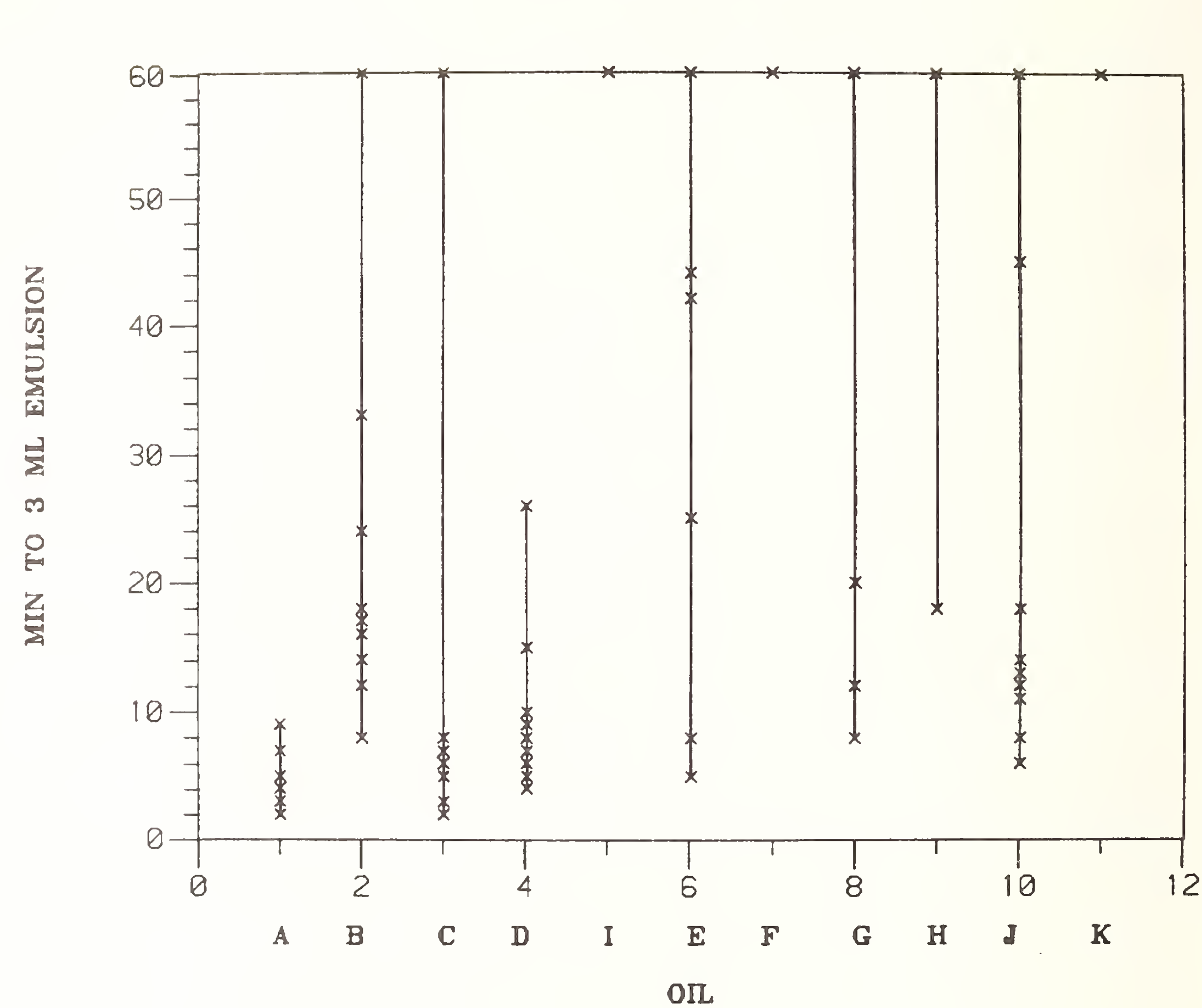
ASTM/NBS BASESTOCK CONSISTENCY STUDY

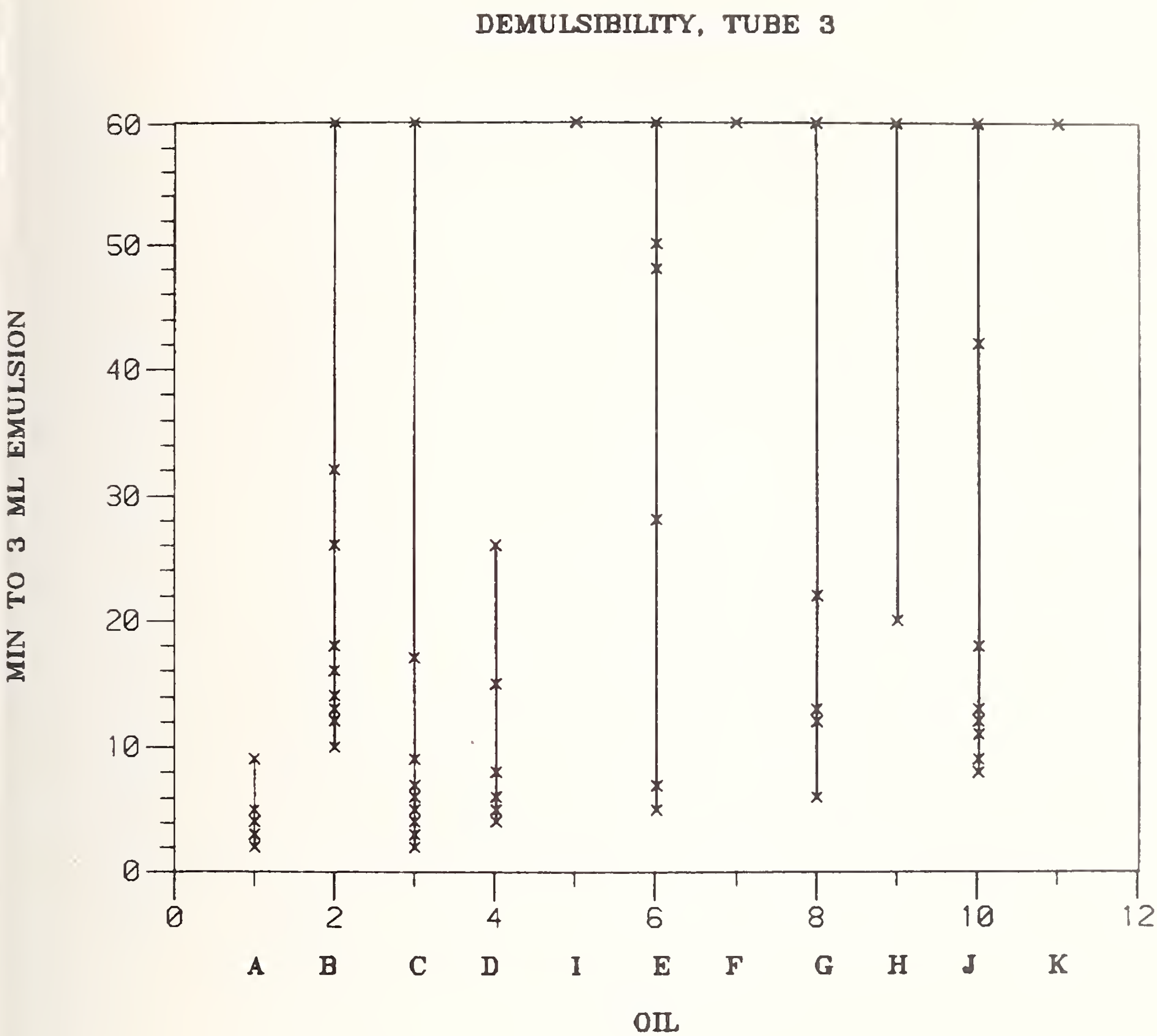
TEST: DEMULSIBILITY, TUBE 4 (MIN TO 3 mL OF EMULSION) ASTM D1401 LABORATORY: W

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	8.	-	6.	6.	11.	>60.	>60.	7.	>60.	12.	>60.
APR 80	8.	15.	>60.	6.	>60.	>60.	>60.	>60.	>60.	12.	-
MAY 80	3.	12.	3.	27.	>60.	>60.	>60.	>60.	>60.	>60.	-
JUN 80	4.	20.	3.	6.	>60.	>60.	>60.	>60.	>60.	8.	-
JUL 80	4.	15.	7.	5.	>60.	42.	>60.	15.	>60.	8.	-
AUG 80	4.	15.	3.	6.	>60.	28.	>60.	>60.	>60.	42.	-
SEP 80	6.	10.	3.	7.	>60.	48.	>60.	>60.	22.	10.	-
OCT 80	5.	12.	7.	9.	>60.	9.	>60.	>60.	>60.	18.	-
NOV 80	4.	32.	6.	3.	>60.	5.	>60.	12.	>60.	>60.	-
DEC 80	9.	17.	5.	7.	>60.	>60.	>60.	>60.	>60.	12.	-
JAN 81	3.	14.	6.	9.	>60.	-	>60.	23.	>60.	7.	-
FEB 81	2.	24.	5.	4.	>60.	-	>60.	>60.	>60.	>60.	>60.
MAR 81	4.	>60.	7.	13.	>60.	-	>60.	>60.	>60.	10.	>60.
MEAN	4.9	20.5	9.3	8.3	56.2	43.2	>60.0	45.9	57.1	24.5	>60.0
STD.DEV.	2.2	13.8	15.3	6.2	13.6	21.8	.0	22.2	10.5	22.1	.0
MIN	2.	10.	3.	3.	11.	5.	>60.	7.	22.	7.	>60.
MAX	9.	>60.	>60.	27.	>60.	>60.	>60.	>60.	>60.	>60.	>60.

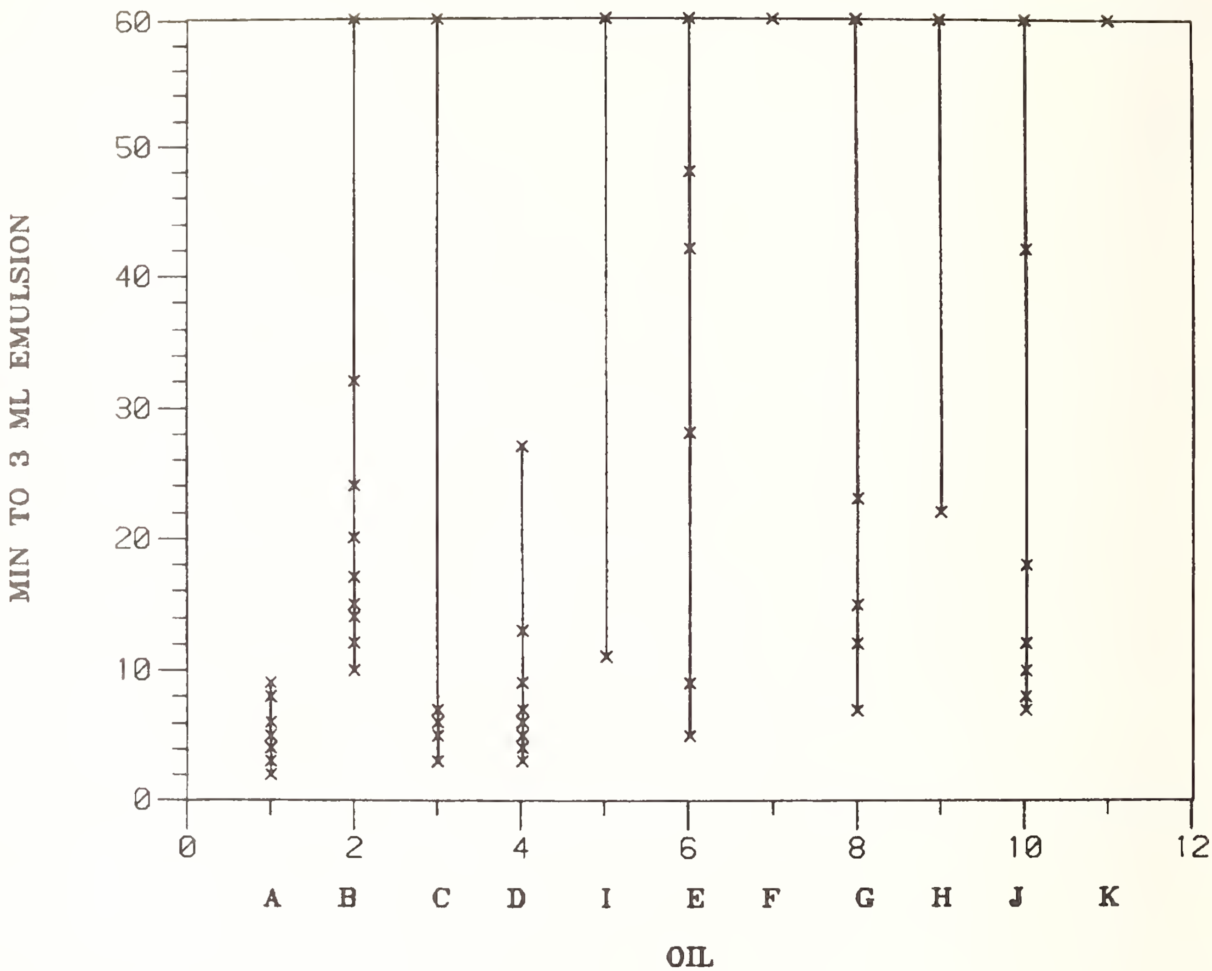
DEMULSIBILITY, TUBE 1



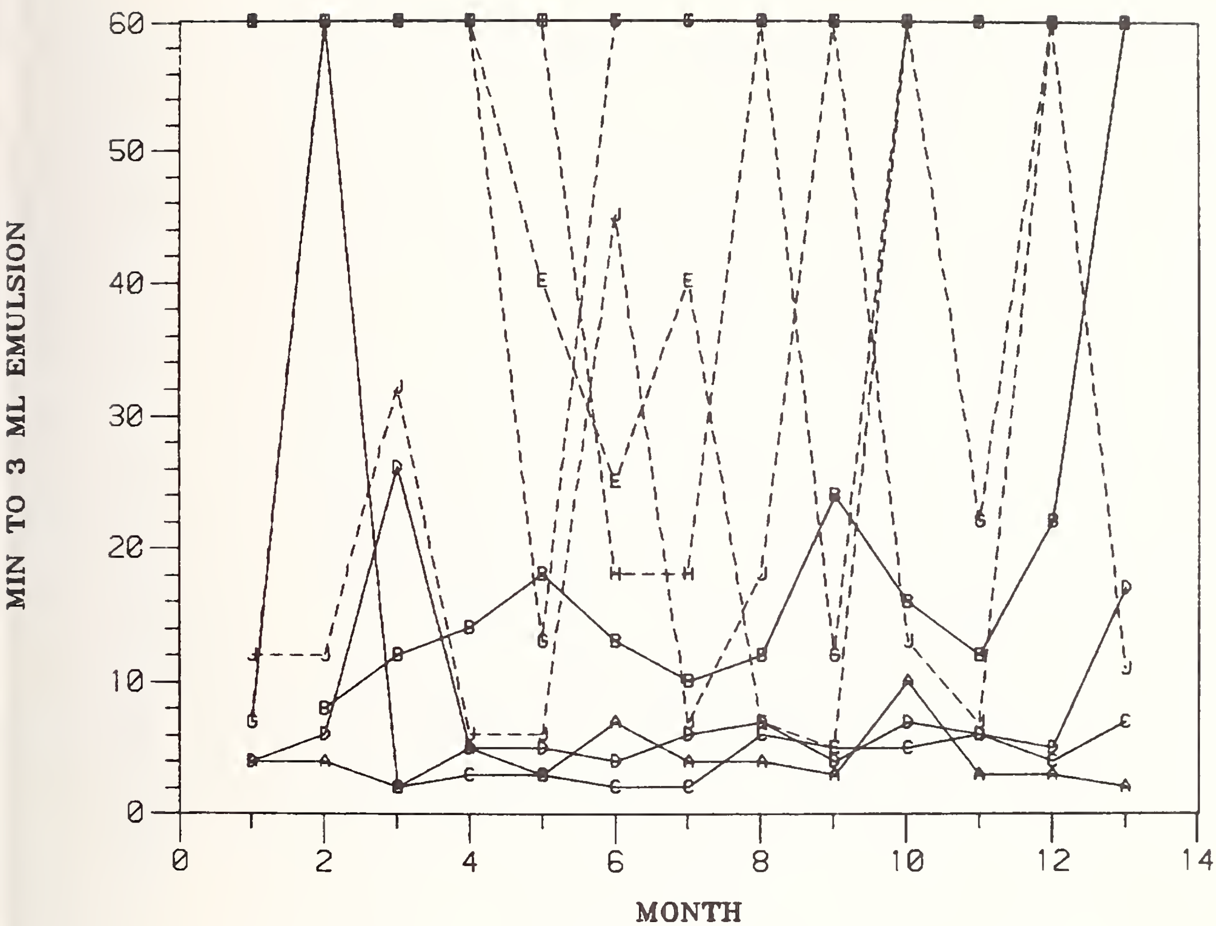

DEMULSIBILITY, TUBE 2
MIN TO 3 ML EMULSION
0
10
20
30
40
50
60
0
2
4
6
8
10
12
A B C D I E F G H J K
OIL


DEMULSIBILITY, TUBE 3
MIN TO 3 ML EMULSION
0
10
20
30
40
50
60
0
2
4
6
8
10
12
A
B
C
D
I
E
F
G
H
J
K
OIL

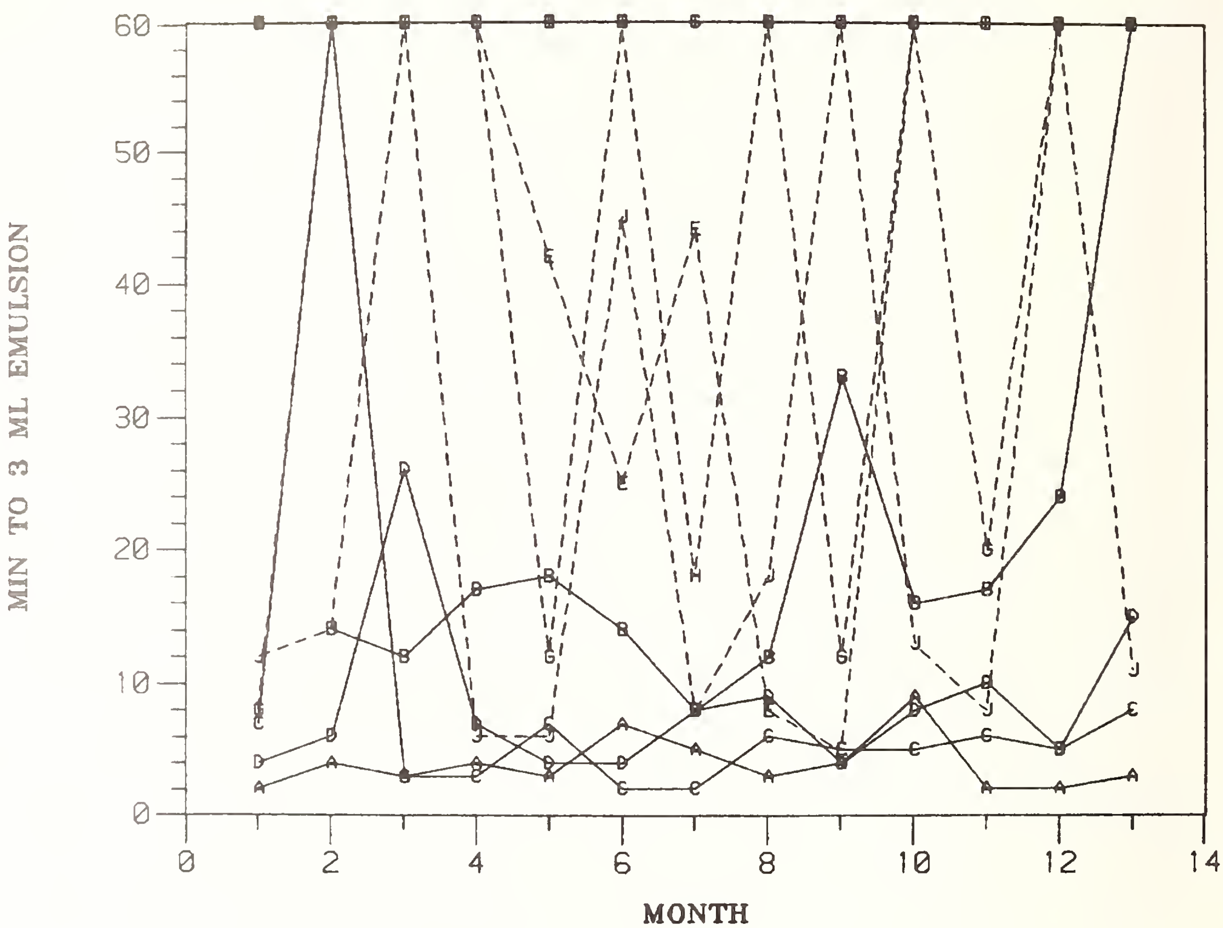
DEMULSIBILITY, TUBE 4



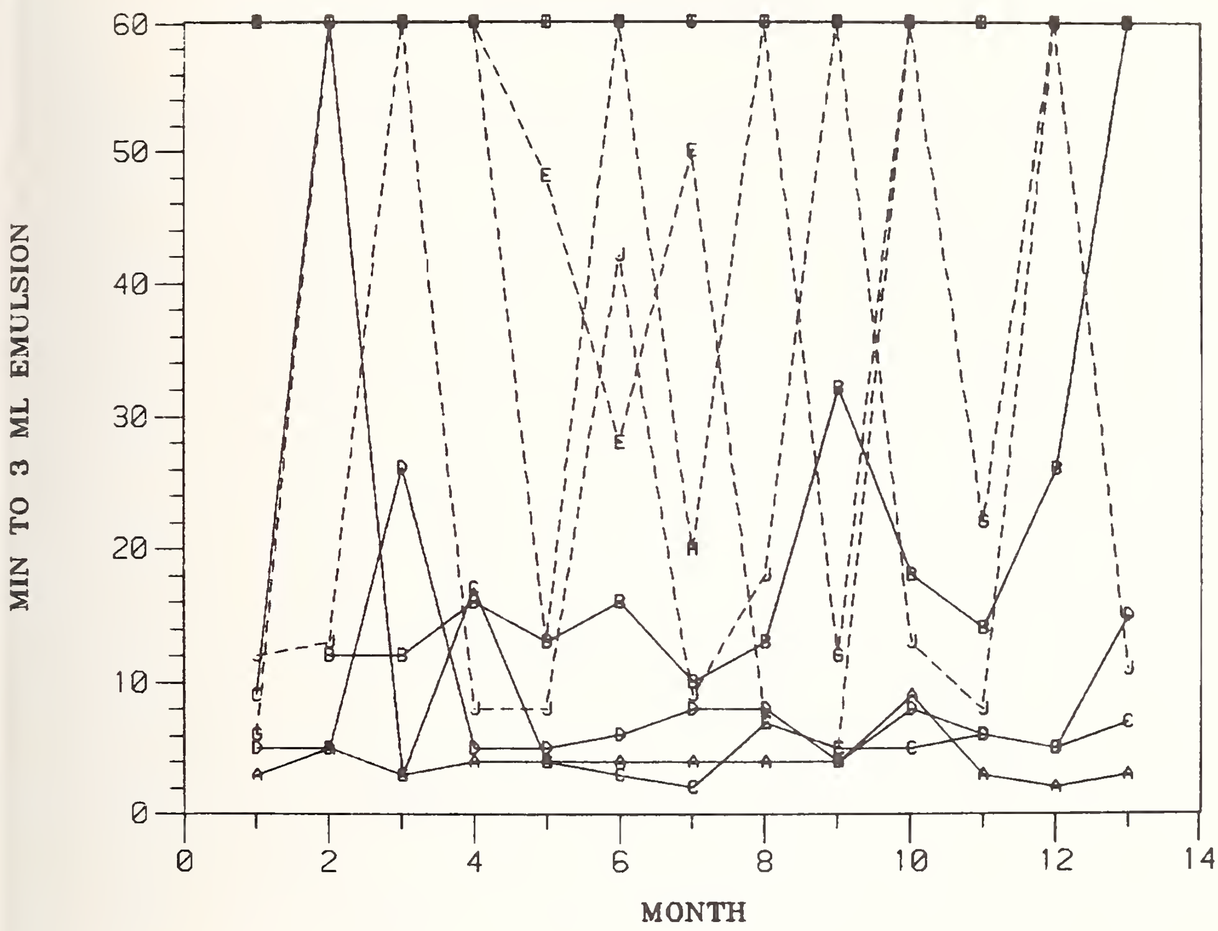
DEMULSIBILITY, TUBE 1



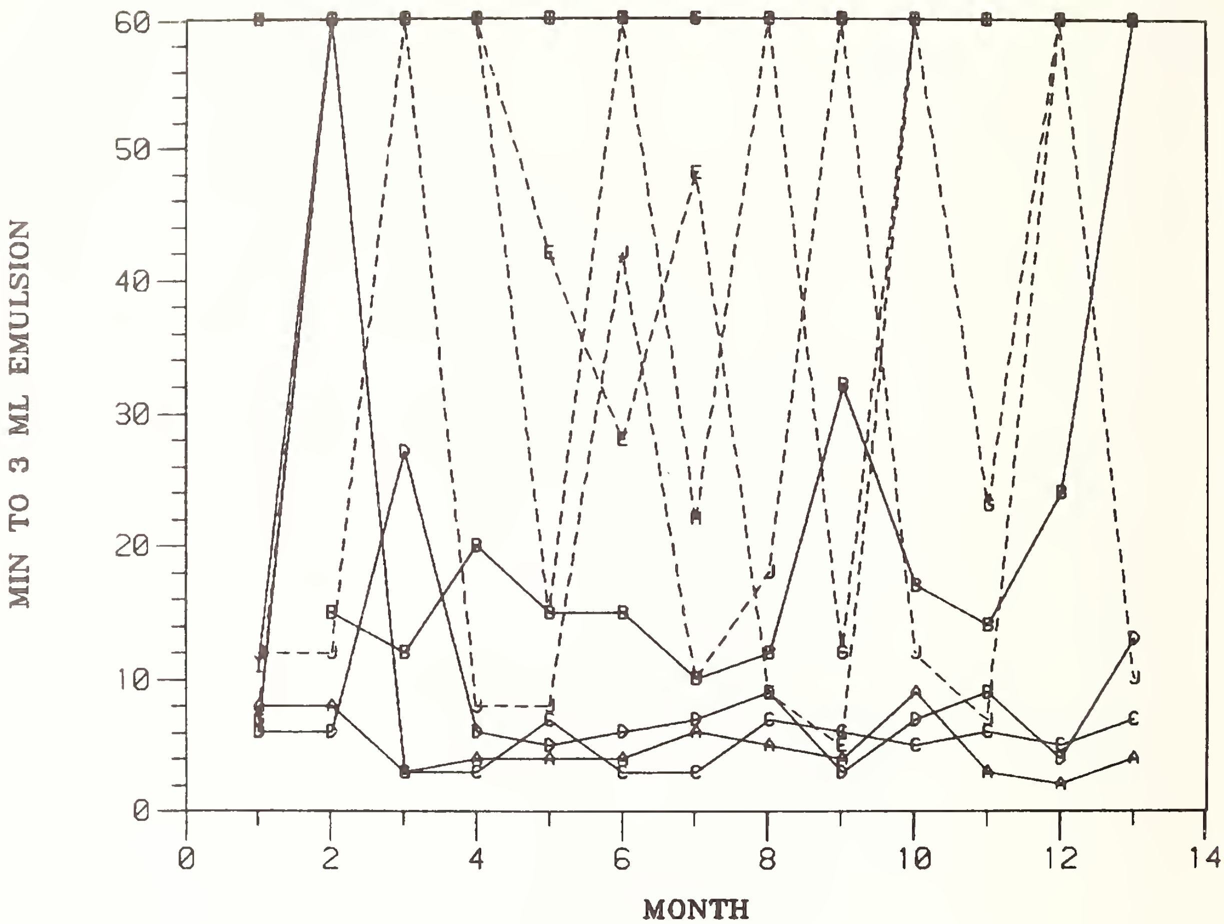
DEMULSIBILITY, TUBE 2



DEMULSIBILITY, TUBE 3



DEMULSIBILITY, TUBE 4



ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: DEMULSIBILITY, TUBE 1 (MIN TO 37 mL OF WATER) ASTM D1401 LABORATORY: W

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	4.	-	7.	6.	>60.	>60.	>60.	8.	>60.	12.	>60.
APR 80	4.	8.	4.	6.	>60.	>60.	>60.	>60.	>60.	12.	-
MAY 80	2.	12.	2.	26.	>60.	>60.	>60.	>60.	>60.	31.	-
JUN 80	5.	14.	3.	5.	>60.	>60.	>60.	>60.	>60.	6.	-
JUL 80	3.	18.	3.	5.	>60.	40.	>60.	13.	>60.	6.	-
AUG 80	7.	13.	2.	4.	>60.	25.	>60.	>60.	18.	45.	-
SEP 80	4.	10.	2.	6.	>60.	40.	>60.	>60.	18.	7.	-
OCT 80	4.	12.	6.	7.	>60.	7.	>60.	>60.	>60.	18.	-
NOV 80	3.	24.	5.	4.	>60.	5.	>60.	12.	>60.	>60.	-
DEC 80	10.	16.	5.	7.	>60.	>60.	>60.	>60.	>60.	13.	-
JAN 81	3.	12.	6.	6.	>60.	-	>60.	22.	>60.	7.	-
FEB 81	3.	22.	4.	5.	>60.	-	>60.	>60.	>60.	>60.	>60.
MAR 81	2.	>60.	8.	18.	>60.	-	>60.	>60.	>60.	11.	>60.
MEAN	4.2	18.4	4.4	8.1	>60.0	41.7	>60.0	45.8	53.5	22.2	>60.0
STD.DEV.	2.2	13.9	2.0	6.5	.0	22.4	.0	22.4	15.8	20.2	.0
MIN	2.	8.	2.	4.	>60.	5.	>60.	8.	18.	6.	>60.
MAX	10.	>60.	8.	26.	>60.	>60.	>60.	>60.	>60.	>60.	>60.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: DEMULSIBILITY, TUBE 2 (MIN TO 37 mL OF WATER) ASTM D1401 — LABORATORY: W

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	2.	-	7.	6.	>60.	>60.	>60.	9.	>60.	12.	>60.
APR 80	4.	14.	4.	6.	>60.	>60.	>60.	>60.	>60.	14.	-
MAY 80	3.	12.	3.	26.	>60.	>60.	>60.	>60.	>60.	23.	-
JUN 80	4.	17.	3.	7.	>60.	>60.	>60.	>60.	>60.	6.	-
JUL 80	3.	18.	7.	4.	>60.	42.	>60.	12.	>60.	6.	-
AUG 80	7.	14.	2.	4.	>60.	25.	>60.	>60.	>60.	45.	-
SEP 80	5.	8.	2.	8.	>60.	44.	>60.	>60.	18.	8.	-
OCT 80	3.	12.	6.	9.	>60.	8.	>60.	>60.	>60.	18.	-
NOV 80	3.	33.	5.	4.	>60.	5.	>60.	12.	>60.	>60.	-
DEC 80	9.	16.	5.	8.	>60.	>60.	>60.	>60.	>60.	13.	-
JAN 81	2.	17.	6.	10.	>60.	-	>60.	20.	>60.	8.	-
FEB 81	2.	24.	5.	5.	>60.	-	>60.	>60.	>60.	>60.	>60.
MAR 81	3.	>60.	9.	16.	>60.	-	>60.	>60.	>60.	11.	>60.
MEAN	3.8	20.4	4.9	8.7	>60.0	42.4	>60.0	45.6	56.8	21.8	>60.0
STD.DEV.	2.1	14.0	2.1	6.1	.0	22.2	.0	22.6	11.6	19.8	.0
MIN	2.	8.	2.	4.	>60.	5.	>60.	9.	18.	6.	>60.
MAX	9.	>60.	9.	26.	>60.	>60.	>60.	>60.	>60.	>60.	>60.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

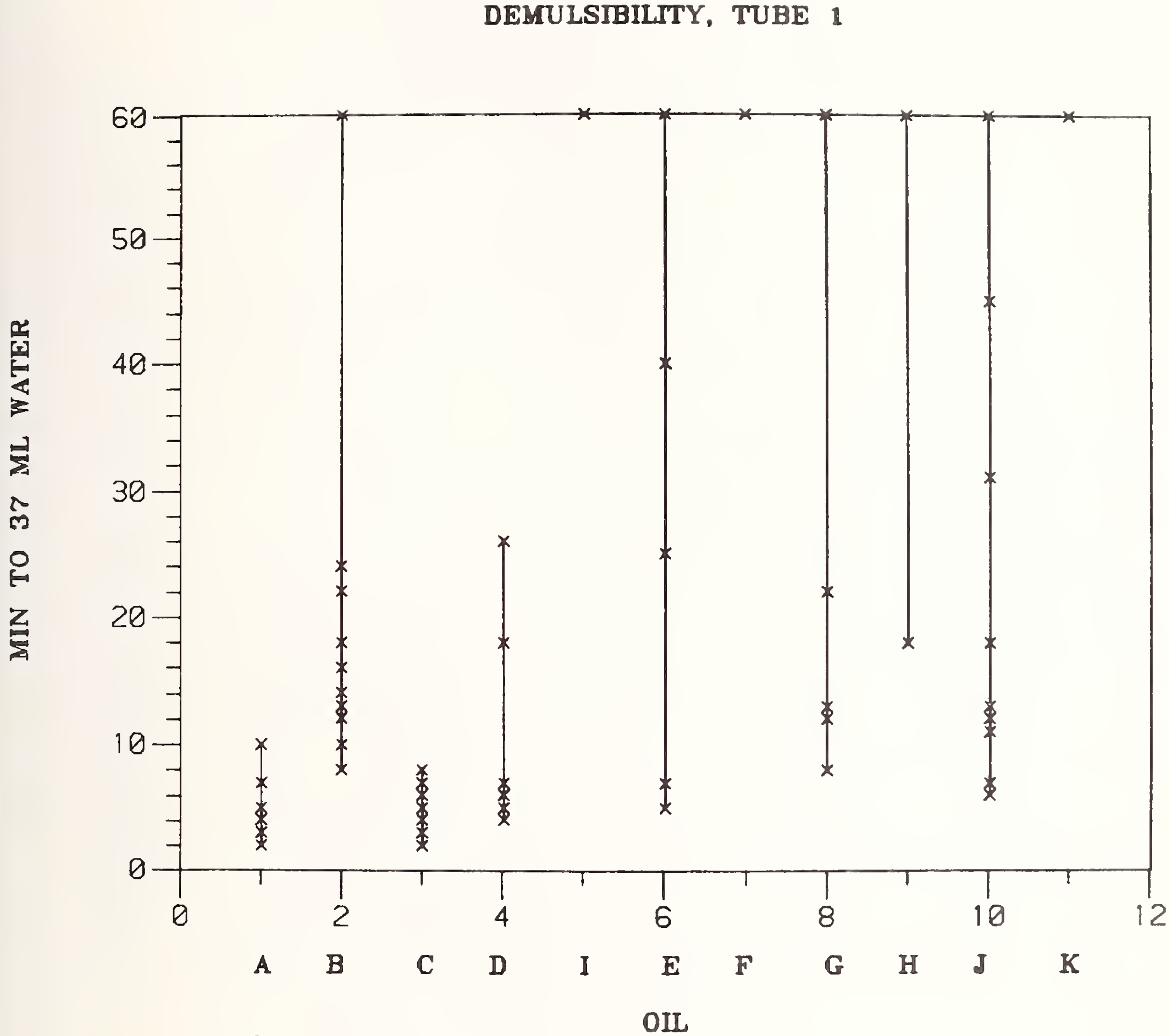
TEST: DEMULSIBILITY, TUBE 3 (MIN TO 37 mL OF WATER) ASTM D1401 LABORATORY: W

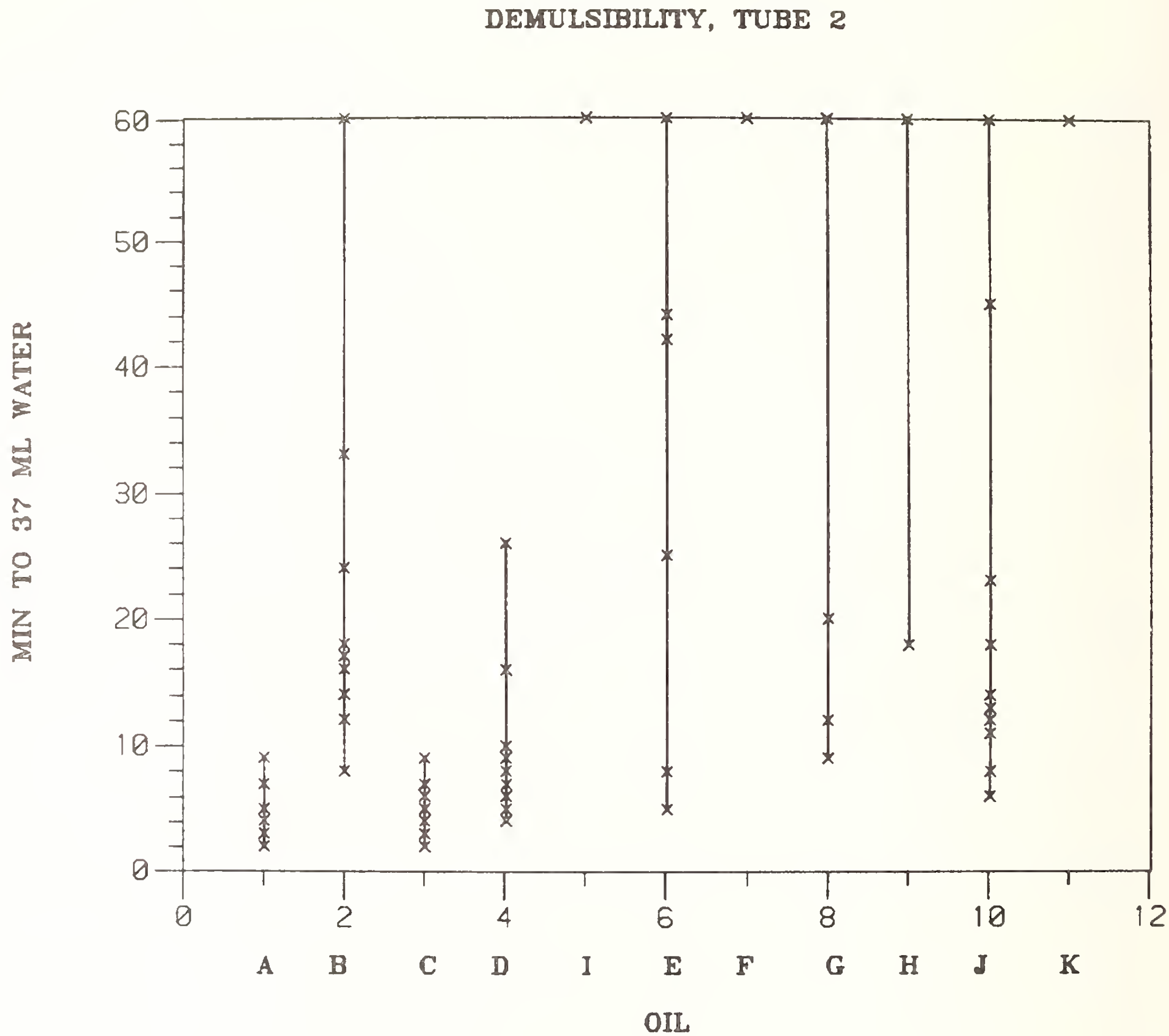
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	2.	-	9.	9.	>60.	>60.	>60.	7.	>60.	12.	>60.
APR 80	5.	12.	5.	5.	>60.	>60.	>60.	>60.	>60.	13.	-
MAY 80	3.	12.	3.	26.	>60.	>60.	>60.	>60.	>60.	21.	-
JUN 80	4.	16.	17.	5.	>60.	>60.	>60.	>60.	>60.	7.	-
JUL 80	4.	13.	4.	5.	>60.	48.	>60.	13.	>60.	8.	-
AUG 80	4.	16.	3.	6.	>60.	28.	>60.	>60.	>60.	42.	-
SEP 80	4.	10.	2.	8.	>60.	50.	>60.	>60.	20.	9.	-
OCT 80	4.	13.	7.	8.	>60.	7.	>60.	>60.	>60.	18.	-
NOV 80	4.	32.	5.	4.	>60.	5.	>60.	12.	>60.	>60.	-
DEC 80	9.	18.	5.	8.	>60.	>60.	>60.	>60.	>60.	13.	-
JAN 81	3.	14.	6.	6.	>60.	-	>60.	22.	>60.	8.	-
FEB 81	2.	26.	5.	5.	>60.	-	>60.	>60.	>60.	>60.	>60.
MAR 81	3.	>60.	6.	18.	>60.	-	>60.	>60.	>60.	11.	>60.
MEAN	3.9	20.2	5.9	8.7	>60.0	43.8	>60.0	45.7	56.9	21.7	>60.0
STD.DEV.	1.8	14.1	3.8	6.3	.0	22.3	.0	22.6	11.1	19.3	.0
MIN	2.	10.	2.	4.	>60.	5.	>60.	7.	20.	7.	>60.
MAX	9.	>60.	17.	26.	>60.	>60.	>60.	>60.	>60.	>60.	>60.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: DEMULSIBILITY, TUBE 4 (MIN TO 37 mL OF WATER) ASTM D1401 LABORATORY: W

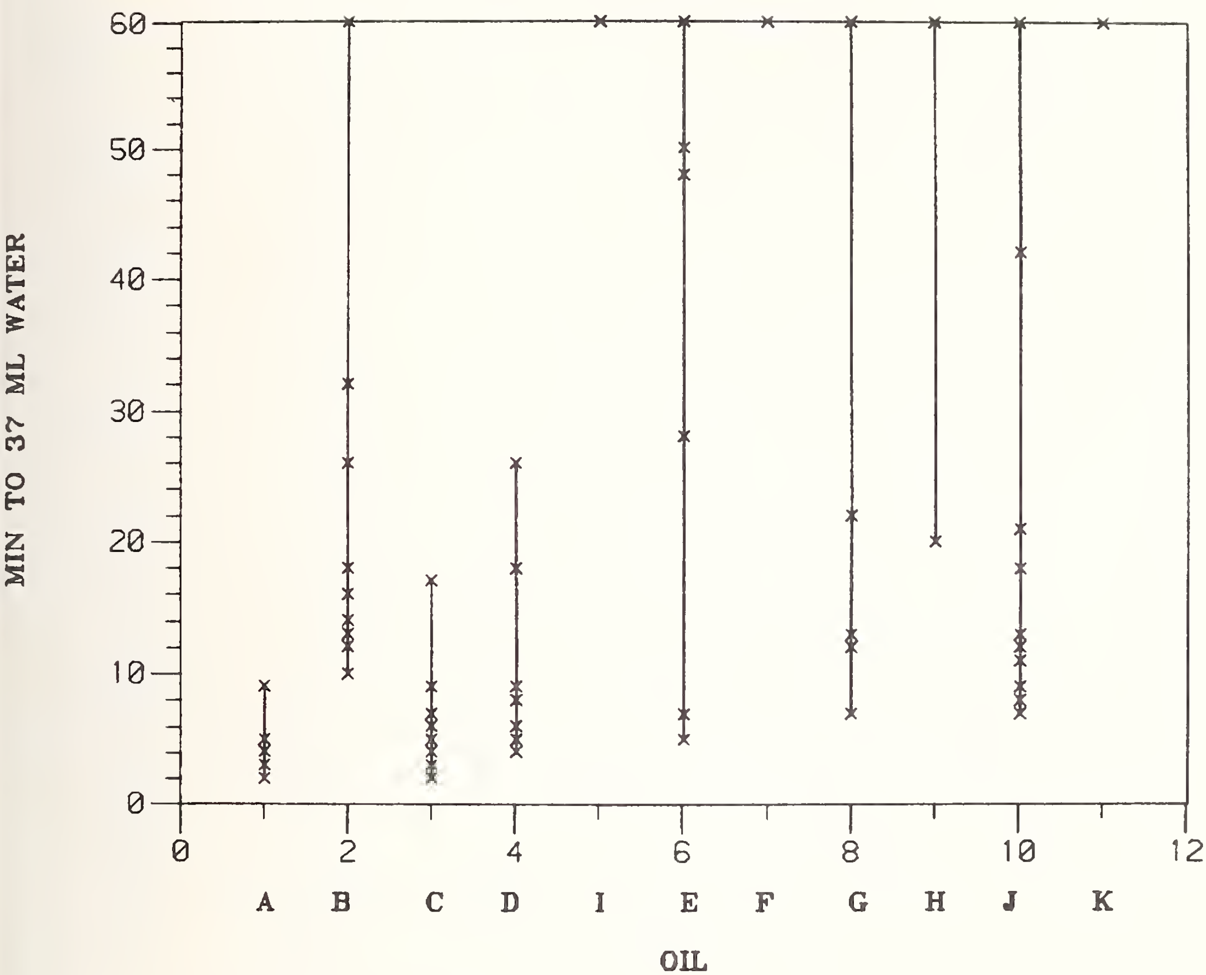
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	7.	-	6.	10.	8.	>60.	>60.	8.	>60.	12.	>60.
APR 80	8.	15.	5.	6.	>60.	>60.	>60.	>60.	>60.	12.	-
MAY 80	3.	12.	3.	27.	>60.	>60.	>60.	>60.	>60.	24.	-
JUN 80	4.	20.	3.	6.	>60.	>60.	>60.	>60.	>60.	7.	-
JUL 80	4.	15.	7.	5.	>60.	42.	>60.	15.	>60.	8.	-
AUG 80	4.	15.	3.	6.	>60.	28.	>60.	>60.	>60.	42.	-
SEP 80	6.	10.	3.	7.	>60.	48.	>60.	>60.	22.	10.	-
OCT 80	5.	12.	7.	9.	>60.	9.	>60.	>60.	>60.	18.	-
NOV 80	4.	32.	6.	3.	>60.	5.	>60.	12.	>60.	>60.	-
DEC 80	9.	17.	5.	7.	>60.	>60.	>60.	>60.	>60.	12.	-
JAN 81	3.	14.	6.	9.	>60.	-	>60.	23.	>60.	7.	-
FEB 81	2.	24.	5.	4.	>60.	-	>60.	>60.	>60.	>60.	>60.
MAR 81	4.	>60.	8.	15.	>60.	-	>60.	>60.	>60.	10.	>60.
MEAN	4.8	20.5	5.2	8.8	56.0	43.2	>60.0	46.0	57.1	21.7	>60.0
STD.DEV.	2.1	13.8	1.7	6.3	14.4	21.8	.0	22.1	10.5	19.5	.0
MIN	2.	10.	3.	3.	8.	5.	>60.	8.	22.	7.	>60.
MAX	9.	>60.	8.	27.	>60.	>60.	>60.	>60.	>60.	>60.	>60.


DEMULSIBILITY, TUBE 1
MIN TO 37 ML WATER
60
50
40
30
20
10
0
0
2
4
6
8
10
12
A B C D I E F G H J K
OIL

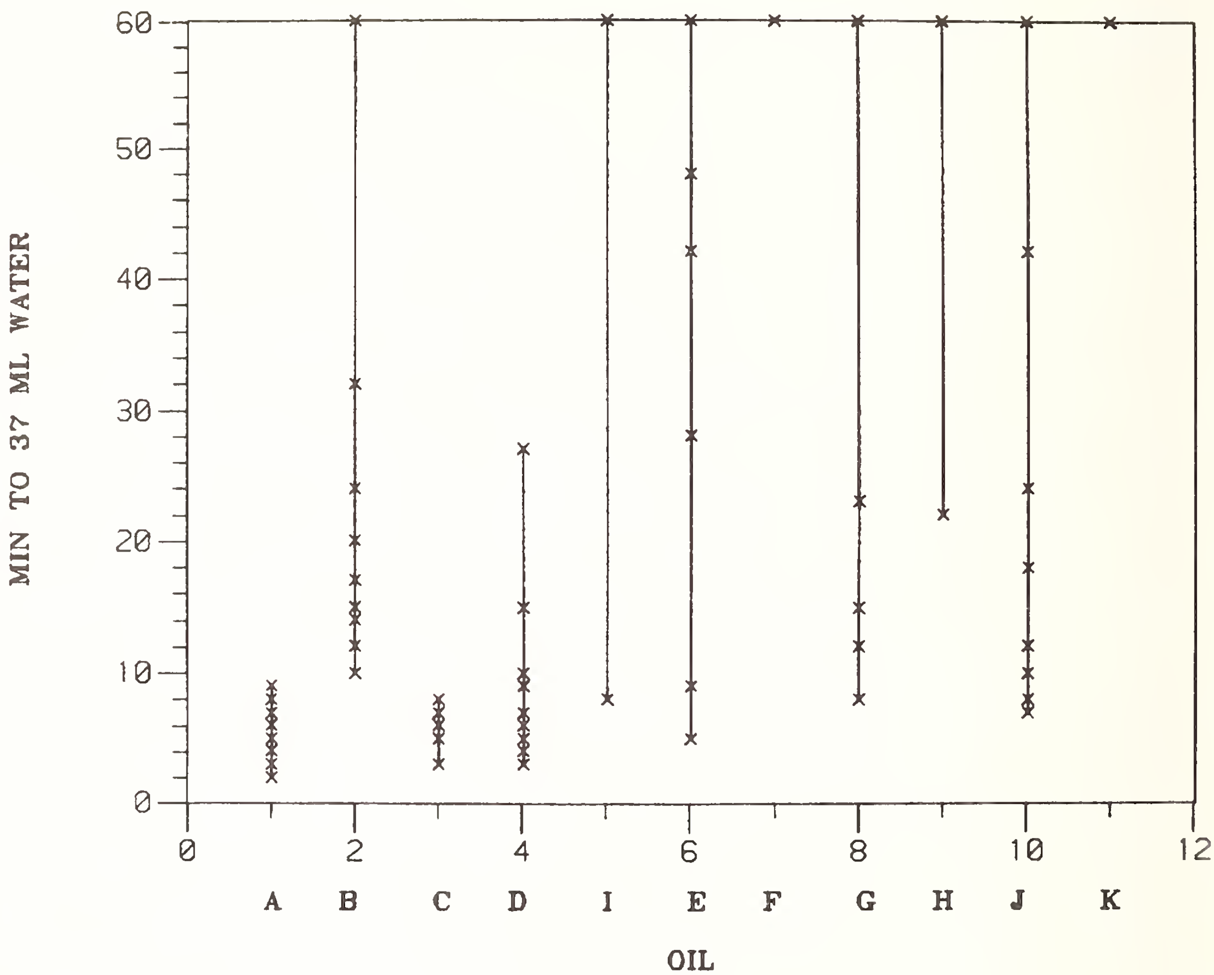


DEMULSIBILITY, TUBE 2
MIN TO 37 ML WATER
0
10
20
30
40
50
60
0
2
4
6
8
10
12
A B C D I E F G H J K
OIL

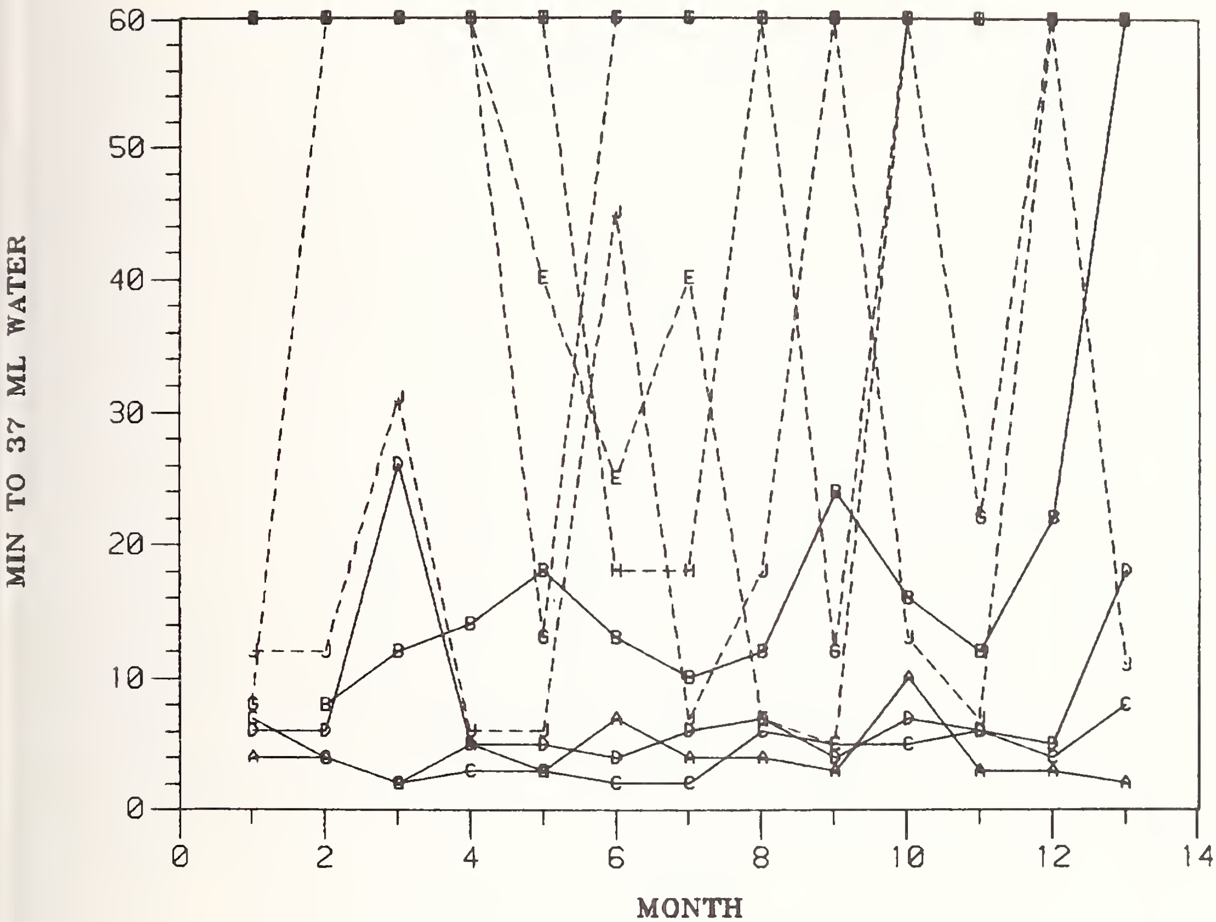
DEMULSIBILITY, TUBE 3



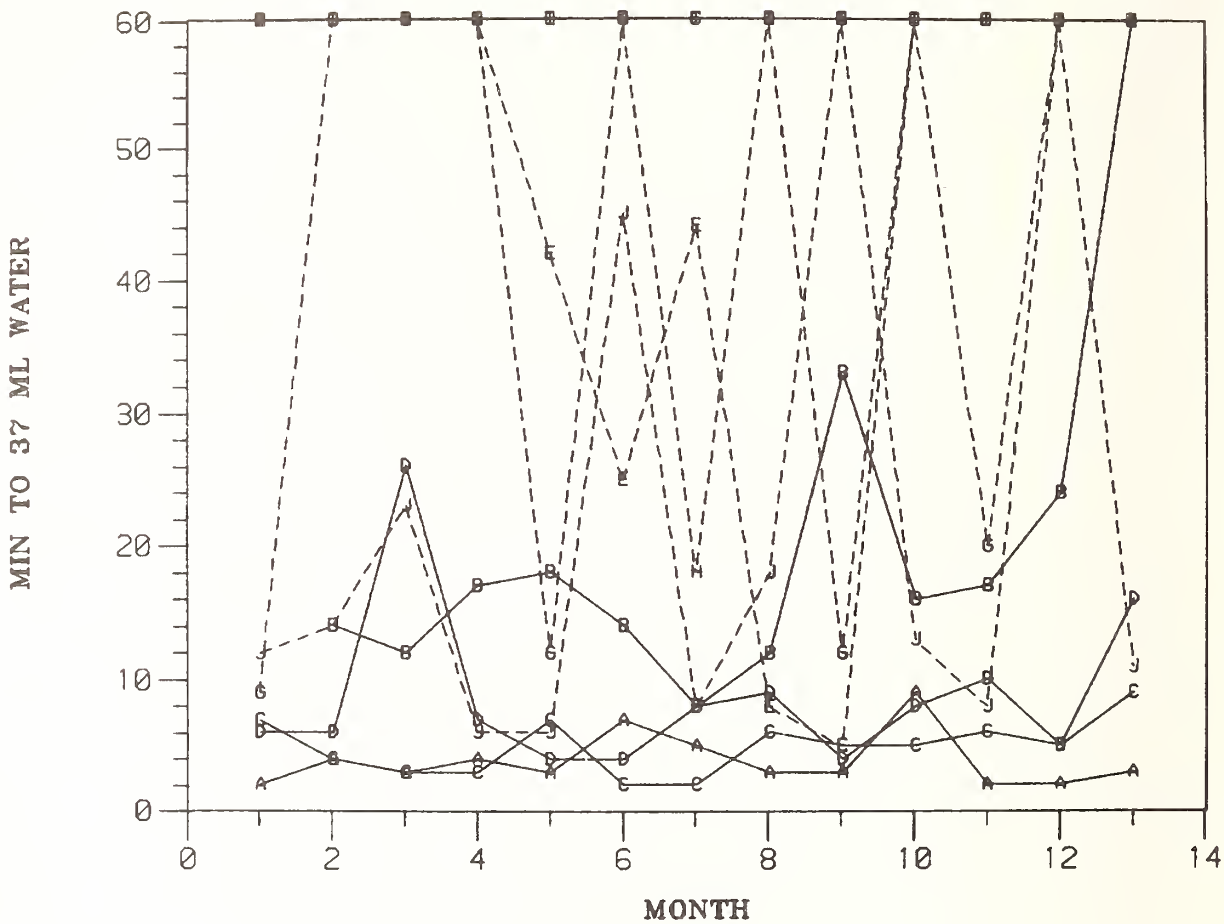
DEMULSIBILITY, TUBE 4



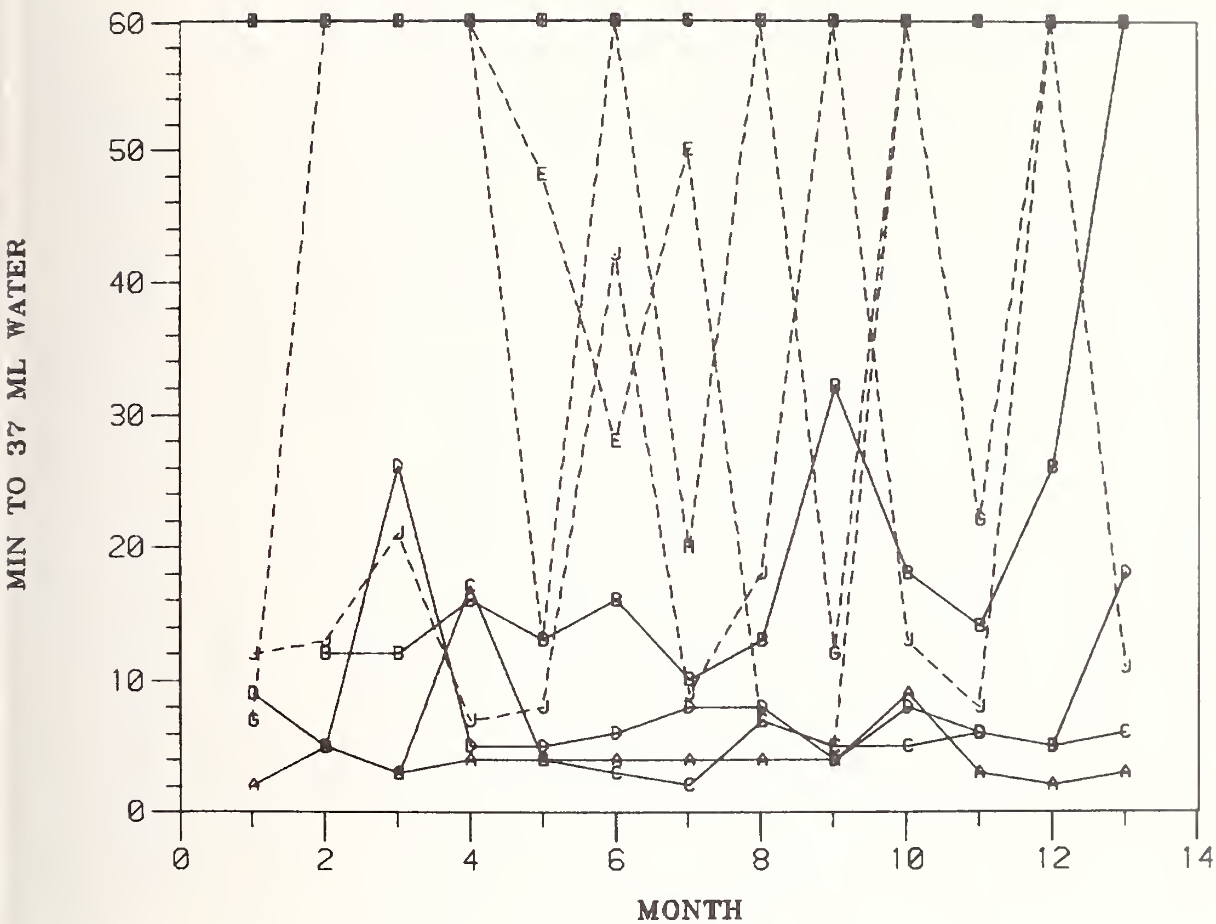
DEMULSIBILITY, TUBE 1



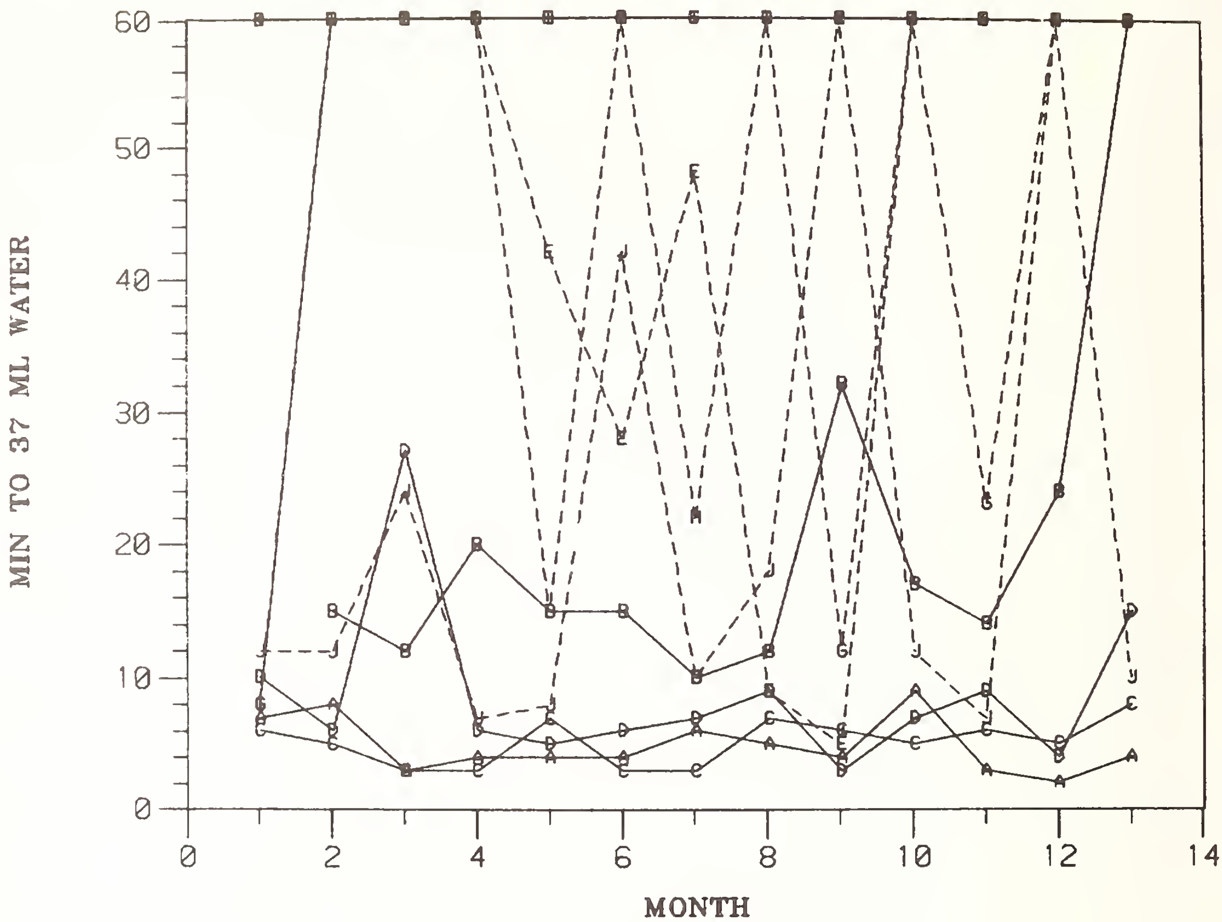
DEMULSIBILITY, TUBE 2



DEMULSIBILITY, TUBE 3



DEMULSIBILITY, TUBE 4



ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: DEMULSIBILITY, TUBE 1 (MIN TO BREAK) ASTM D1401 LABORATORY: W

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	5.	-	9.	6.	>60.	>60.	>60.	8.	>60.	14.	>60.
APR 80	7.	10.	>60.	9.	>60.	>60.	>60.	>60.	>60.	18.	-
MAY 80	3.	14.	3.	29.	>60.	>60.	>60.	>60.	>60.	>60.	-
JUN 80	6.	16.	4.	6.	>60.	>60.	>60.	>60.	>60.	8.	-
JUL 80	4.	24.	5.	8.	>60.	>60.	>60.	15.	>60.	9.	-
AUG 80	9.	25.	4.	7.	>60.	43.	>60.	>60.	>60.	>60.	-
SEP 80	6.	12.	4.	8.	>60.	>60.	>60.	>60.	>60.	9.	-
OCT 80	6.	15.	7.	18.	>60.	10.	>60.	>60.	>60.	27.	-
NOV 80	4.	35.	6.	5.	>60.	6.	>60.	13.	>60.	>60.	-
DEC 80	19.	21.	6.	8.	>60.	>60.	>60.	>60.	>60.	15.	-
JAN 81	5.	48.	7.	7.	>60.	-	>60.	24.	>60.	9.	-
FEB 81	5.	34.	7.	9.	>60.	-	>60.	>60.	>60.	>60.	>60.
MAR 81	3.	>60.	>60.	> 60.	>60.	-	>60.	>60.	>60.	13.	>60.
MEAN	6.3	26.2	14.0	13.8	>60.0	47.9	>60.0	46.2	>60.0	27.8	>60.0
STD.DEV.	4.2	15.5	20.5	15.4	.0	21.7	.0	21.9	.0	22.9	.0
MIN	3.	10.	3.	5.	>60.	6.	>60.	8.	>60.	8.	>60.
MAX	19.	>60.	>60.	>60.	>60.	>60.	>60.	>60.	>60.	>60.	>60.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: DEMULSIBILITY,TUBE 2 (MIN TO BREAK) ASTM D1401 LABORATORY: W

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	3.	-	9.	6.	>60.	>60.	>60.	9.	>60.	15.	>60.
APR 80	6.	23.	>60.	12.	>60.	>60.	>60.	>60.	>60.	19.	-
MAY 80	4.	14.	4.	29.	>60.	>60.	>60.	>60.	>60.	>60.	-
JUN 80	5.	20.	4.	8.	>60.	>60.	>60.	>60.	>60.	8.	-
JUL 80	4.	26.	8.	6.	>60.	>60.	>60.	14.	>60.	9.	-
AUG 80	9.	24.	4.	7.	>60.	43.	>60.	>60.	>60.	>60.	-
SEP 80	7.	10.	4.	10.	>60.	>60.	>60.	>60.	>60.	9.	-
OCT 80	6.	14.	7.	18.	>60.	10.	>60.	>60.	>60.	27.	-
NOV 80	5.	>60.	6.	5.	>60.	6.	>60.	13.	>60.	>60.	-
DEC 80	18.	21.	6.	10.	>60.	>60.	>60.	>60.	>60.	15.	-
JAN 81	4.	50.	7.	11.	>60.	-	>60.	22.	>60.	10.	-
FEB 81	4.	36.	8.	8.	>60.	-	>60.	>60.	>60.	>60.	>60.
MAR 81	4.	>60.	>60.	>60.	>60.	-	>60.	>60.	>60.	13.	>60.
MEAN	6.1	29.8	14.4	14.6	>60.0	47.9	>60.0	46.0	>60.0	28.1	>60.0
STD.DEV.	3.9	17.7	20.3	15.1	.0	21.7	.0	22.0	.0	22.7	.0
MIN	3.	10.	4.	5.	>60.	6.	>60.	9.	>60.	8.	>60.
MAX	18.	>60.	>60.	>60.	>60.	>60.	>60.	>60.	>60.	>60.	>60.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: DEMULSIBILITY,TUBE 3 (MIN TO BREAK) ASTM D1401 LABORATORY: W

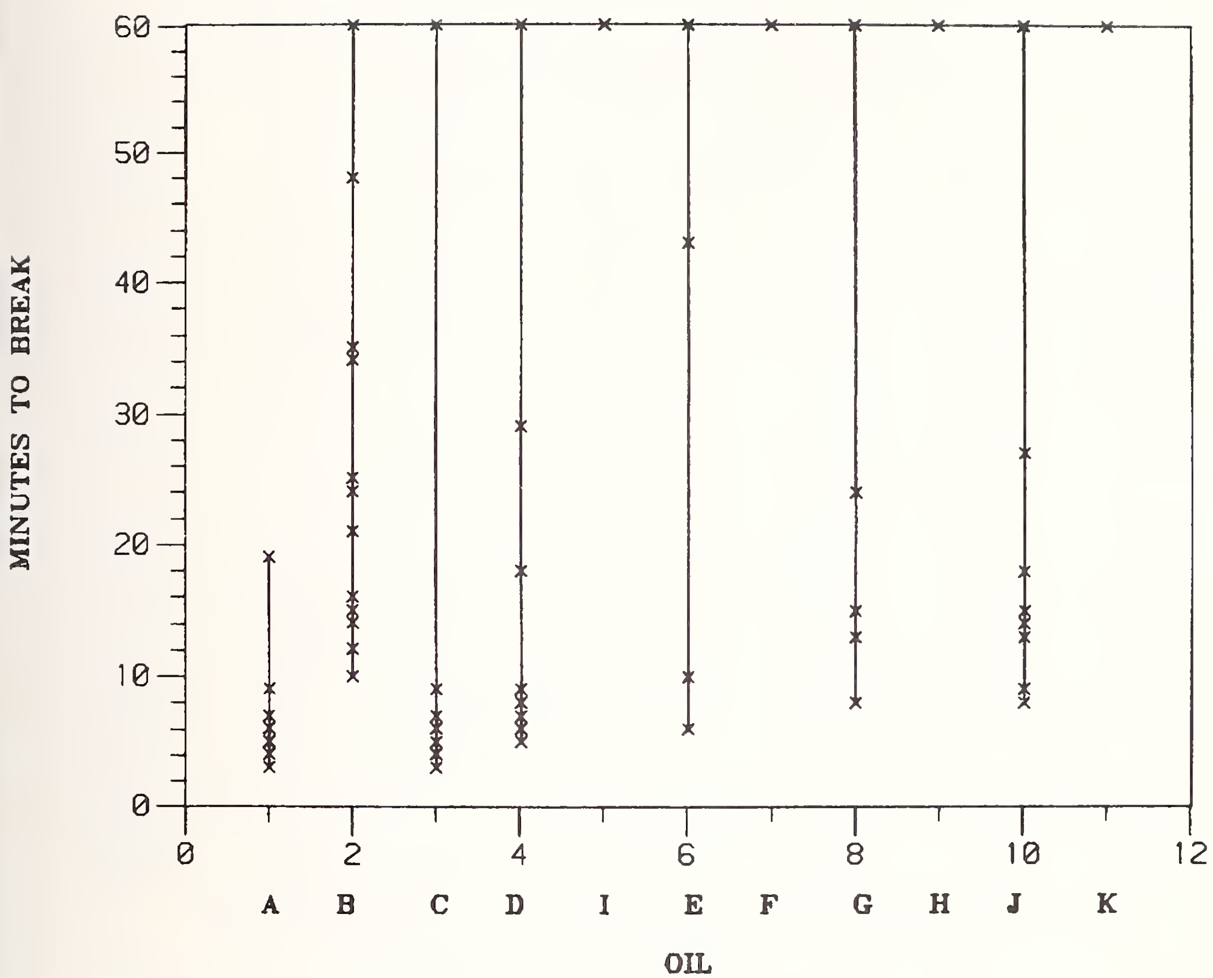
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	4.	-	15.	10.	>60.	>60.	>60.	7.	>60.	15.	>60.
APR 80	6.	20.	>60.	7.	>60.	>60.	>60.	>60.	>60.	18.	-
MAY 80	4.	14.	4.	29.	>60.	>60.	>60.	>60.	>60.	>60.	-
JUN 80	5.	26.	21.	7.	>60.	>60.	>60.	>60.	>60.	9.	-
JUL 80	5.	20.	5.	7.	>60.	>60.	>60.	15.	>60.	10.	-
AUG 80	6.	27.	5.	9.	>60.	47.	>60.	>60.	>60.	>60.	-
SEP 80	6.	12.	4.	10.	>60.	>60.	>60.	>60.	>60.	10.	-
OCT 80	7.	16.	8.	18.	>60.	10.	>60.	>60.	>60.	27.	-
NOV 80	5.	36.	7.	5.	>60.	6.	>60.	13.	>60.	>60.	-
DEC 80	18.	23.	6.	10.	>60.	>60.	>60.	>60.	>60.	15.	-
JAN 81	5.	53.	7.	7.	>60.	-	>60.	24.	>60.	10.	-
FEB 81	4.	40.	8.	8.	>60.	-	>60.	>60.	>60.	>60.	>60.
MAR 81	4.	>60.	>60.	>60.	>60.	-	>60.	>60.	>60.	13.	>60.
MEAN	6.1	28.9	16.2	14.4	>60.0	48.3	>60.0	46.1	>60.0	28.2	>60.0
STD.DEV.	3.7	15.4	20.0	15.1	.0	21.6	.0	22.0	.0	22.5	.0
MIN	4.	12.	4.	5.	>60.	6.	>60.	7.	>60.	9.	>60.
MAX	18.	>60.	>60.	>60.	>60.	>60.	>60.	>60.	>60.	>60.	>60.

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

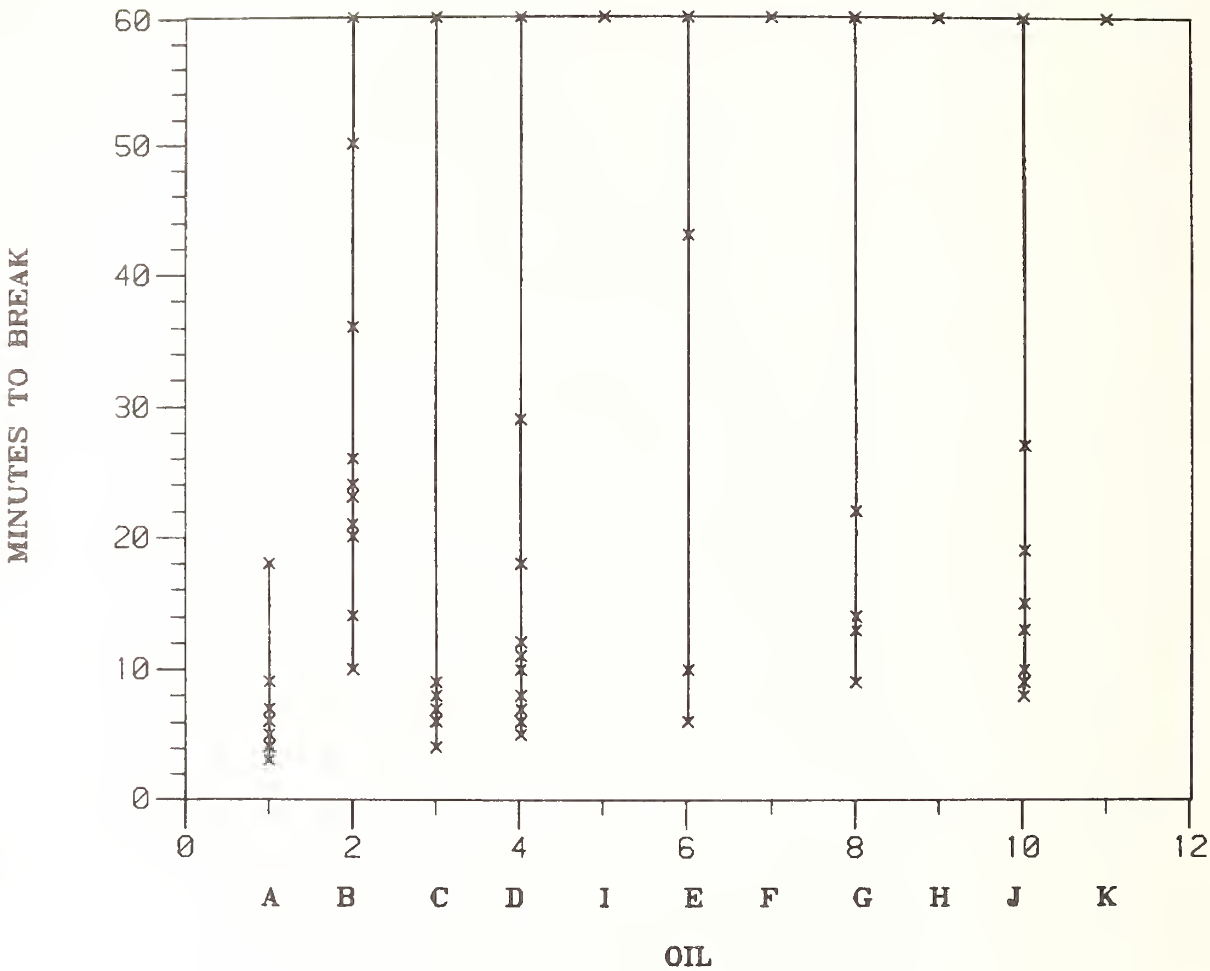
TEST: DEMULSIBILITY,TUBE 4 (MIN TO BREAK) ASTM D1401 LABORATORY: W

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	9.	-	9.	10.	>60.	>60.	>60.	8.	>60.	15.	>60.
APR 80	9.	23.	>60.	11.	>60.	>60.	>60.	>60.	>60.	17.	-
MAY 80	4.	14.	4.	30.	>60.	>60.	>60.	>60.	>60.	>60.	-
JUN 80	5.	29.	4.	8.	>60.	>60.	>60.	>60.	>60.	9.	-
JUL 80	5.	22.	8.	7.	>60.	>60.	>60.	17.	>60.	10.	-
AUG 80	6.	25.	5.	9.	>60.	47.	>60.	>60.	>60.	>60.	-
SEP 80	8.	12.	5.	9.	>60.	>60.	>60.	>60.	>60.	11.	-
OCT 80	8.	14.	8.	19.	>60.	12.	>60.	>60.	>60.	27.	-
NOV 80	5.	>60.	7.	4.	>60.	6.	>60.	13.	>60.	>60.	-
DEC 80	18.	21.	6.	9.	>60.	>60.	>60.	>60.	>60.	14.	-
JAN 81	5.	50.	7.	10.	>60.	-	>60.	25.	>60.	9.	-
FEB 81	4.	38.	8.	7.	>60.	-	>60.	>60.	>60.	>60.	>60.
MAR 81	5.	>60.	>60.	>60.	>60.	-	>60.	>60.	>60.	11.	>60.
MEAN	7.0	30.7	14.7	14.8	>60.0	48.5	>60.0	46.4	>60.0	27.9	>60.0
STD.DEV.	3.8	17.4	20.2	15.1	.0	21.3	.0	21.6	.0	22.7	.0
MIN	4.	12.	4.	4.	>60.	6.	>60.	8.	>60.	9.	>60.
MAX	18.	>60.	>60.	>60.	>60.	>60.	>60.	>60.	>60.	>60.	>60.

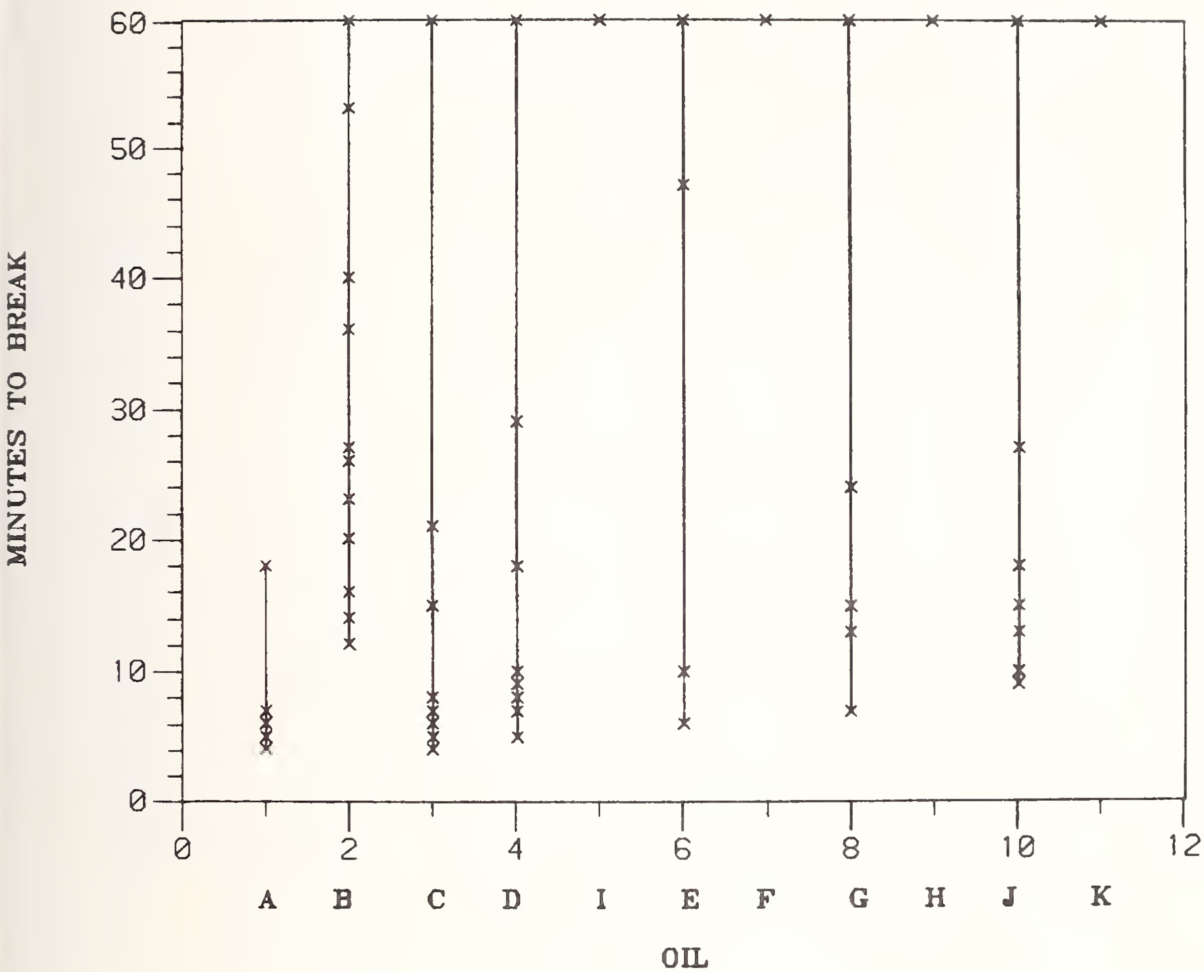
DEMULSIBILITY, TUBE 1



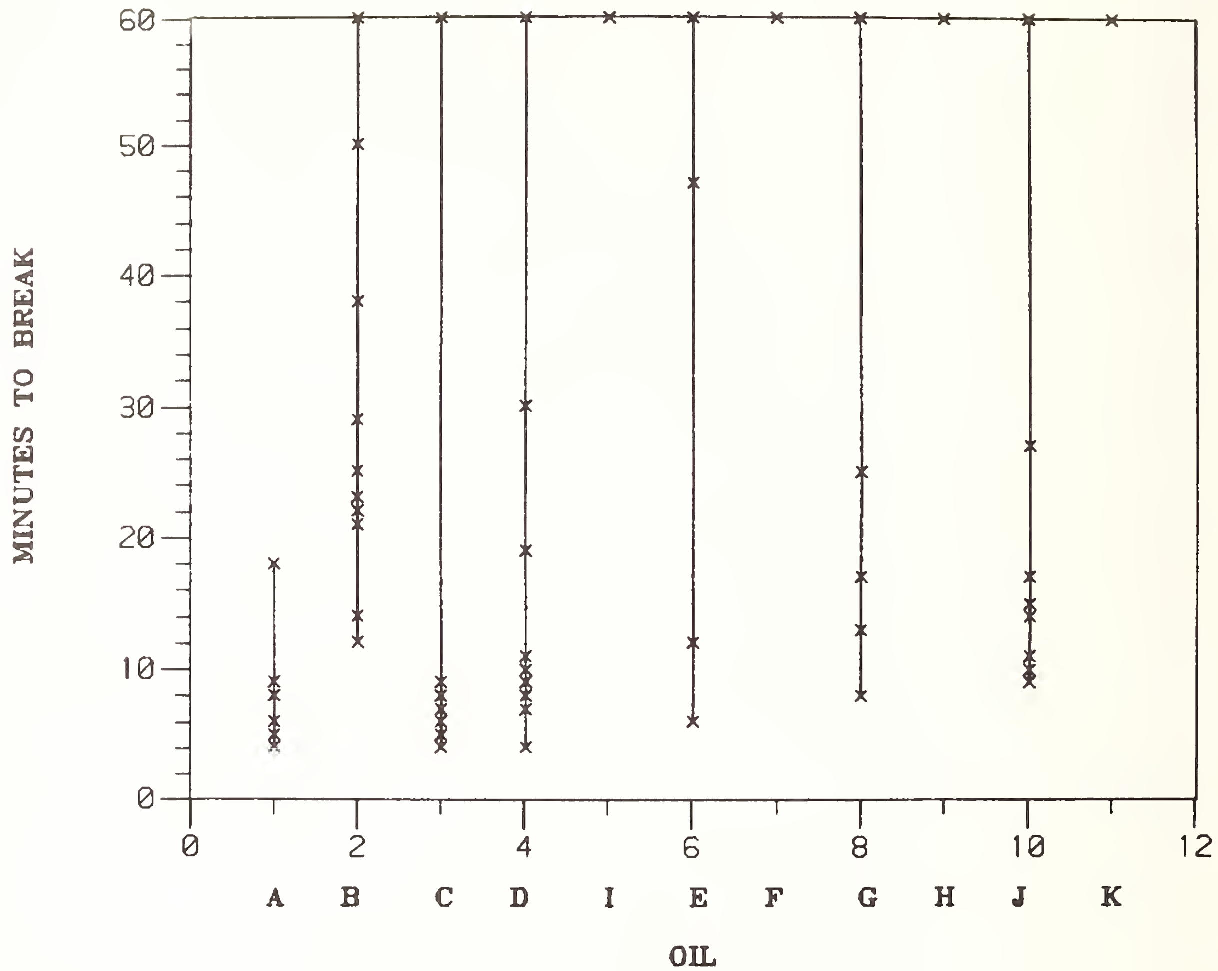
DEMULSIBILITY, TUBE 2

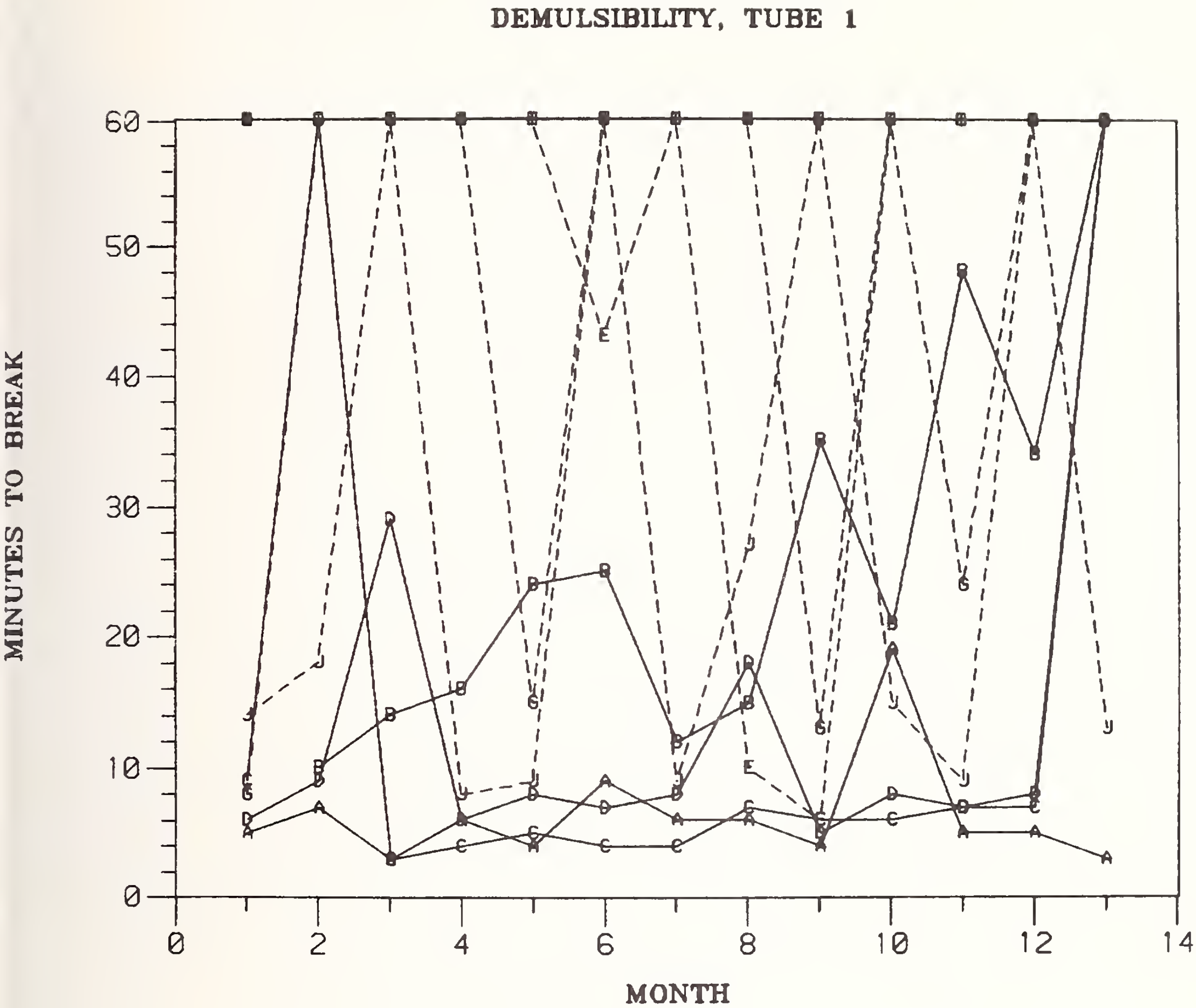


DEMULSIBILITY, TUBE 3

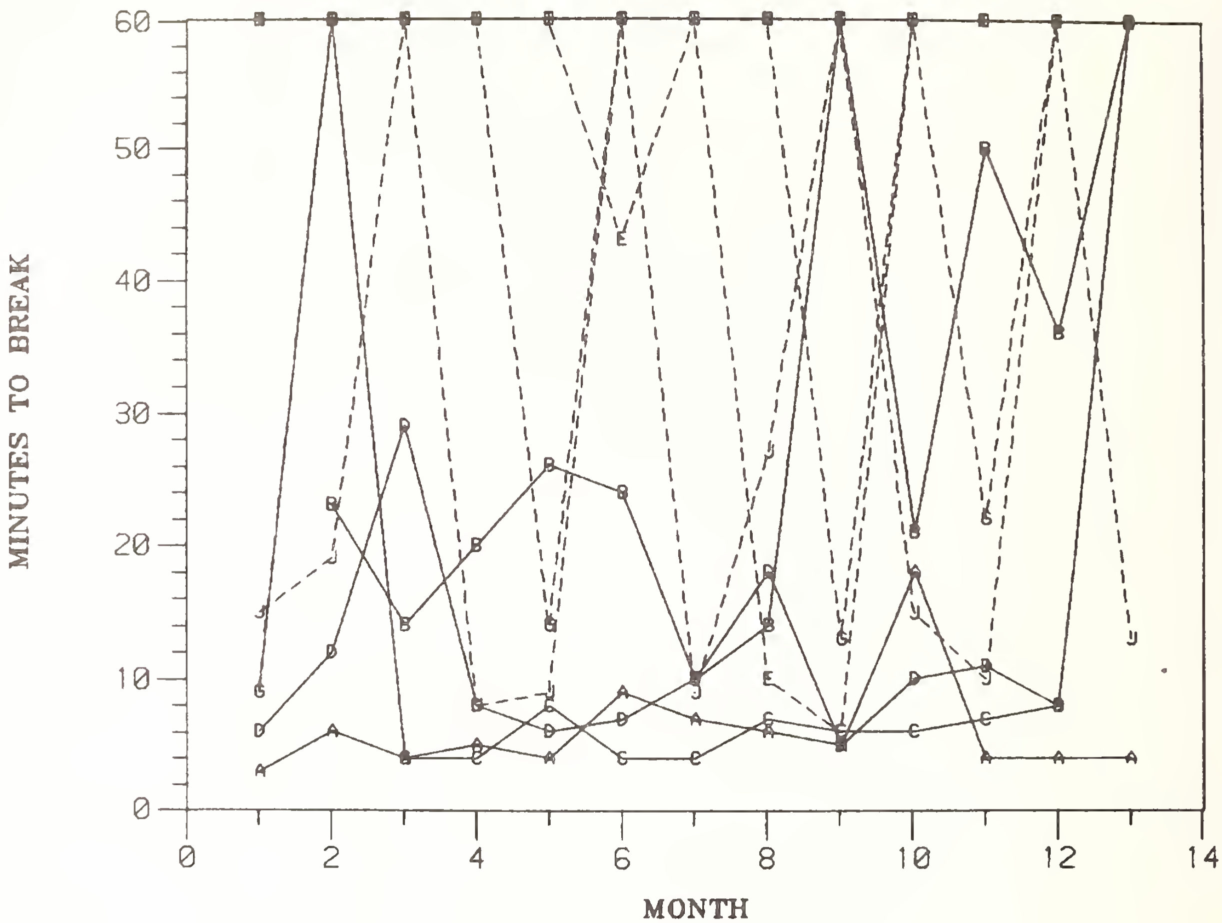


DEMULSIBILITY, TUBE 4

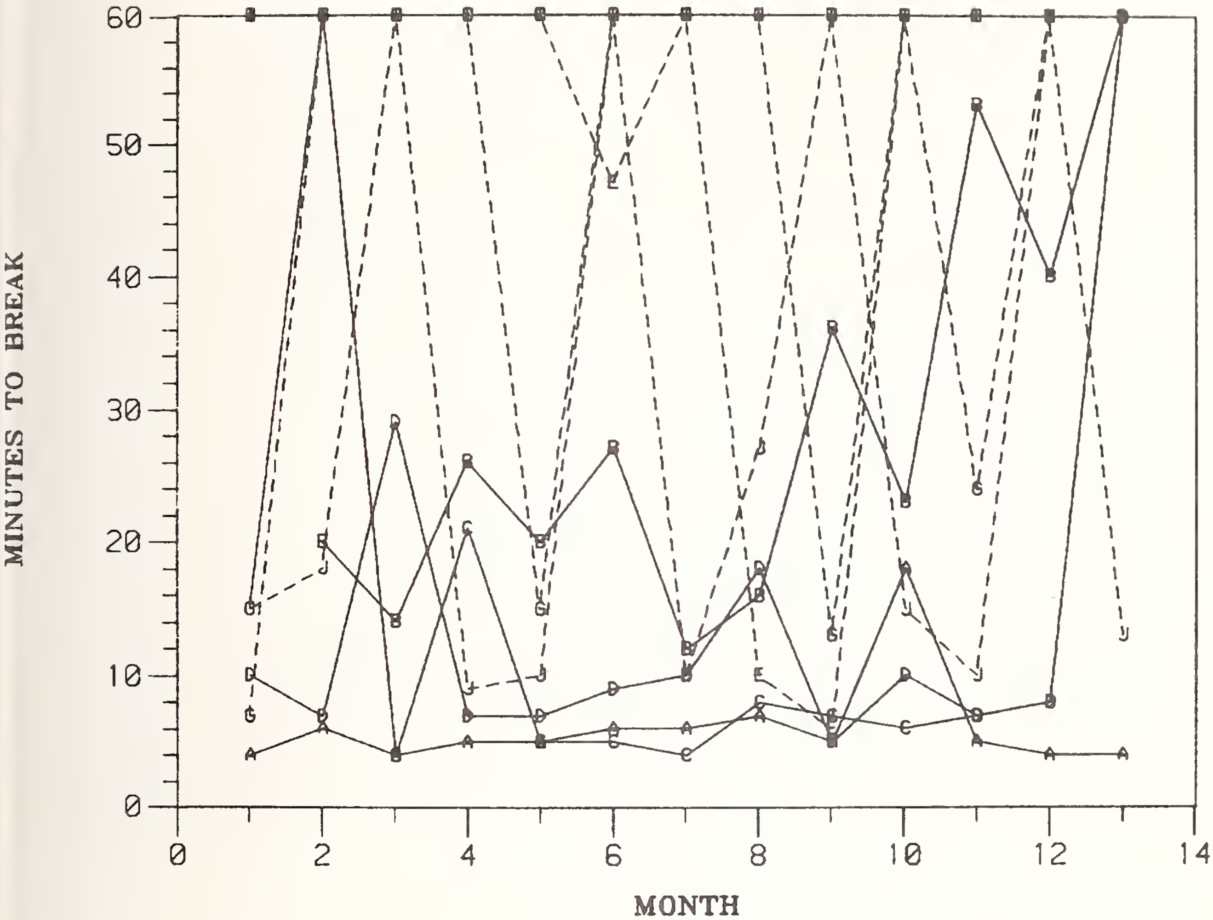



DEMULSIBILITY, TUBE 1
MINUTES TO BREAK
MONTH
0
10
20
30
40
50
60
0
2
4
6
8
10
12
14

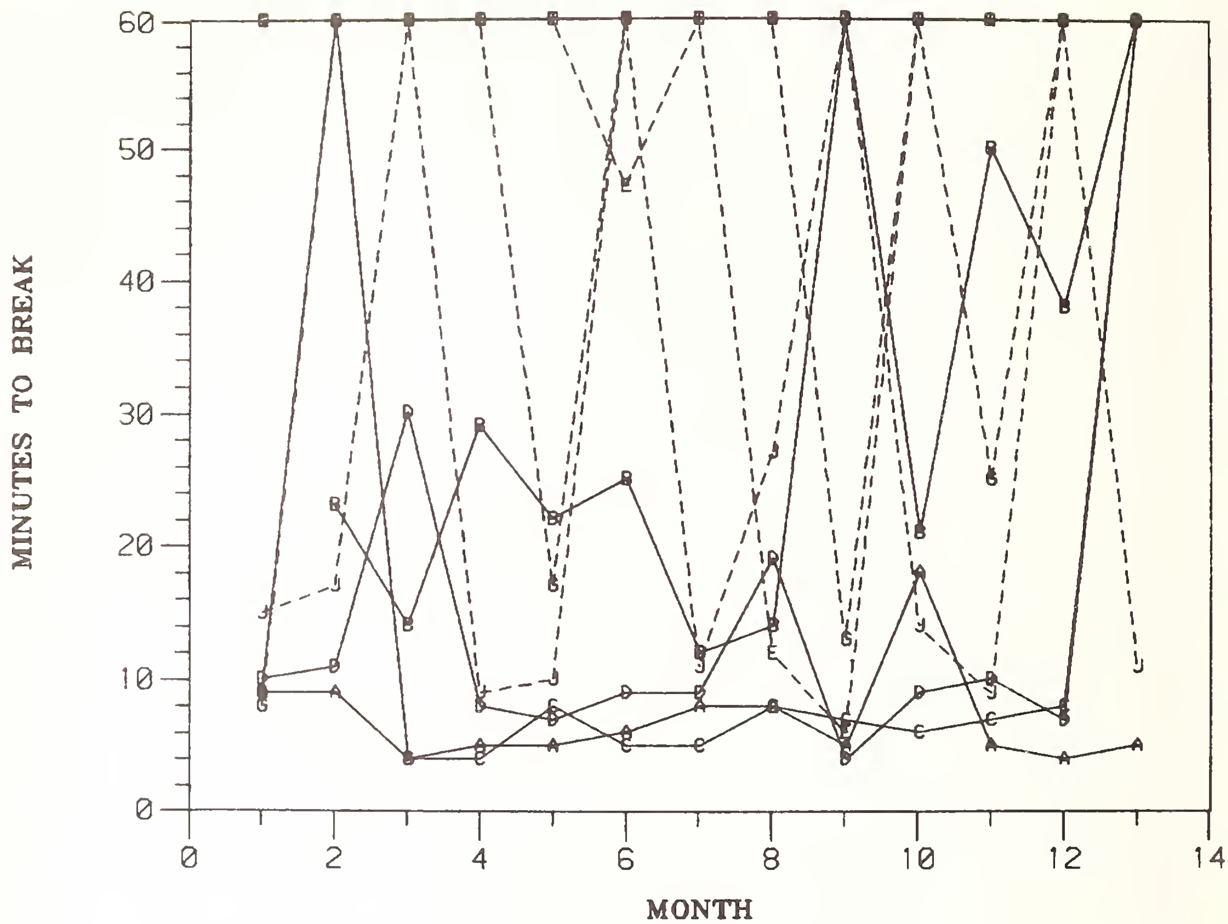
DEMULSIBILITY, TUBE 2



DEMULSIBILITY, TUBE 3



DEMULSIBILITY, TUBE 4



ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: FILTERABILITY. RUN 1 (mg SEDIMENT) 0.8 MICROMETER MEMBRANE FILTR METHOD

LABORATORY: W

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	21.6	-	13.1	9.2	16.1	2.2	NF	14.2	3.1	1.1	4.6
APR 80	4.6	1.5	6.9	1.4	1.4	4.8	3.2	54.8	NF	1.6	-
MAY 80	2.1	2.1	15.1	4.7	6.8	6.8	NF	3.5	3.3	.6	-
JUN 80	1.4	1.0	1.5	4.1	2.1	3.6	1.9	NF	1.4	1.3	-
JUL 80	1.7	3.0	2.2	.7	1.1	4.4	2.3	1.0	NF	1.1	-
AUG 80	.5	.5	1.0	.5	1.5	NF	NF	NF	NF	NF	-
SEP 80	.3	.4	--	.1	1.1	7.0	2.1	2.1	NF	.5	-
OCT 80	1.1	.5	3.2	.3	.5	1.1	5.1	NF	NF	.9	-
NOV 80	.6	.7	.3	.1	.8	.4	NF	.2	NF	NF	-
DEC 80	.3	.6	.7	.3	.4	8.8	1.3	.5	NF	NF	-
JAN 81	.4	.6	.4	.5	.7	-	NF	.5	.3	1.1	-
FEB 81	.5	.7	.2	.4	--	-	4.0	.8	.7	1.8	NF
MAR 81	.5	3.4	.2	--	.7	-	NF	7.5	1.1	1.3	--
MEAN	2.74	1.25	3.73	1.86	2.77	4.34	2.84	8.51	1.65	1.13	4.60
STD.DEV.	5.79	1.04	5.21	2.79	4.54	2.84	1.33	16.85	1.26	.40	-
MIN	.3	.4	.2	.1	.4	.4	1.3	.2	.3	.5	4.6
MAX	21.6	3.0	15.1	9.2	16.1	8.8	5.1	54.8	3.3	1.6	4.6

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: FILTERABILITY, RUN 2 (mg SEDIMENT) 0.8 MICROMETER MEMBRANE FILTR METHOD LABORATORY: W

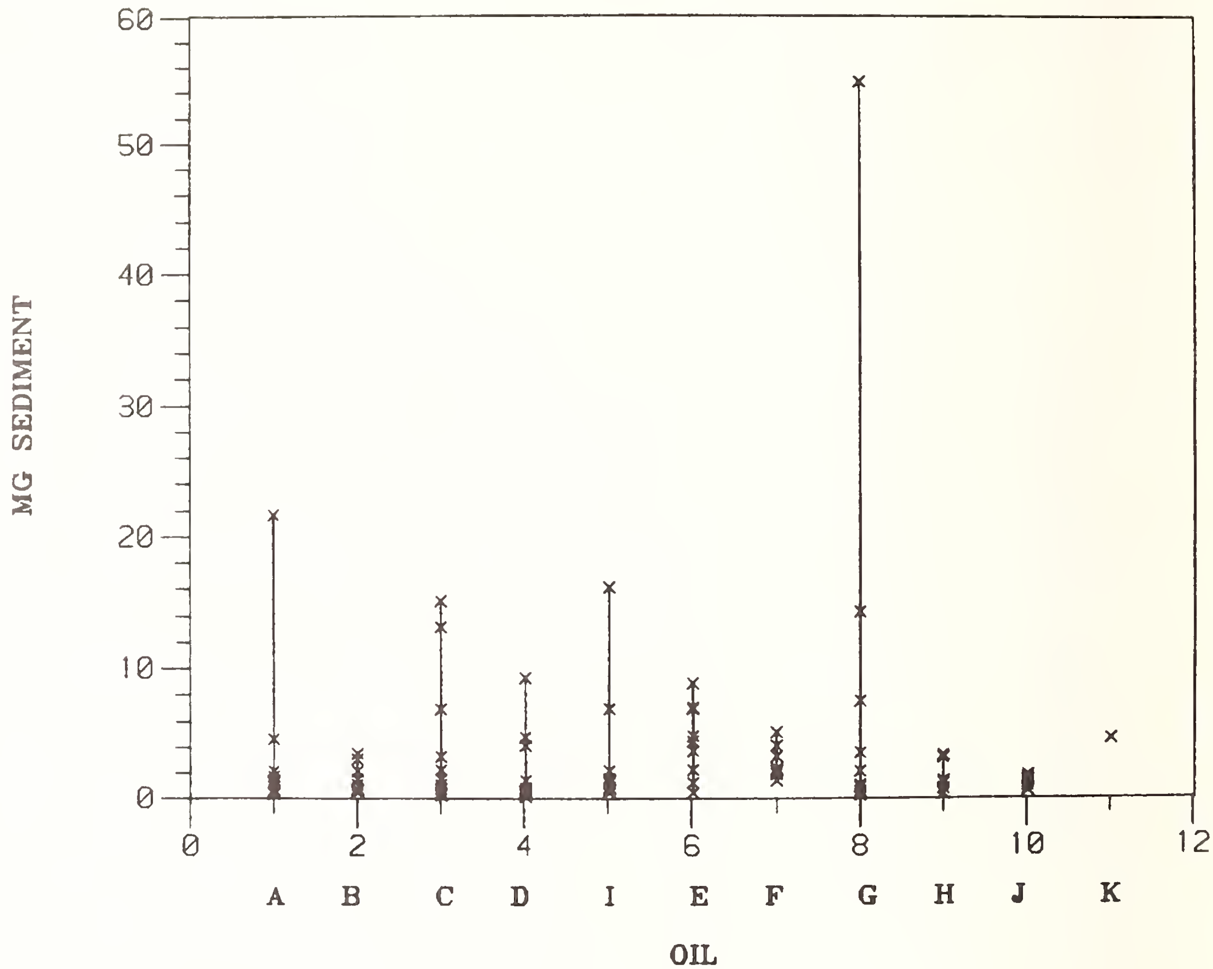
DATE	A	B	C	D	I	E	F	G	H	J	K
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
MAR 80	8.9	-	15.0	19.8	7.5	1.1	NF	6.9	1.1	1.4	3.9
APR 80	.8	5.1	5.8	3.0	1.2	1.6	1.4	54.2	NF	3.5	-
MAY 80	1.5	9.1	.8	4.5	6.0	5.6	NF	2.2	3.1	.4	-
JUN 80	2.0	.6	1.2	1.9	1.3	3.8	2.1	NF	1.0	1.7	-
JUL 80	1.3	1.5	3.2	5.6	.6	3.9	1.9	1.2	NF	1.2	-
AUG 80	.3	2.1	.6	.3	.8	NF	NF	NF	NF	NF	-
SEP 80	.8	.4	--	--	2.7	6.7	2.2	.9	NF	1.5	-
OCT 80	.5	.4	4.3	1.3	.6	1.4	5.6	NF	NF	1.2	-
NOV 80	.5	.6	.4	.1	1.1	1.5	NF	1.0	NF	NF	-
DEC 80	.2	1.7	.6	.5	.2	5.1	1.3	.3	NF	NF	-
JAN 81	.7	.7	.1	.4	.5	-	NF	.7	.2	.9	-
FEB 81	.5	.6	.3	.3	.4	-	4.0	.3	1.3	2.7	NF
MAR 81	5.0	3.8	.3	--	1.3	-	NF	9.5	1.0	1.6	--
MEAN	1.77	2.22	2.72	3.43	1.86	3.41	2.64	7.72	1.28	1.61	3.90
STD.DEV.	2.49	2.62	4.28	5.74	2.28	2.10	1.58	16.63	0.97	0.89	-
MIN	.2	.4	.1	.1	.2	1.1	1.3	.3	.2	.4	3.9
MAX	8.9	9.1	15.0	19.8	7.5	6.7	5.6	54.2	3.1	3.5	3.9

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

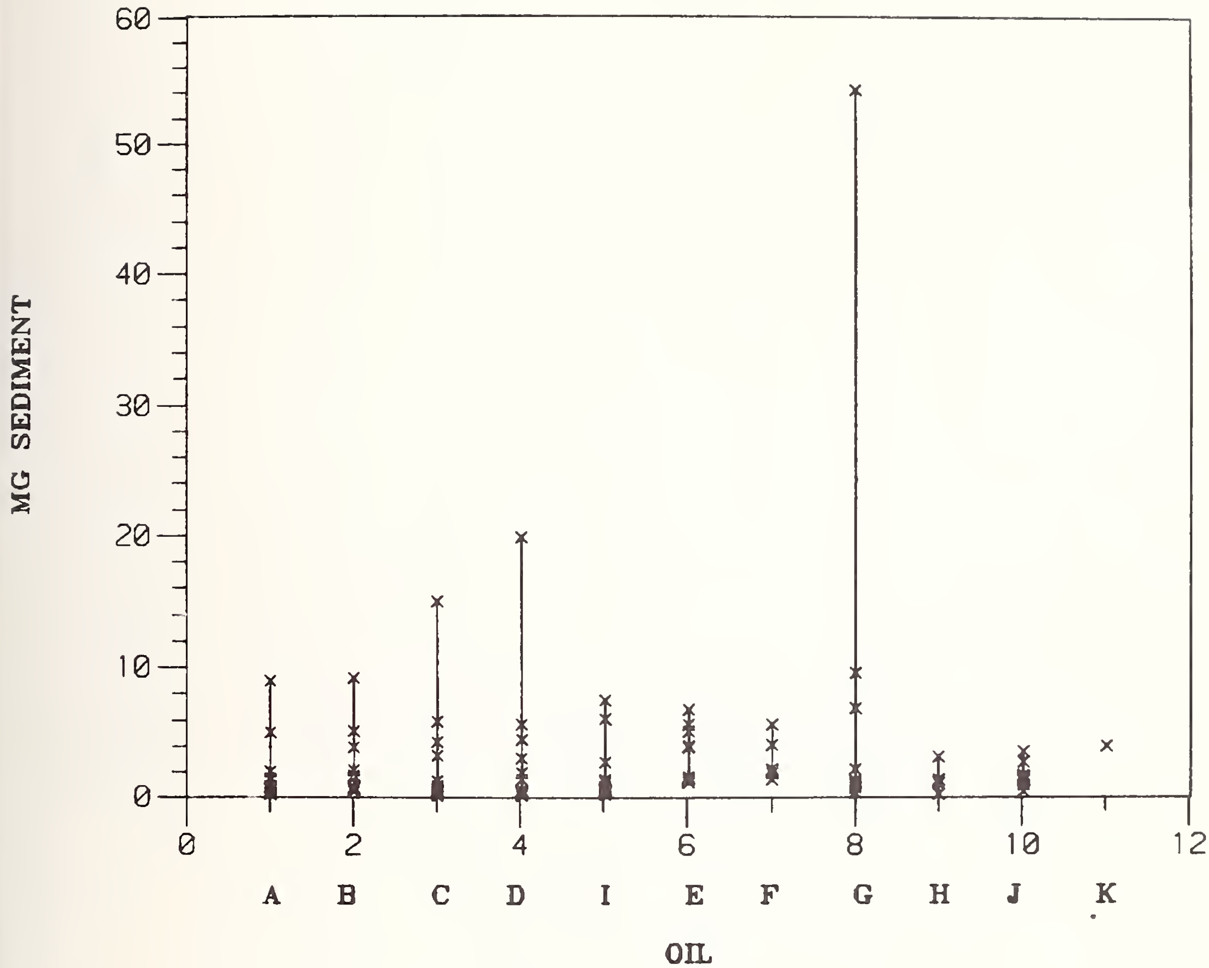
TEST: FILTERABILITY, RUN 3 (mg SEDIMENT) 0.8 MICROMETER MEMBRANE FILTR METHOD LABORATORY: W

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	14.6	-	12.3	20.6	3.5	2.9	NF	12.1	1.5	1.1	3.0
APR 80	1.3	6.4	2.2	1.1	1.8	1.5	2.7	54.1	NF	2.6	-
MAY 80	1.7	.8	1.1	2.7	11.1	4.1	NF	2.1	1.4	2.8	-
JUN 80	1.7	2.3	1.6	2.5	.9	5.0	1.9	NF	1.2	1.4	-
JUL 80	1.1	.5	3.6	1.4	1.0	4.3	3.4	1.9	NF	1.8	-
AUG 80	.6	.7	.6	.6	1.4	NF	NF	NF	NF	NF	-
SEP 80	.3	.8	--	--	.7	10.1	1.2	2.0	NF	1.1	-
OCT 80	1.3	.4	2.4	.4	.6	1.1	5.2	NF	NF	1.4	-
NOV 80	.7	.4	.1	.2	.5	.3	NF	.7	NF	NF	-
DEC 80	.3	.5	.9	.5	.3	--	1.5	.4	NF	NF	-
JAN 81	.6	.5	.2	.6	.5	-	NF	.2	.2	.9	-
FEB 81	.6	.7	--	.4	3.0	-	4.0	.5	.9	1.5	NF
MAR 81	.7	2.2	.1	--	.6	-	NF	11.3	1.1	1.2	--
MEAN	1.96	1.35	2.28	2.82	1.99	3.66	2.84	8.53	1.05	1.58	3.00
STD.DEV.	3.83	1.72	3.50	5.96	2.91	3.09	1.45	16.62	.47	.64	-
MIN	.3	.4	.1	.2	.3	.3	1.2	.2	.2	.9	3.0
MAX	14.6	6.4	12.3	20.6	11.1	10.1	5.2	54.1	1.5	2.8	3.0

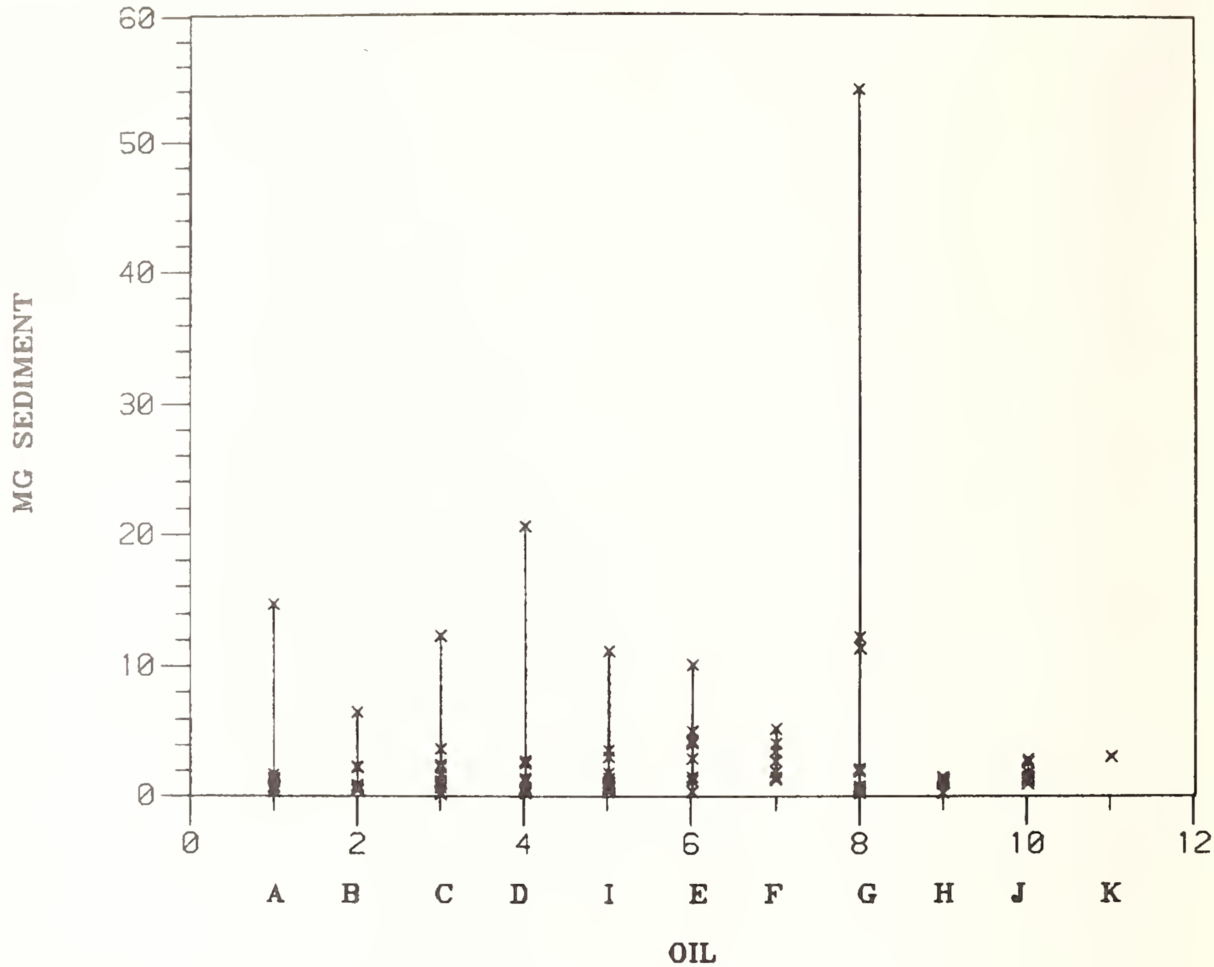
FILTERABILITY, RUN 1



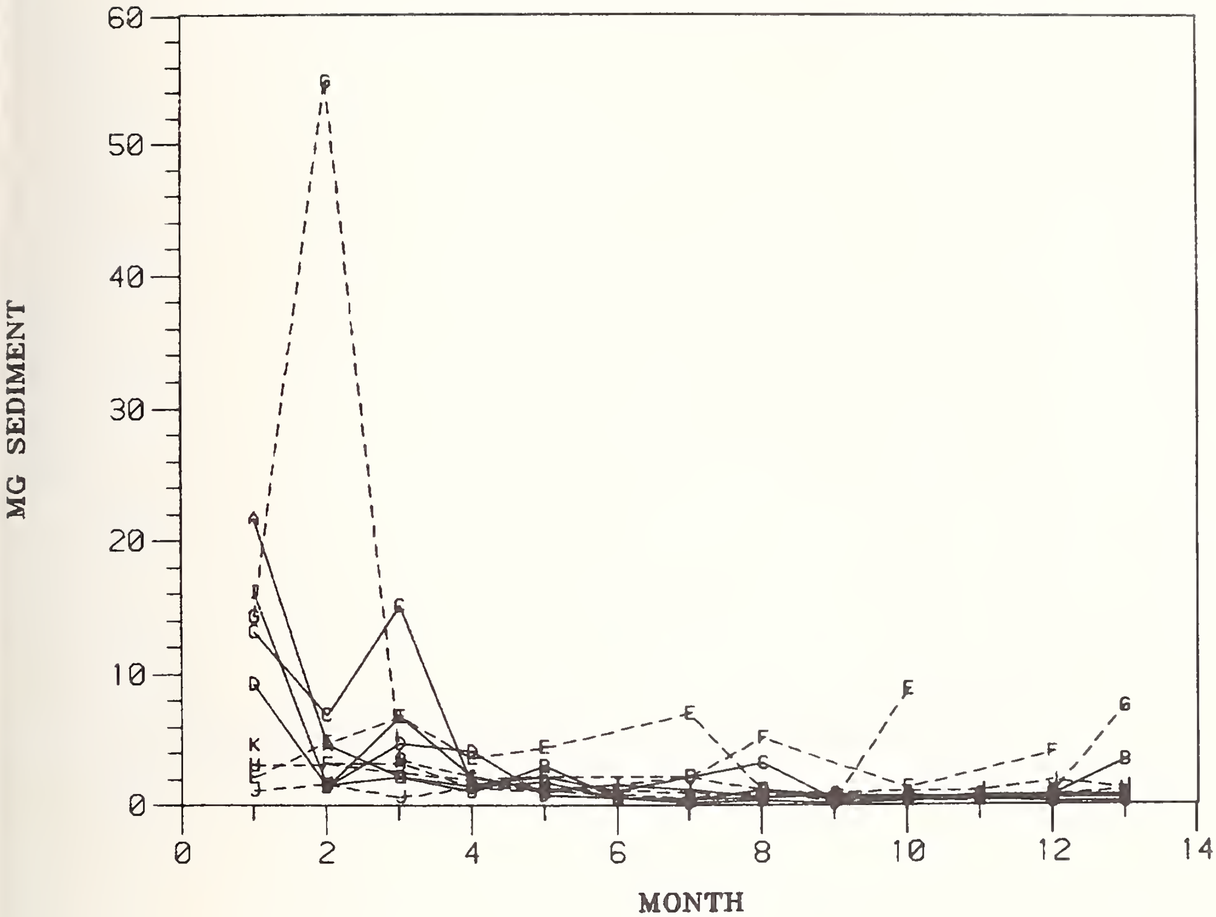
FILTERABILITY, RUN 2



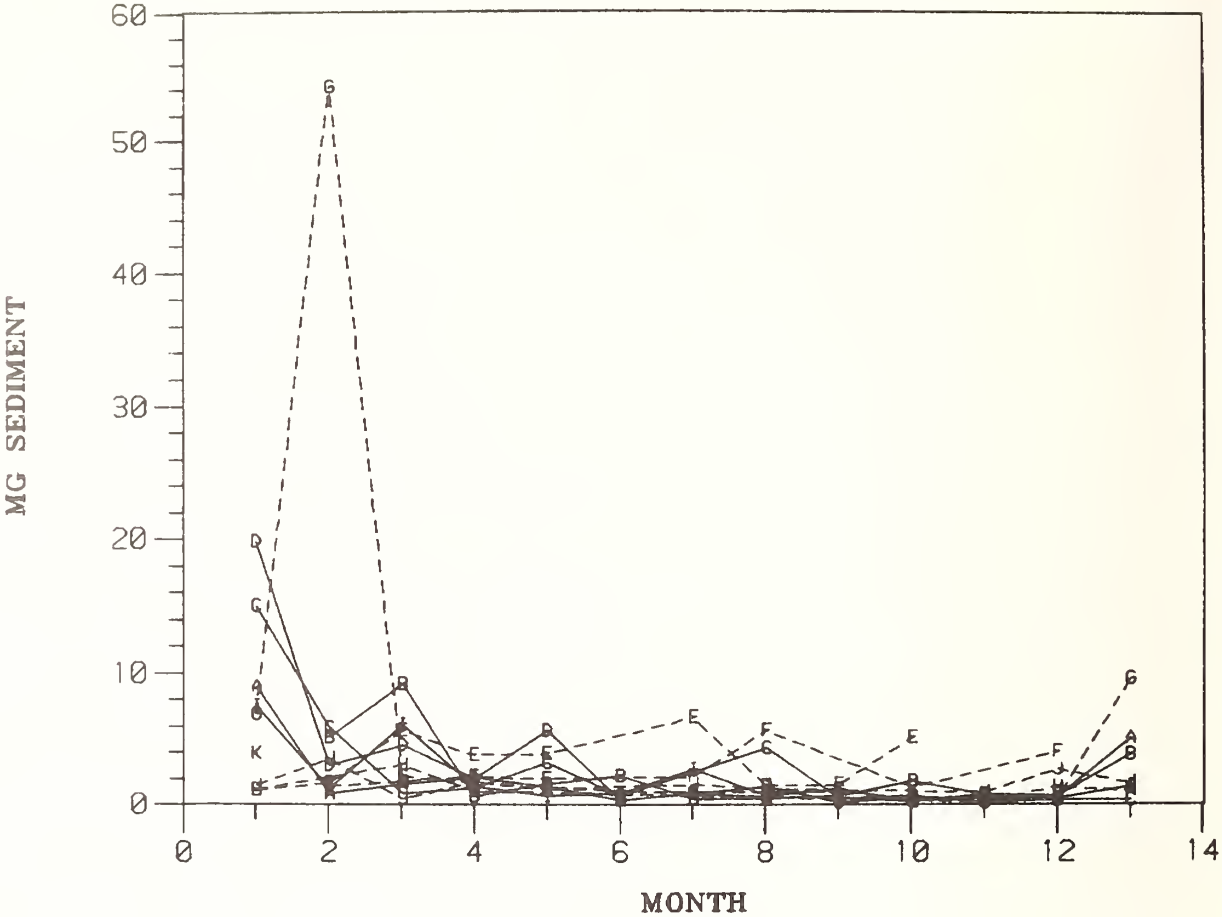
FILTERABILITY, RUN 3



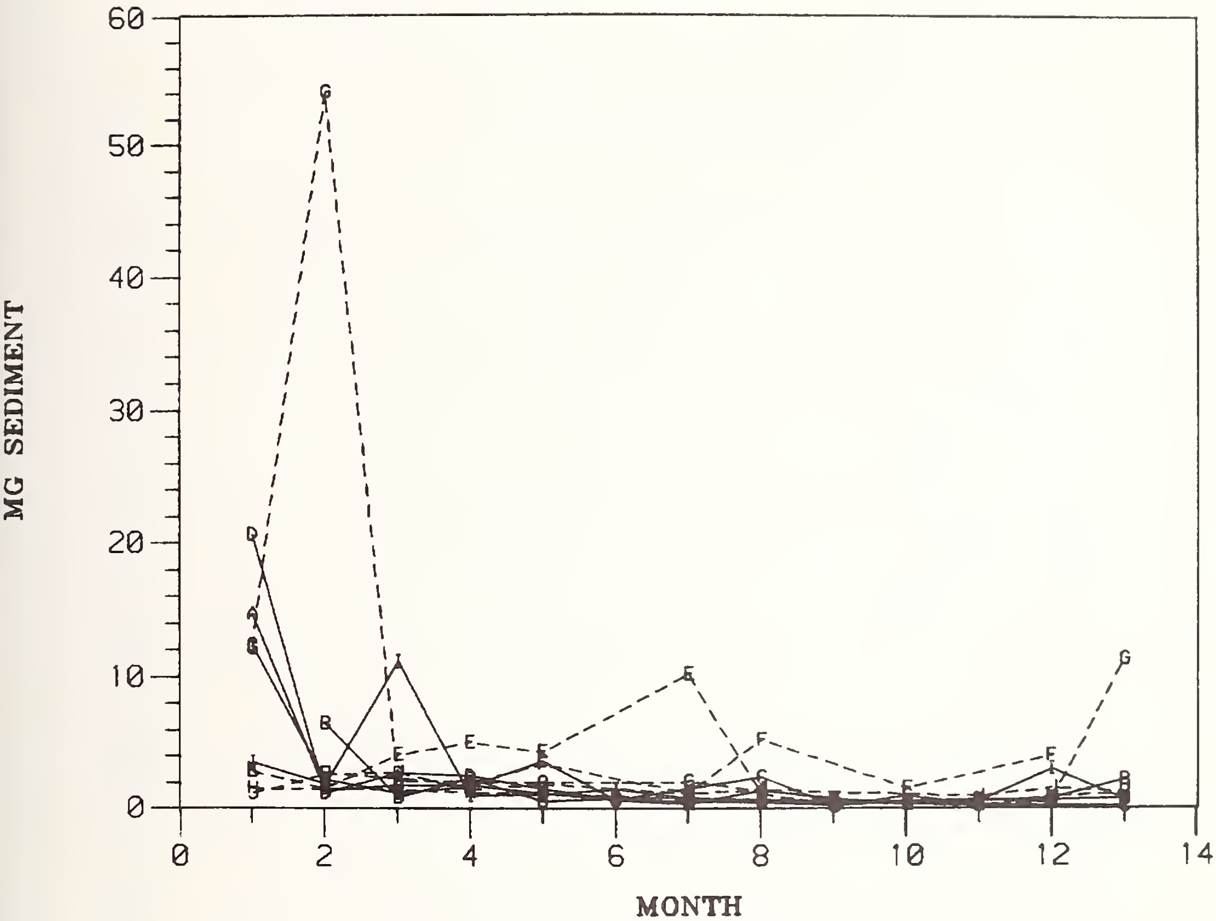
FILTERABILITY, RUN 1



FILTERABILITY, RUN 2



FILTERABILITY, RUN 3



ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: FILTERABILITY, RUN 1 (100mL FILTER TIME, SEC) MEMBRANE FILTR METHOD LABORATORY: W

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	85.2	-	92.2	107.8	128.1	110.7	>1800.0	94.7	175.7	117.8	223.5
APR 80	83.2	124.6	98.9	115.9	116.7	111.9	175.8	1060.0	>1800.0	259.6	-
MAY 80	78.8	120.5	91.9	101.5	102.3	357.1	>1800.0	111.7	128.7	114.8	-
JUN 80	67.0	104.5	109.2	89.9	121.0	291.2	180.6	>1800.0	120.2	470.7	-
JUL 80	61.3	101.6	75.6	81.9	83.5	485.8	141.3	85.7	>1800.0	1508.0	-
AUG 80	69.6	95.3	66.1	78.8	89.9	>1800.0	>1800.0	>1800.0	>1800.0	>1800.0	-
SEP 80	43.7	68.9	53.7	59.2	66.2	1403.0	112.5	82.8	>1800.0	106.8	-
OCT 80	53.8	80.2	56.2	77.5	62.5	160.8	132.7	>1800.0	>1800.0	698.0	-
NOV 80	91.0	127.2	88.9	109.9	114.2	95.7	>1800.0	99.3	>1800.0	>1800.0	-
DEC 80	73.0	112.0	85.0	106.0	108.0	1760.0	134.9	96.0	>1800.0	>1800.0	-
JAN 81	77.2	127.7	87.5	105.2	81.6	-	>1800.0	88.5	124.4	113.3	-
FEB 81	69.2	108.5	72.5	101.0	113.8	-	--	94.1	277.3	297.3	>1800.0
MAR 81	61.9	325.8	85.9	95.9	85.6	-	>1800.0	182.7	186.7	120.5	>1800.0
MEAN	70.38	124.73	81.82	94.65	97.95	657.62	973.15	568.88	1047.15	708.22	1274.50
STD.DEV.	13.19	65.92	16.28	16.26	21.18	706.28	863.80	749.51	847.26	730.53	910.19
MIN	43.7	68.9	53.7	59.2	62.5	95.7	112.5	82.8	120.2	106.8	223.5
MAX	91.0	325.8	109.2	115.9	128.1	>1800.0	>1800.0	>1800.0	>1800.0	>1800.0	>1800.0

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: FILTERABILITY, RUN 2 (100mL FILTER TIME, SEC) MEMBRANE FILTR METHOD LABORATORY: W

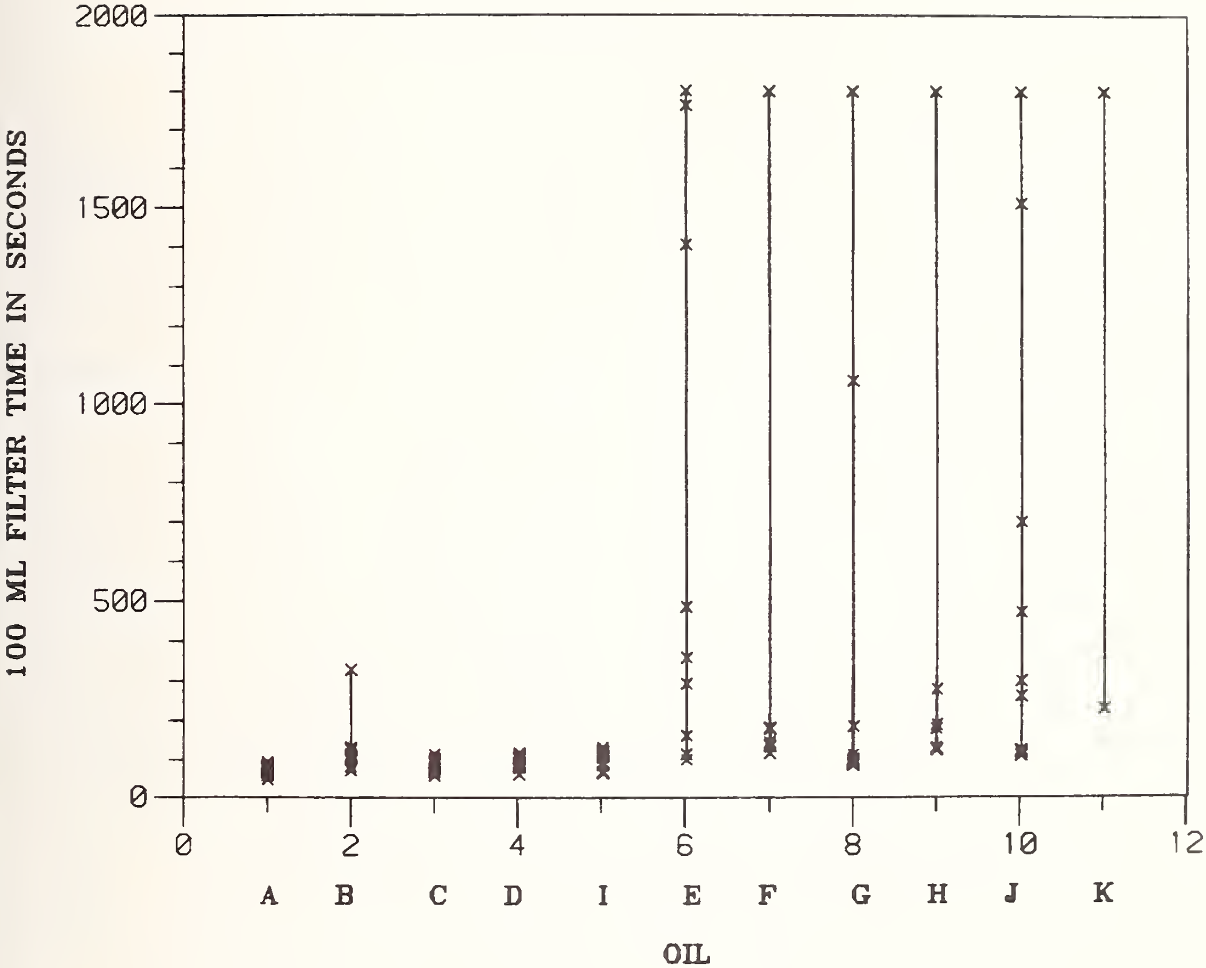
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	85.7	-	96.1	110.4	124.0	106.4	>1800.0	97.7	178.1	114.0	217.3
APR 80	84.3	124.4	96.1	113.9	118.5	106.5	176.1	1045.3	>1800.0	242.6	-
MAY 80	78.2	123.0	91.7	106.7	104.1	359.8	>1800.0	115.4	134.5	114.0	-
JUN 80	62.0	101.4	116.1	84.7	117.8	287.8	176.6	>1800.0	119.5	477.3	-
JUL 80	61.7	100.1	80.6	80.4	88.4	480.9	136.4	86.9	>1800.0	1484.0	-
AUG 80	68.1	98.2	65.7	78.3	84.3	>1800.0	>1800.0	>1800.0	>1800.0	>1800.0	-
SEP 80	43.2	70.1	55.2	59.7	65.8	1409.3	109.0	84.3	>1800.0	110.9	-
OCT 80	50.9	81.9	56.8	75.9	65.0	164.5	137.1	>1800.0	>1800.0	822.0	-
NOV 80	92.1	130.1	88.3	112.8	118.1	97.9	>1800.0	101.5	>1800.0	>1800.0	-
DEC 80	73.0	115.0	82.0	102.0	104.0	1884.0	143.0	92.0	>1800.0	>1800.0	-
JAN 81	86.2	137.2	86.6	107.0	82.8	-	>1800.0	97.4	127.8	117.2	-
FEB 81	69.4	113.4	79.9	94.2	101.0	-	--	94.3	178.5	375.5	>1800.0
MAR 81	69.4	377.6	80.3	94.9	93.6	-	>1800.0	184.2	262.6	125.7	>1800.0
MEAN	71.09	131.03	82.72	93.92	97.49	669.71	973.18	569.15	1046.23	721.78	1272.43
STD.DEV.	14.38	80.09	16.68	16.92	19.64	729.79	863.76	747.78	848.11	725.76	913.77
MIN	43.2	70.1	55.2	59.7	65.0	97.9	109.0	84.3	119.5	110.9	217.3
MAX	92.1	377.6	116.1	113.9	124.0	1884.0	>1800.0	>1800.0	>1800.0	>1800.0	>1800.0

ASTM/NBS BASESTOCK CONSISTENCY STUDY

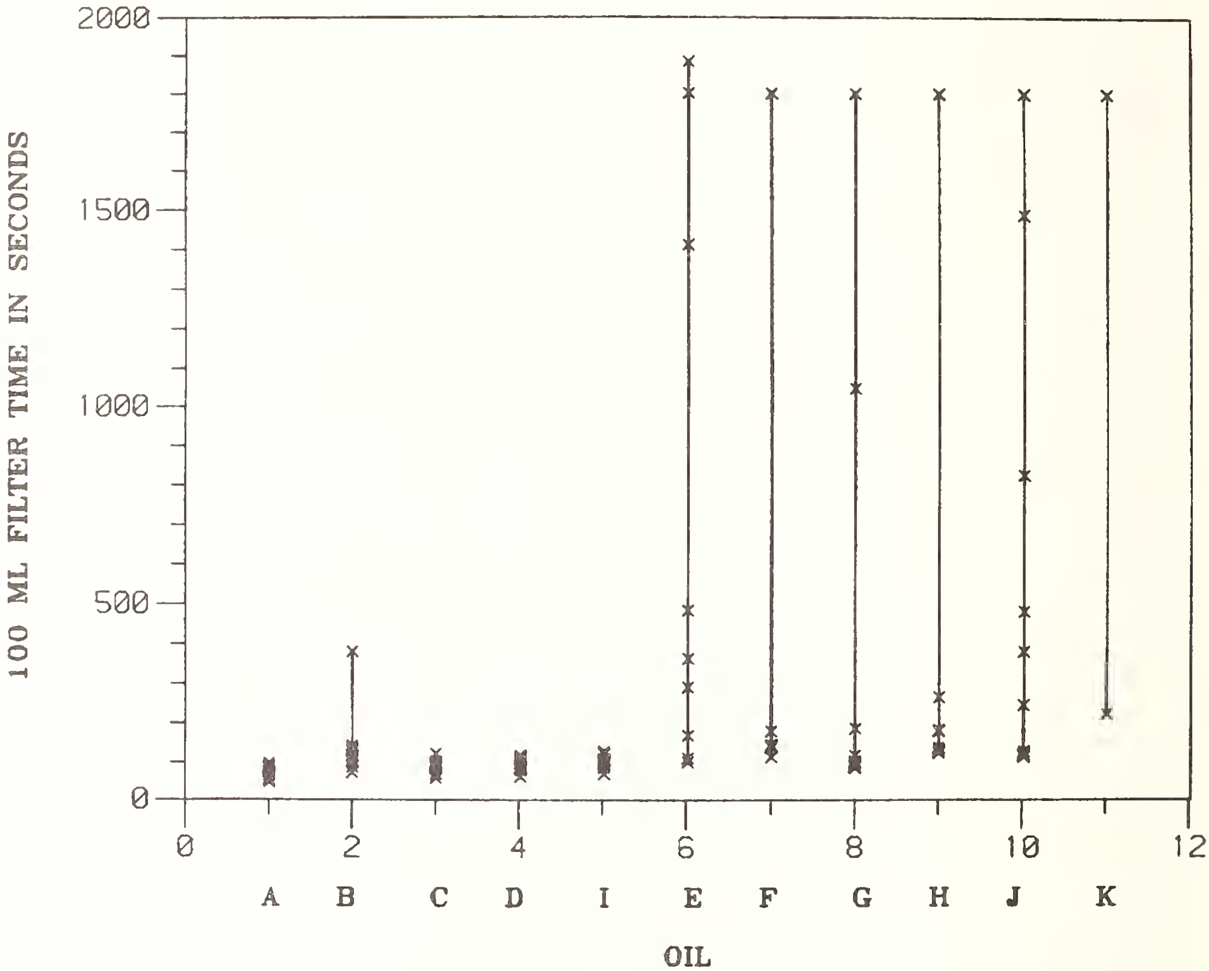
TEST: FILTERABILITY, RUN 3 (100mL FILTER TIME, SEC) MEMERANE FILTR METHOD — LABORATORY: W

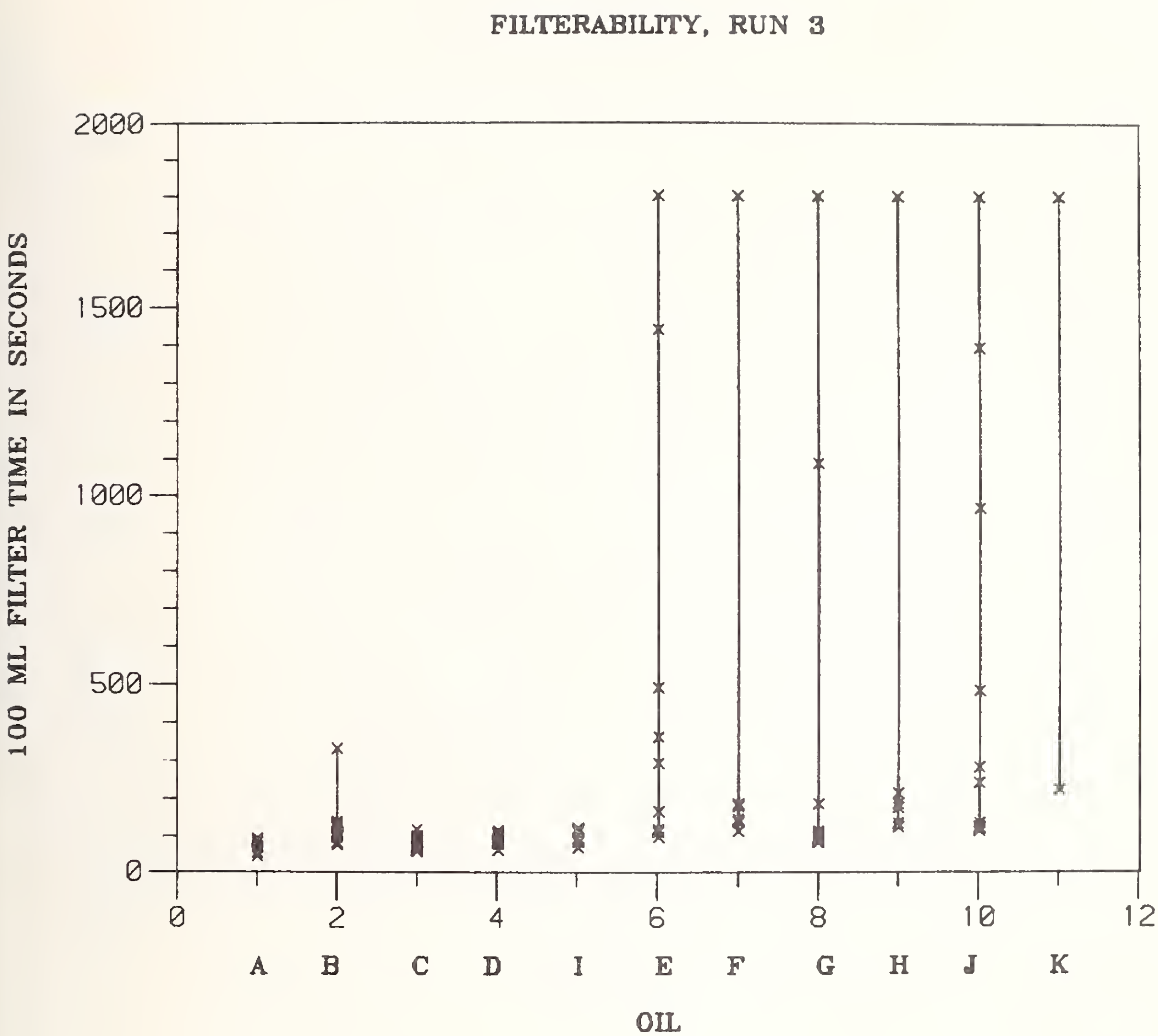
DATE	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
	A	B	C	D	I	E	F	G	H	J	K
MAR 80	80.7	-	94.9	109.4	118.3	106.7	>1800.0	98.2	182.1	117.1	218.3
APR 80	87.3	124.3	98.2	111.5	112.4	113.0	177.7	1084.7	>1800.0	237.4	-
MAY 80	79.6	120.8	96.1	105.5	106.3	361.0	>1800.0	109.6	132.4	111.2	-
JUN 80	68.6	99.3	112.8	87.4	114.7	289.9	182.3	>1800.0	122.1	481.5	-
JUL 80	66.0	106.2	75.5	84.2	90.3	488.6	134.5	81.1	>1800.0	1390.4	-
AUG 80	70.2	94.6	66.8	79.6	84.1	>1800.0	>1800.0	>1800.0	>1800.0	>1800.0	-
SEP 80	42.9	71.3	54.3	60.2	64.8	1436.3	109.4	83.9	>1800.0	110.6	-
OCT 80	53.2	80.5	57.5	75.7	64.8	163.9	134.3	>1800.0	>1800.0	967.0	-
NOV 80	90.1	129.6	87.8	111.0	116.3	93.9	>1800.0	104.0	>1800.0	>1800.0	-
DEC 80	69.0	116.0	84.0	106.0	106.0	>1800.0	141.1	90.0	>1800.0	>1800.0	-
JAN 81	79.4	133.2	84.9	107.4	84.3	-	>1800.0	89.1	130.4	119.8	-
FEB 81	66.7	135.2	68.9	94.7	--	-	--	94.5	173.0	279.2	>1800.0
MAR 81	66.6	330.2	80.6	98.9	79.4	-	>1800.0	184.4	210.6	132.2	>1800.0
MEAN	70.79	128.43	81.72	94.73	95.14	665.33	973.27	570.73	1042.35	718.95	1272.77
STD.DEV.	13.06	66.78	16.92	16.15	19.68	717.19	863.69	750.95	852.07	724.85	913.19
MIN	42.9	71.3	54.3	60.2	64.8	93.9	109.4	81.1	122.1	110.6	218.3
MAX	90.1	330.2	112.8	111.5	118.3	>1800.0	>1800.0	>1800.0	>1800.0	>1800.0	>1800.0

FILTERABILITY, RUN 1

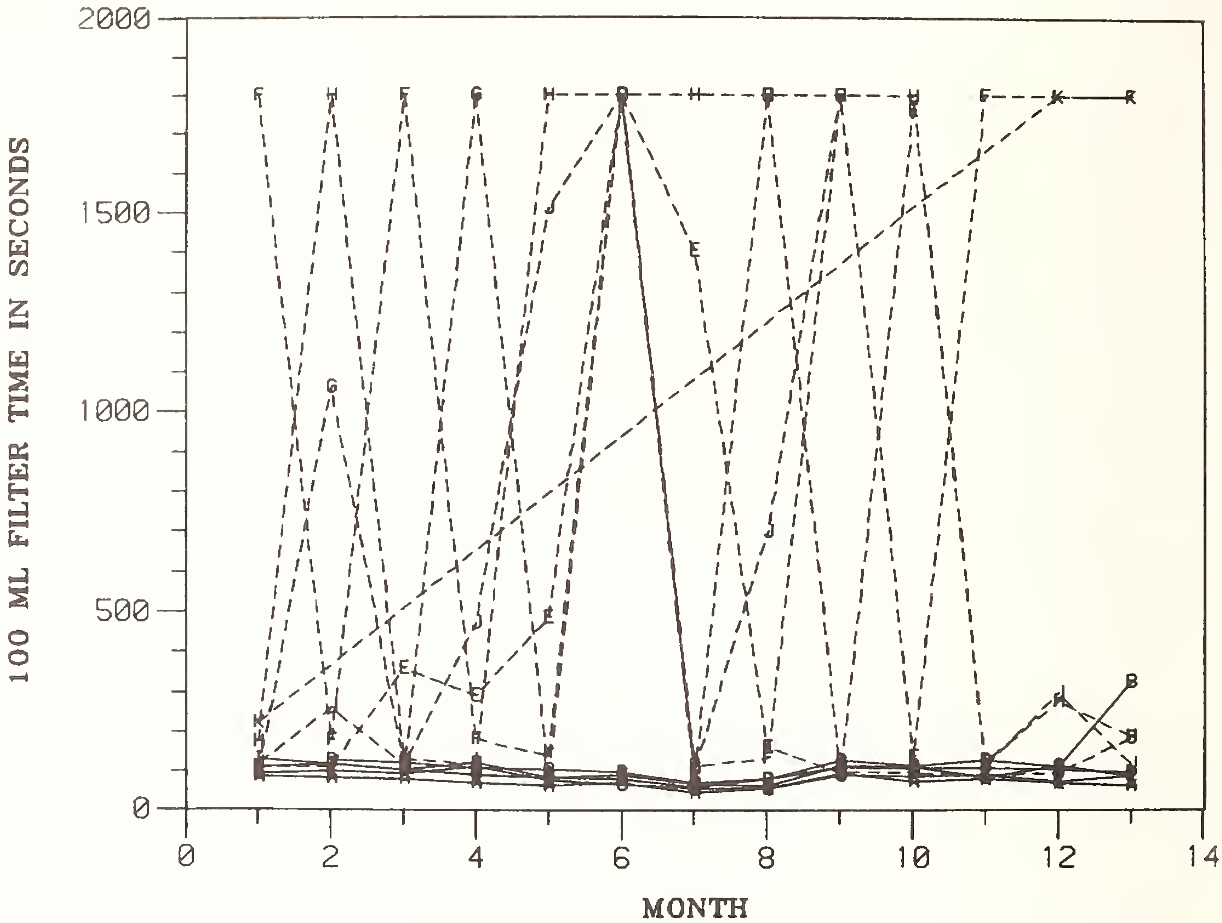


FILTERABILITY, RUN 2

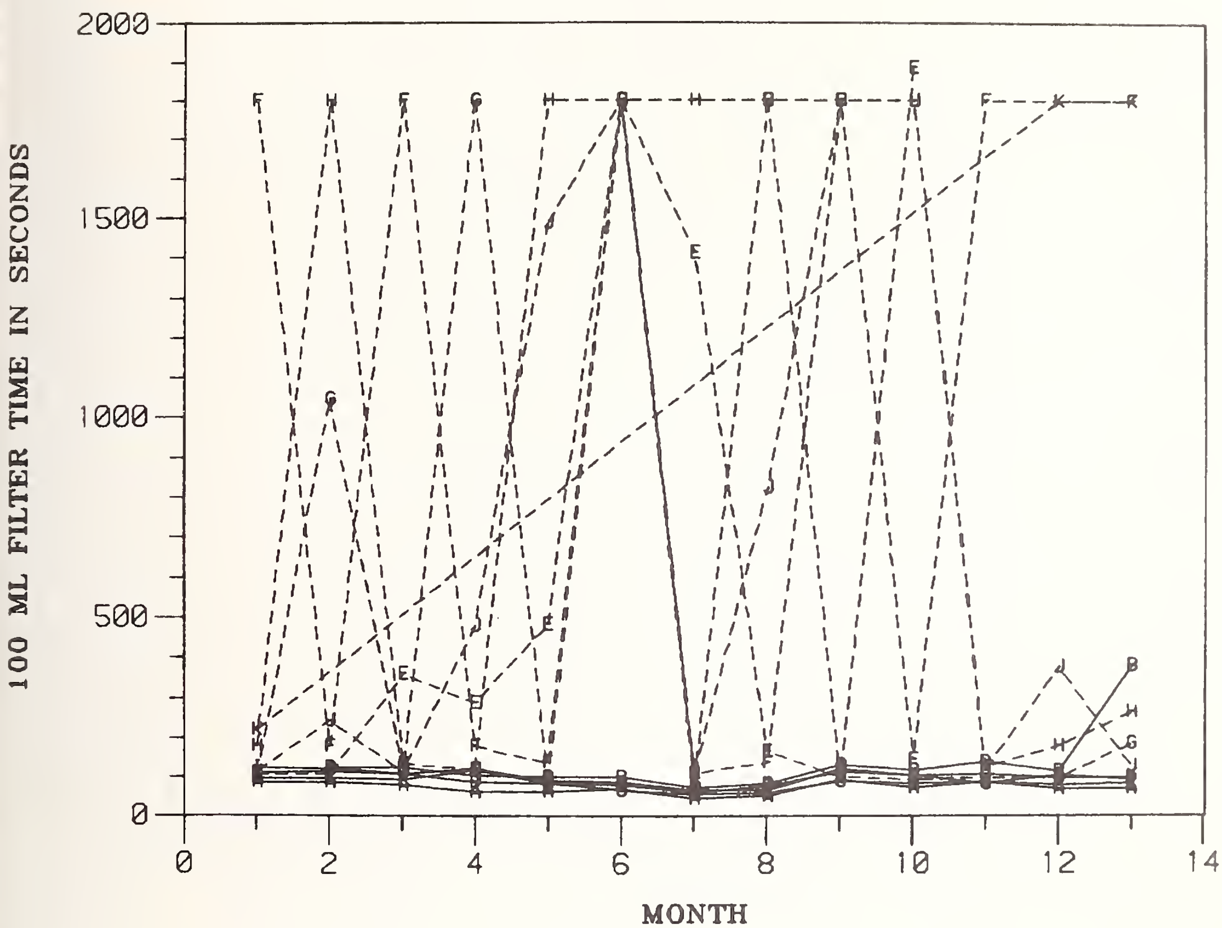


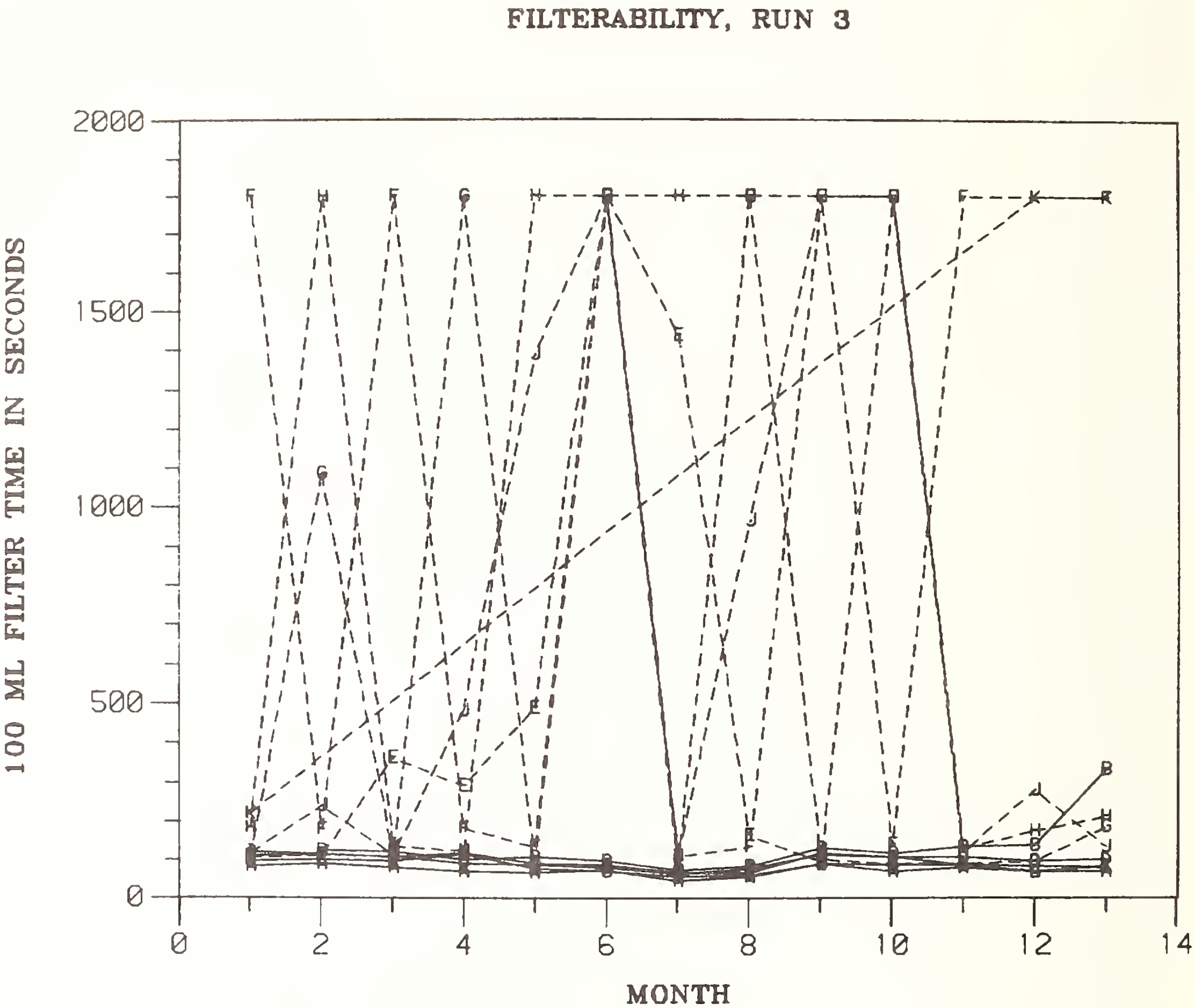

FILTERABILITY, RUN 3
100 ML FILTER TIME IN SECONDS
2000
1500
1000
500
0
0
2
4
6
8
10
12
A B C D I E F G H J K
OIL

FILTERABILITY, RUN 1



FILTERABILITY, RUN 2





FILTERABILITY, RUN 3
100 ML FILTER TIME IN SECONDS
2000
1500
1000
500
0
0
2
4
6
8
10
12
14
MONTH

ASTM/NBS BASESTOCK CONSISTENCY STUDY

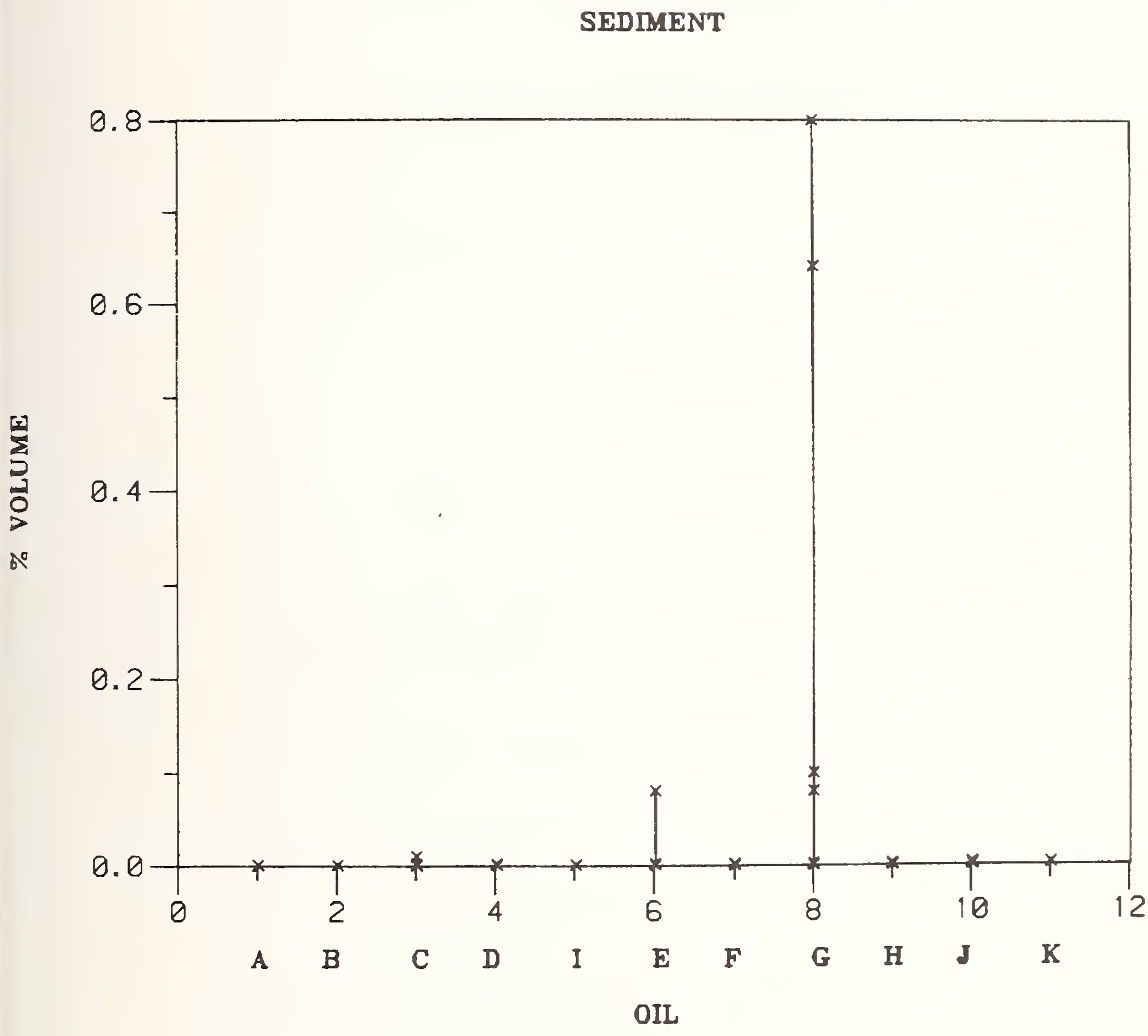
TEST: FILTERABILITY TEST, 8 MICROMETER (P=PASS,F=FAIL,DP=DARK PATCH,BP=BLACK PATCH) LABORATORY: Y

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	--	--	F-BP	F-DP
APR 80	P	P	P	P	P	P	P	P	F	F-DP	-
MAY 80	P	P	P	P	F-DP	P	F-DP	F-DP	F-64	P	-
JUN 80	P	P	P	P	P	P	P	F-50	F-DP	F-DP	-
JUL 80	P	P	P	P	P	F-44	P	F-DP	P	P	-
AUG 80	P	P	F-DP	P	P	P	P	P	P	P	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	P	P	-	P	-	-	-	-	-	-	F-DP
STD.DEV.	.0	.0	-	.0	-	-	-	-	-	-	.0
MIN	P	P	P	P	P	P	P	P	P	P	F-DP
MAX	P	P	F-DP	P	F-DP	F-44	F-DP	F-50	F-64	F-BP	F-DP

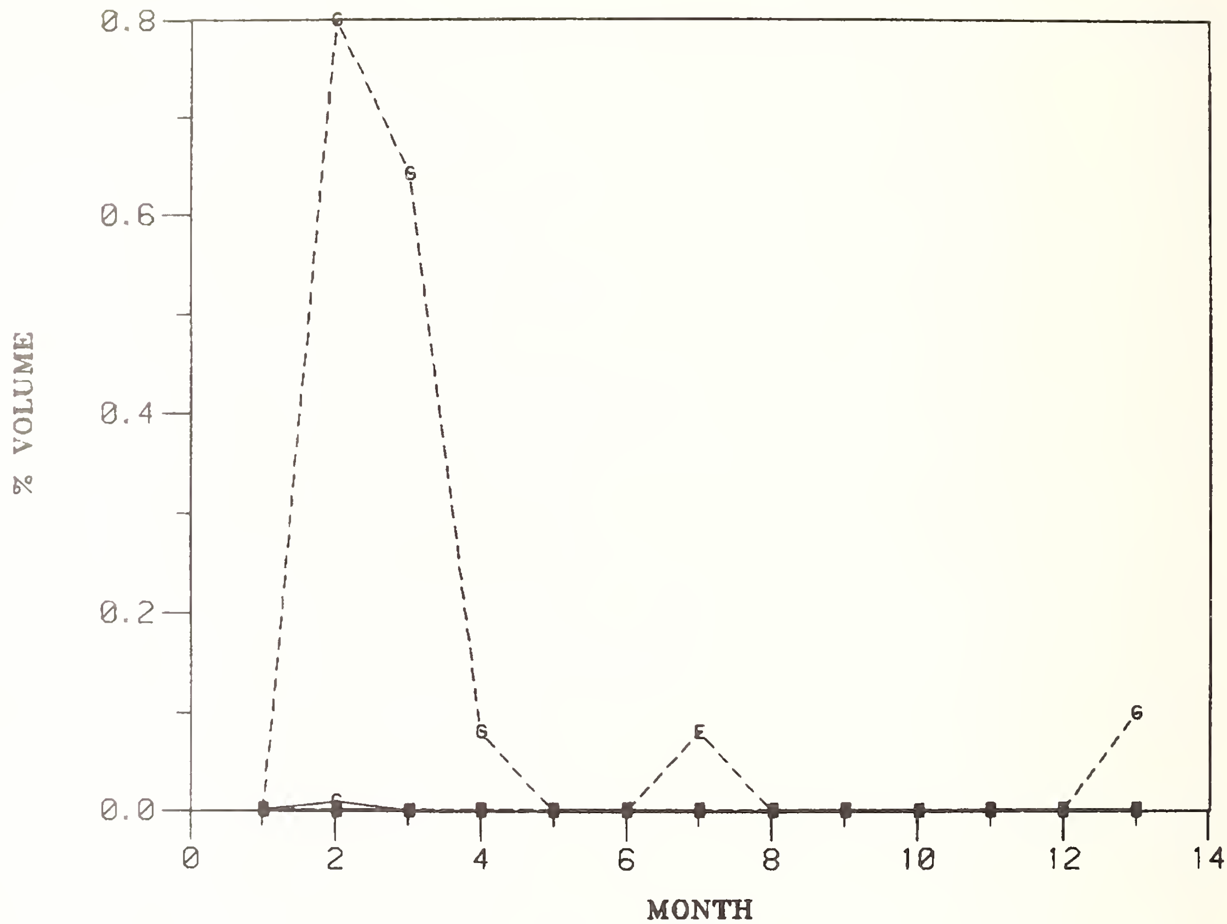
ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: SEDIMENT (% VOL) ASTM D2273 LABORATORY: M

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.000	–	<.001	<.001	.000	<.001	.002	.000	<.001	.000	.001
APR 80	.000	.000	.010	.000	.000	.000	<.001	.800	.000	.002	–
MAY 80	.000	.000	.000	.000	.000	.000	.000	.640	.000	<.001	–
JUN 80	.000	.000	.000	.000	.000	.001	.001	.080	.000	.000	–
JUL 80	.000	.000	.000	.000	.000	.000	.002	.000	.000	.000	–
AUG 80	.000	.000	.000	.000	.000	.001	.001	.002	.002	.003	–
SEP 80	.000	.000	.000	.000	.000	.080	.002	.002	.000	.000	–
OCT 80	.000	.000	.000	.000	.000	.000	.000	.001	.000	.001	–
NOV 80	.000	.000	.000	.000	.000	.000	<.001	<.001	.000	.001	–
DEC 80	.000	.000	.000	.000	.000	.000	.000	.000	.000	<.001	–
JAN 81	.000	.000	<.001	.000	.000	–	<.001	<.001	.000	.000	–
FEB 81	.000	.000	.000	.000	.000	–	.002	<.001	.000	<.001	<.001
MAR 81	.000	.000	.000	.000	.000	–	.001	.100	.000	<.001	<.001
MEAN	.0000	.0000	.0009	.0001	.0000	.0083	.0011	.1252	.0002	.0008	.0010
STD.DEV.	.0000	.0000	.0028	.0003	.0000	.0252	.0008	.2680	.0006	.0009	.0000
MIN	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	<.001
MAX	.000	.000	.010	<.001	.000	.080	.002	.800	.002	.003	.001


SEDIMENT
0.8
0.6
0.4
0.2
0.0
% VOLUME
0
2
4
6
8
10
12
A
B
C
D
I
E
F
G
H
J
K
OIL

SEDIMENT



ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: FOAMING TENDENCY, SEQUENCE I (mL FOAM MADE-mL FOAM BREAK) ASTM D892 LABORATORY: X

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	370-0	-	490-0	468-0	330-0	400-0	10-0	770-0	40-0	390-0	370-0
APR 80	130-0	470-0	240-0	520-0	370-0	140-0	0-0	290-0	280-0	220-0	-
MAY 80	240-0	360-10	120-0	460-10	240-0	260-0	0-0	150-0	230-0	310-0	-
JUN 80	120-0	400-10	300-0	340-Tr	300-0	130-0	13-0	170-Tr	300-0	365-0	-
JUL 80	165-0	490-10	315-0	420-Tr	100-0	40-0	Tr-0	410-0	290-0	330-0	-
AUG 80	170-0	400-Tr	260-0	120-0	480-0	450-0	15-0	90-0	10-0	315-0	-
SEP 80	130-0	550-190	610-0	550-0	120-0	40-0	210-0	310-0	10-Tr	30-0	-
OCT 80	210-0	500-0	340-0	450-0	250-0	380-0	420-0	270-0	100-0	420-0	-
NOV 80	150-0	400-0	260-0	90-0	230-0	350-0	0-0	500-0	220-0	360-0	-
DEC 80	360-0	460-Tr	360-0	390-0	340-0	400-0	20-0	310-0	20-0	250-0	-
JAN 81	300-0	380-0	380-0	170-0	220-0	-	20-0	480-0	90-Tr	0-0	-
FEB 81	170-0	500-0	390-0	140-0	260-0	-	10-0	330-0	220-0	350-0	500-10
MAR 81	240-0	180-0	270-0	290-0	350-0	-	0-0	490-0	270-0	370-0	400-0
MEAN	211.9	424.2	333.5	339.1	276.2	259.0	55.2	351.5	160.0	285.4	423.3
STD.DEV.	85.5	96.5	121.7	160.9	102.6	158.4	123.2	180.9	116.4	131.6	68.1
MIN	120.	180.	120.	90.	100.	40.	0.	90.	10.	0.	370.
MAX	370.	550.	610.	550.	480.	450.	420.	770.	300.	420.	500.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: FOAMING TENDENCY, SEQUENCE II (mL FOAM MADE-mL FOAM BREAK) ASTM D892 LABORATORY: X

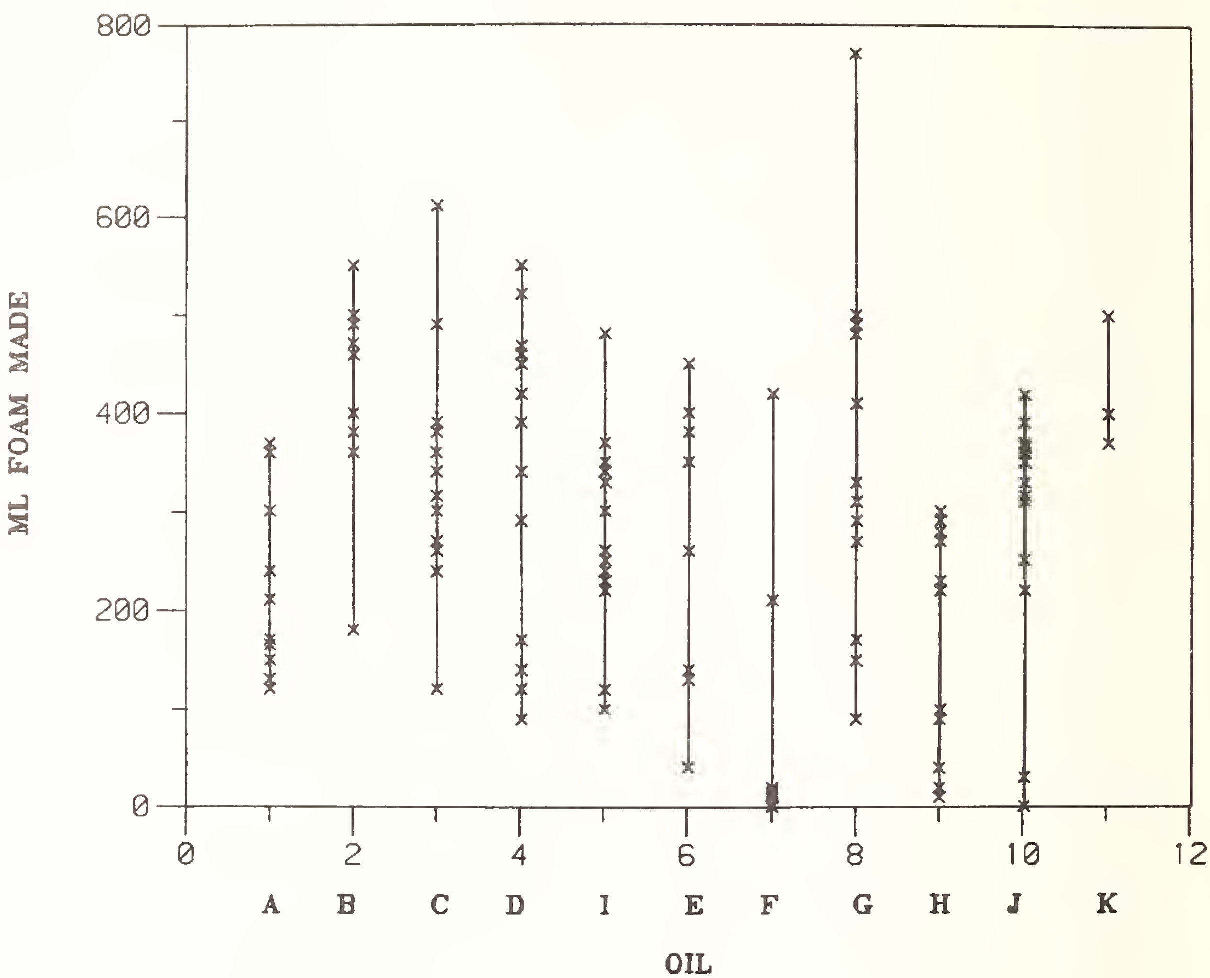
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	20-0	-	10-0	10-0	5-0	20-0	80-0	150-0	40-0	30-0	20-0
APR 80	30-0	20-0	20-0	30-0	20-0	10-0	30-0	30-0	50-0	10-0	-
MAY 80	20-0	40-0	20-0	20-0	10-0	10-0	10-0	50-0	30-0	20-0	-
JUN 80	10-0	20-0	10-0	20-0	10-0	10-0	37-0	10-0	10-0	20-0	-
JUL 80	30-0	40-0	30-0	35-0	20-0	30-0	30-0	110-0	70-0	50-0	-
AUG 80	30-0	40-0	25-0	25-0	25-0	30-0	90-0	30-0	180-0	15-0	-
SEP 80	30-0	40-0	30-0	50-0	10-0	30-0	40-0	40-0	80-0	30-0	-
OCT 80	20-0	50-0	50-0	40-0	30-0	30-0	30-0	40-0	50-0	20-0	-
NOV 80	30-0	50-0	20-0	20-0	20-0	30-0	70-0	0-0	30-0	20-0	-
DEC 80	30-0	50-0	30-0	20-0	10-0	30-0	70-0	40-0	80-0	30-0	-
JAN 81	30-0	50-0	30-0	20-0	20-0	-	50-0	40-0	30-0	Tr-0	-
FEB 81	30-0	50-0	20-0	20-0	10-0	-	30-0	30-0	30-0	30-0	0-0
MAR 81	30-0	40-0	30-0	20-0	20-0	-	20-0	30-0	30-0	20-0	40-0
MEAN	26.2	40.8	25.0	25.4	16.2	23.0	45.2	46.2	54.6	22.7	20.0
STD.DEV.	6.5	10.8	10.4	10.7	7.4	9.5	24.8	40.3	43.3	12.0	20.0
MIN	10.	20.	10.	10.	5.	10.	10.	0.	10.	0.	0.
MAX	30.	50.	50.	50.	30.	30.	90.	150.	180.	50.	40.

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

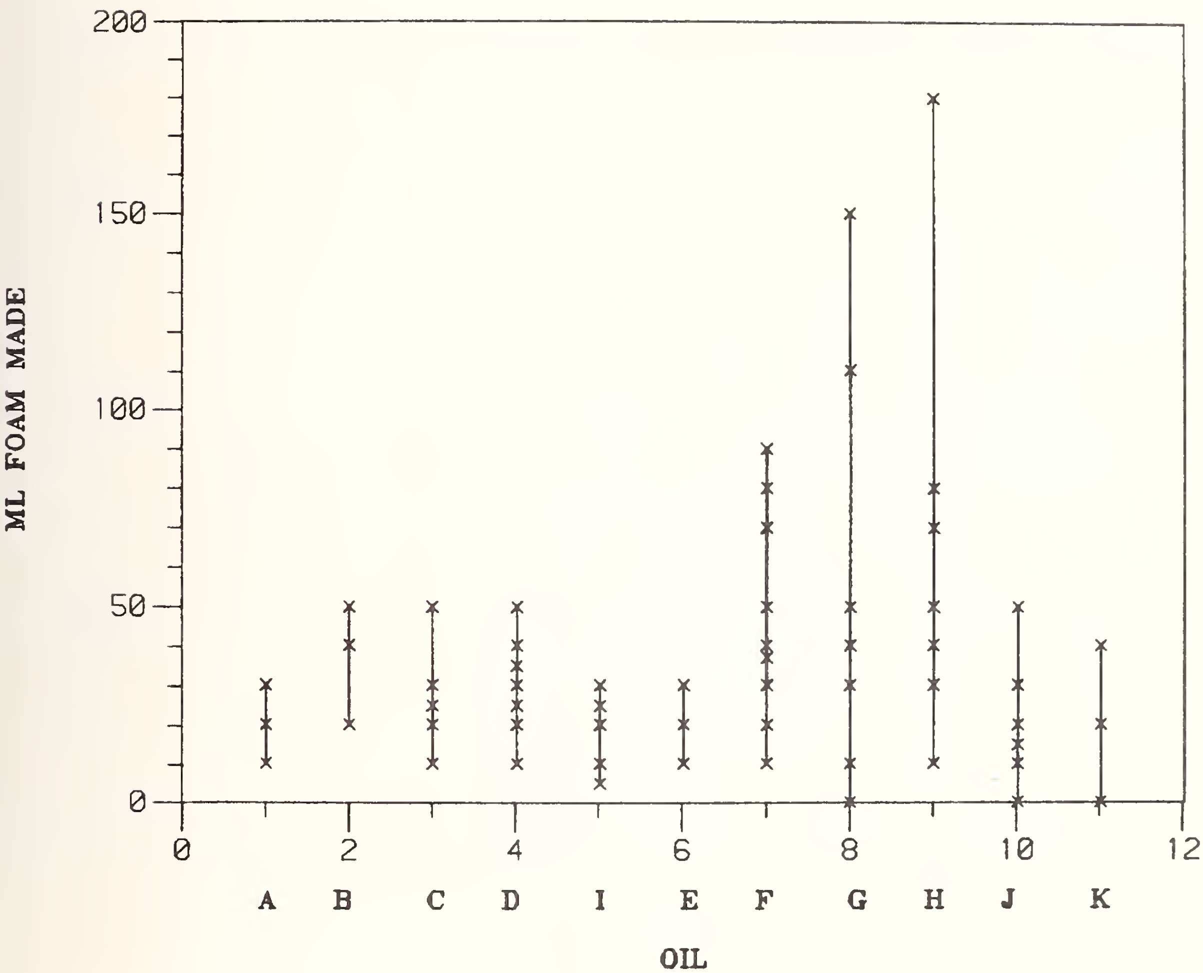
TEST: FOAMING TENDENCY, SEQUENCE III (mL FOAM MADE-mL FOAM BREAK) ASTM D892 LABORATORY: X

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	420-0	-	480-0	600-0	310-0	270-0	10-0	760-0	10-0	370-0	320-0
APR 80	280-0	520-0	270-0	320-0	250-0	120-0	0-0	480-0	360-0	320-0	-
MAY 80	100-0	470-0	120-0	500-10	190-0	270-0	0-0	620-0	330-0	230-0	-
JUN 80	110-0	400-10	240-0	360-0	250-0	100-0	53-0	120-0	330-0	360-0	-
JUL 80	210-0	430-Tr	305-0	370-0	170-0	410-0	Tr-0	435-0	340-0	580-0	-
AUG 80	290-0	570-Tr	430-0	305-0	230-0	200-0	10-0	290-0	20-0	100-0	-
SEP 80	230-0	330-30	320-0	500-0	10-0	370-Tr	20-0	360-0	50-10	410-0	-
OCT 80	190-0	0-0	430-0	270-0	190-0	320-0	380-0	300-0	120-0	370-0	-
NOV 80	230-0	310-0	400-0	190-0	20-0	410-0	0-0	520-0	300-0	320-0	-
DEC 80	280-0	390-Tr	340-0	370-0	260-0	0-0	0-0	380-0	150-0	390-0	-
JAN 81	260-0	480-Tr	510-0	330-0	80-0	-	Tr-0	380-0	310-0	10-0	-
FEB 81	210-0	380-0	360-0	380-0	280-0	-	0-0	380-0	220-0	290-0	420-Tr
MAR 81	260-0	380-0	310-0	290-0	280-0	-	0-0	360-0	350-0	340-0	420-0
MEAN	236.2	388.3	347.3	368.1	193.8	247.0	36.4	414.2	222.3	314.6	386.7
STD.DEV.	81.5	143.9	105.6	109.5	99.1	139.7	104.3	158.7	134.6	141.6	57.7
MIN	100.	0.	120.	190.	10.	0.	0.	120.	10.	10.	320.
MAX	420.	570.	510.	600.	310.	410.	380.	760.	360.	580.	420.

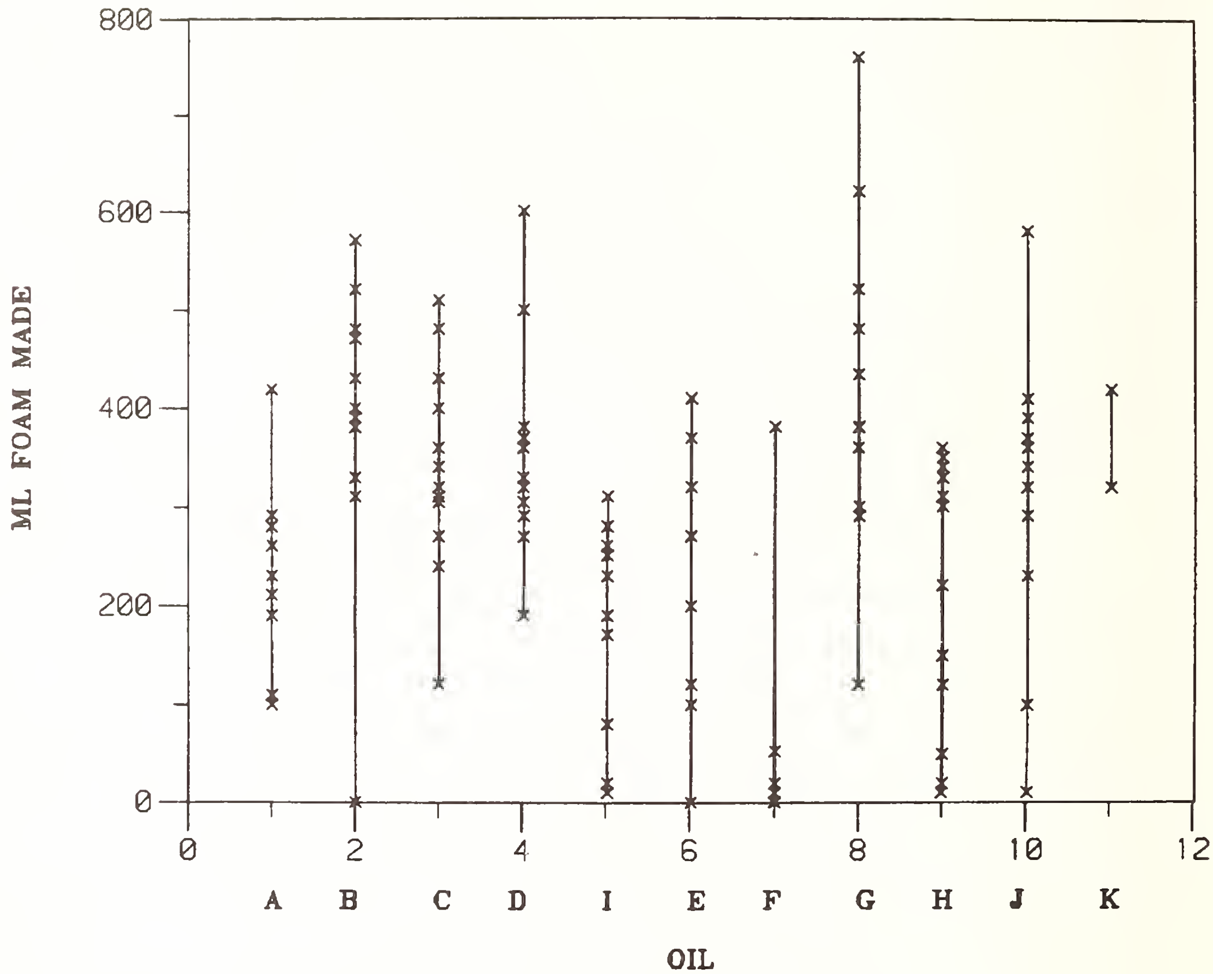
FOAM SEQUENCE 1



FOAM SEQUENCE 2



FOAM SEQUENCE 3



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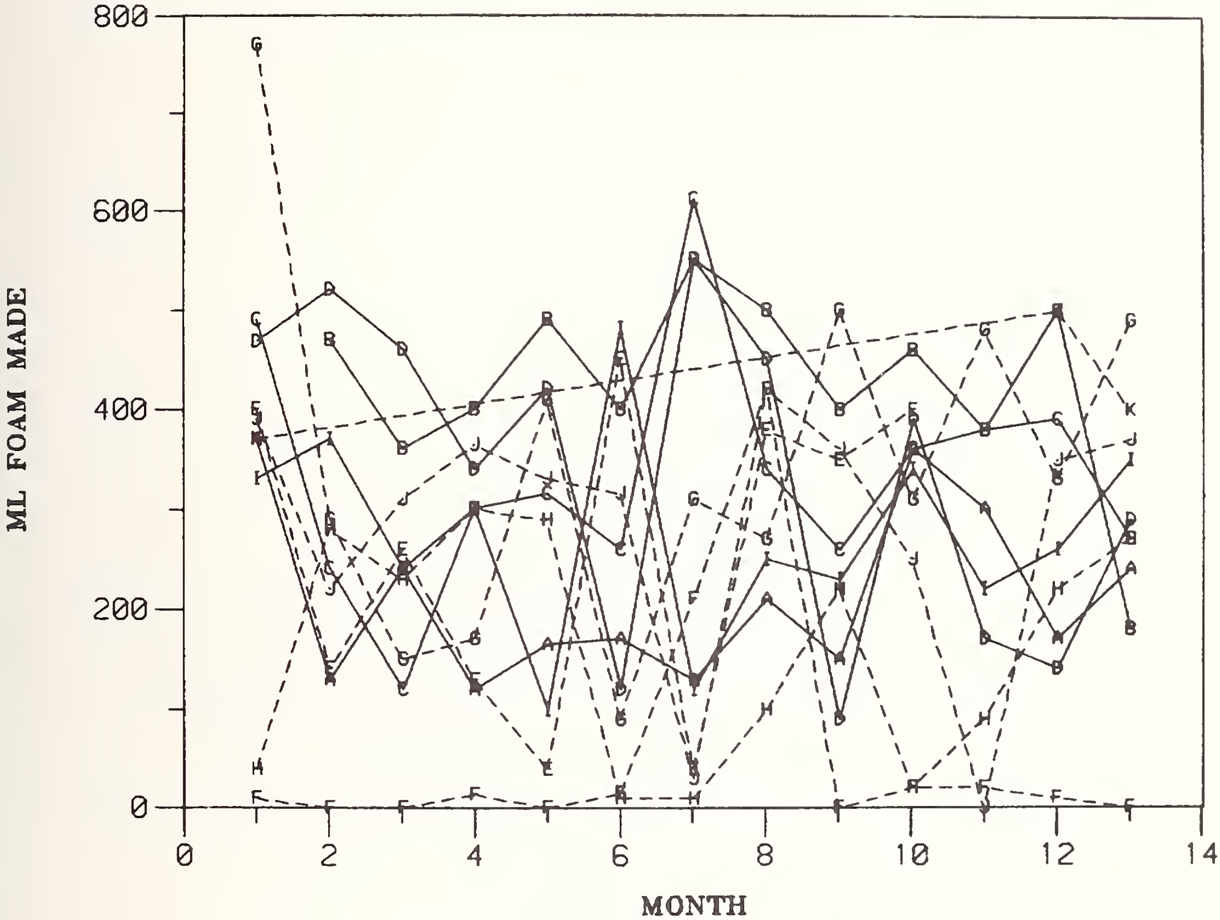

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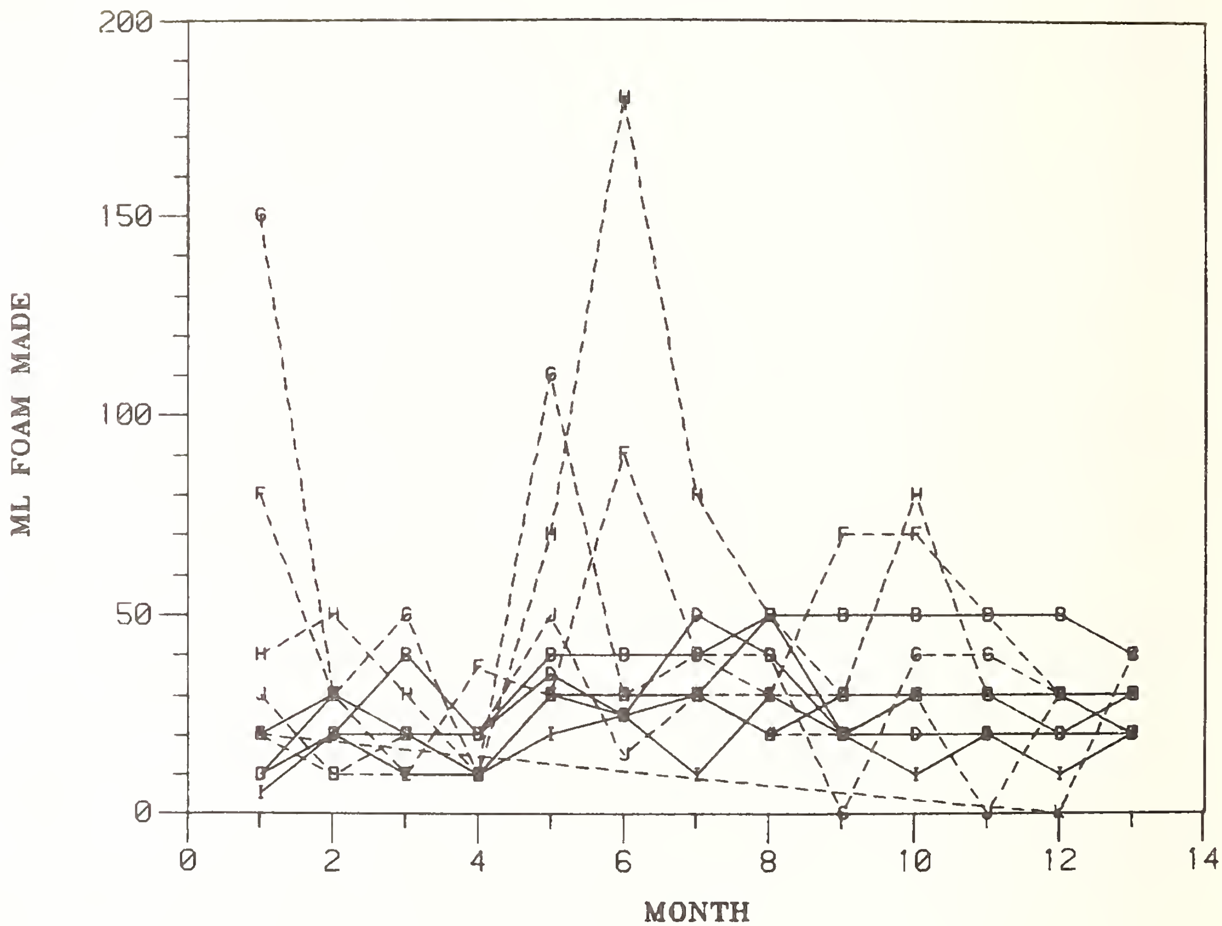
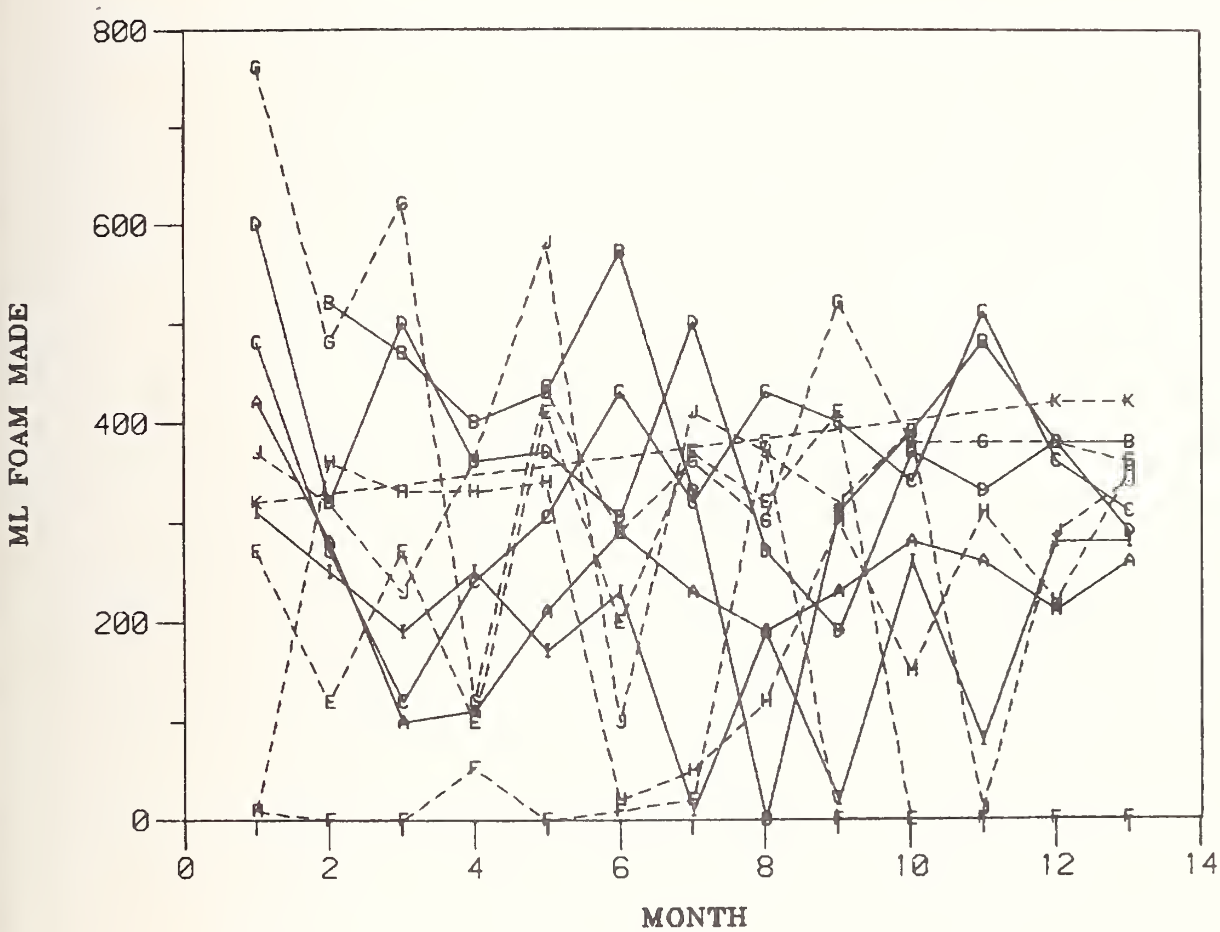


FOAM SEQUENCE 3



ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: RUST (NONE=0.LIGHT=1.MEDIUM=2,HEAVY=3.SEVERE=4) ASTM D665, PROCEDURE A

LABORATORY: X

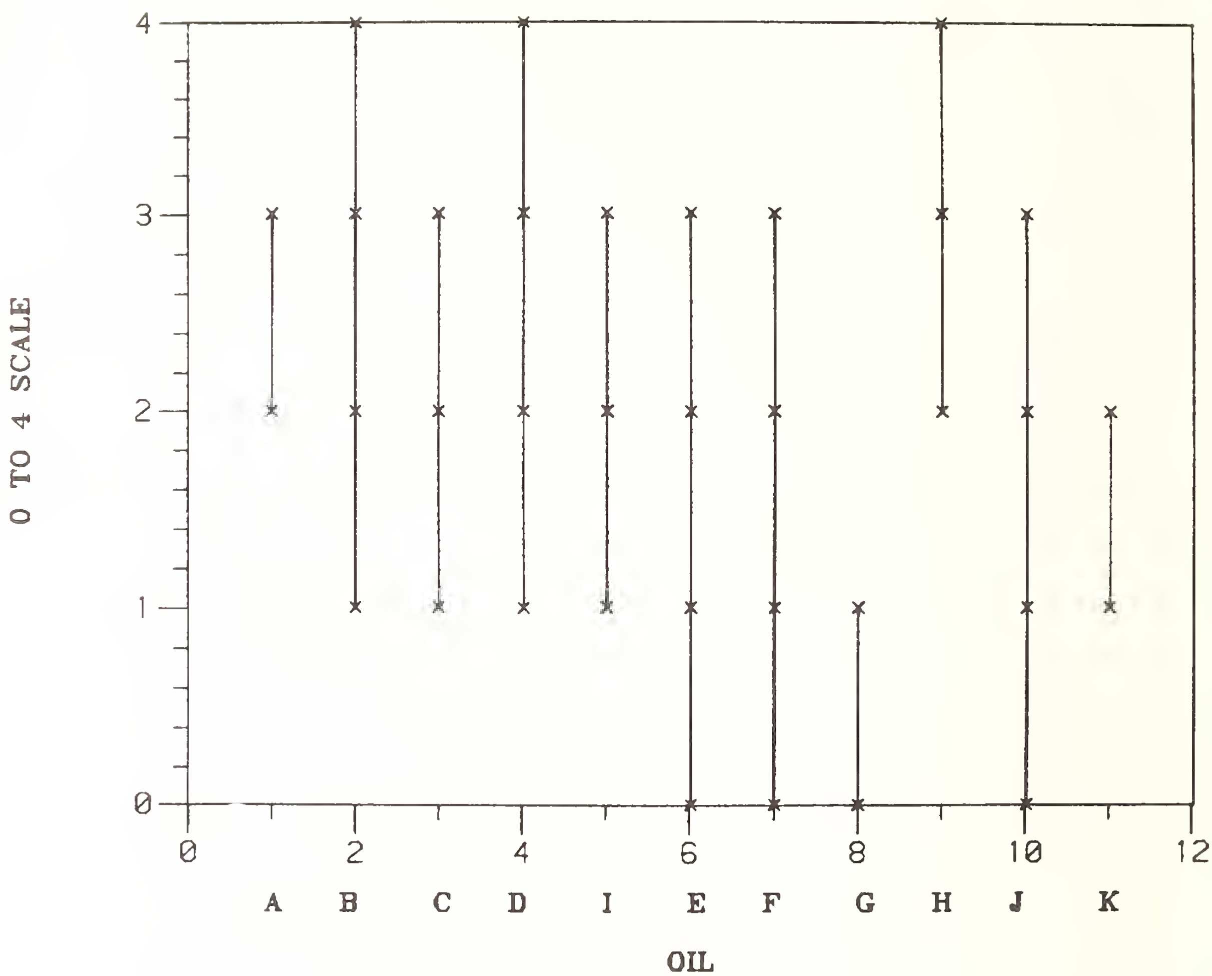
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	3.	-	3.	3.	2.	2.	1.	1.	3.	2.	2.
APR 80	3.	3.	3.	3.	3.	0.	0.	0.	3.	2.	-
MAY 80	3.	3.	3.	3.	2.	0.	1.	1.	3.	0.	-
JUN 80	3.	2.	3.	3.	2.	1.	1.	0.	3.	3.	-
JUL 80	3.	3.	3.	3.	2.	1.	2.	0.	3.	2.	-
AUG 80	3.	3.	3.	3.	3.	1.	0.	0.	3.	1.	-
SEP 80	3.	3.	3.	3.	1.	1.	3.	0.	3.	1.	-
OCT 80	3.	3.	3.	3.	2.	0.	3.	0.	3.	0.	-
NOV 80	3.	4.	3.	4.	1.	3.	1.	1.	4.	0.	-
DEC 80	2.	3.	3.	3.	2.	0.	2.	0.	3.	1.	-
JAN 81	3.	2.	2.	2.	1.	-	2.	0.	3.	0.	-
FEB 81	2.	2.	2.	3.	3.	-	2.	0.	2.	0.	2.
MAR 81	3.	1.	1.	1.	3.	-	0.	0.	2.	0.	1.
MEAN	2.8	2.7	2.7	2.8	2.1	.9	1.4	.2	2.9	.9	1.7
STD.DEV.	.4	.8	.6	.7	.8	1.0	1.0	.4	.5	1.0	.6
MIN	2.	1.	1.	1.	1.	0.	0.	0.	2.	0.	1.
MAX	3.	4.	3.	4.	3.	3.	3.	1.	4.	3.	2.

ASTM/NBS BASESTOCK CONSISTENCY STUDY

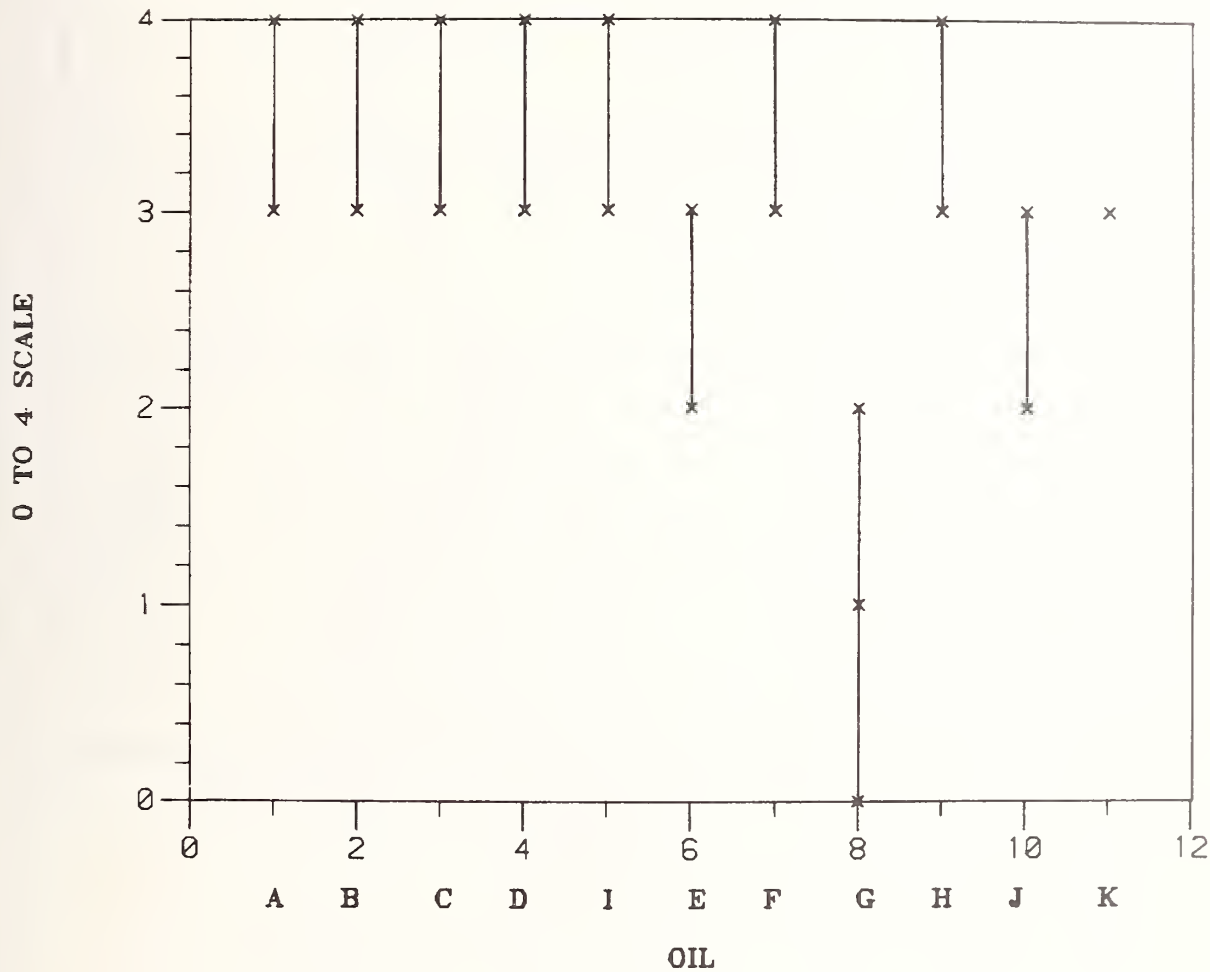
TEST: RUST (NONE=0,LIGHT=1,MEDIUM=2,HEAVY=3,SEVERE=4) ASTM D665, PROCEDURE B LABORATORY: X

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE :	A	B	C	D	I	E	F	G	H	J	K
MAR 80 :	3.	-	3.	3.	3.	3.	3.	1.	3.	3.	3.
APR 80 :	3.	3.	3.	3.	3.	3.	3.	0.	3.	2.	-
MAY 80 :	3.	3.	3.	3.	3.	3.	3.	0.	3.	2.	-
JUN 80 :	3.	3.	3.	3.	3.	3.	2.	0.	3.	3.	-
JUL 80 :	3.	3.	3.	3.	3.	3.	3.	2.	3.	3.	-
AUG 80 :	3.	3.	3.	3.	3.	3.	3.	0.	3.	3.	-
SEP 80 :	3.	3.	3.	3.	3.	3.	3.	0.	3.	3.	-
OCT 80 :	4.	3.	4.	4.	4.	3.	4.	0.	3.	2.	-
NOV 80 :	3.	4.	3.	4.	4.	3.	3.	1.	4.	3.	-
DEC 80 :	4.	4.	3.	4.	3.	2.	3.	0.	3.	3.	-
JAN 81 :	3.	3.	3.	3.	3.	-	3.	0.	3.	2.	-
FEB 81 :	3.	3.	3.	4.	4.	-	3.	0.	3.	2.	3.
MAR 81 :	3.	3.	3.	3.	4.	-	3.	0.	3.	3.	3.
MEAN :	3.2	3.2	3.1	3.3	3.3	2.9	3.0	.3	3.1	2.6	3.0
STD.DEV. :	.4	.4	.3	.5	.5	.3	.4	.6	.3	.5	.0
MIN :	3.	3.	3.	3.	3.	2.	2.	0.	3.	2.	3.
MAX :	4.	4.	4.	4.	4.	3.	4.	2.	4.	3.	3.

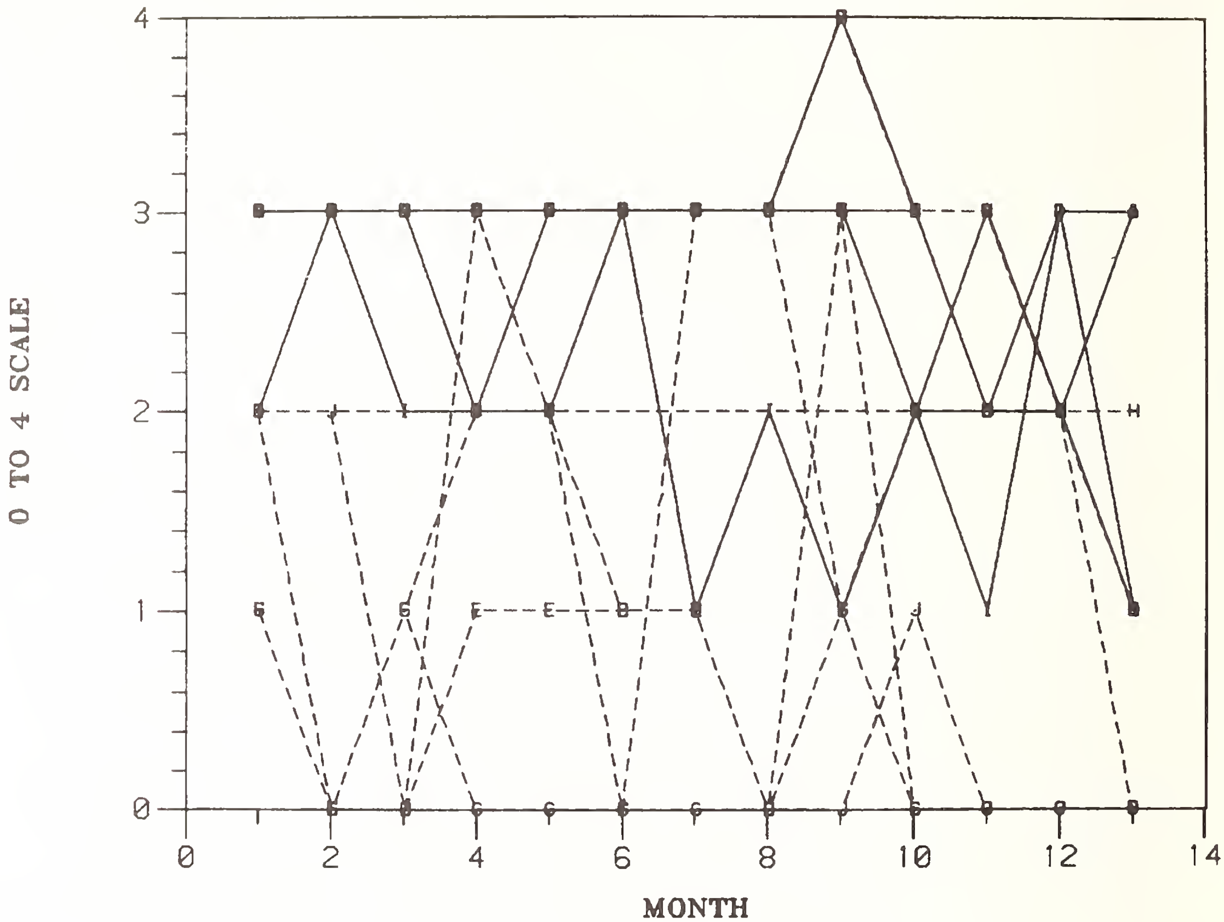
RUST, PROCEDURE A



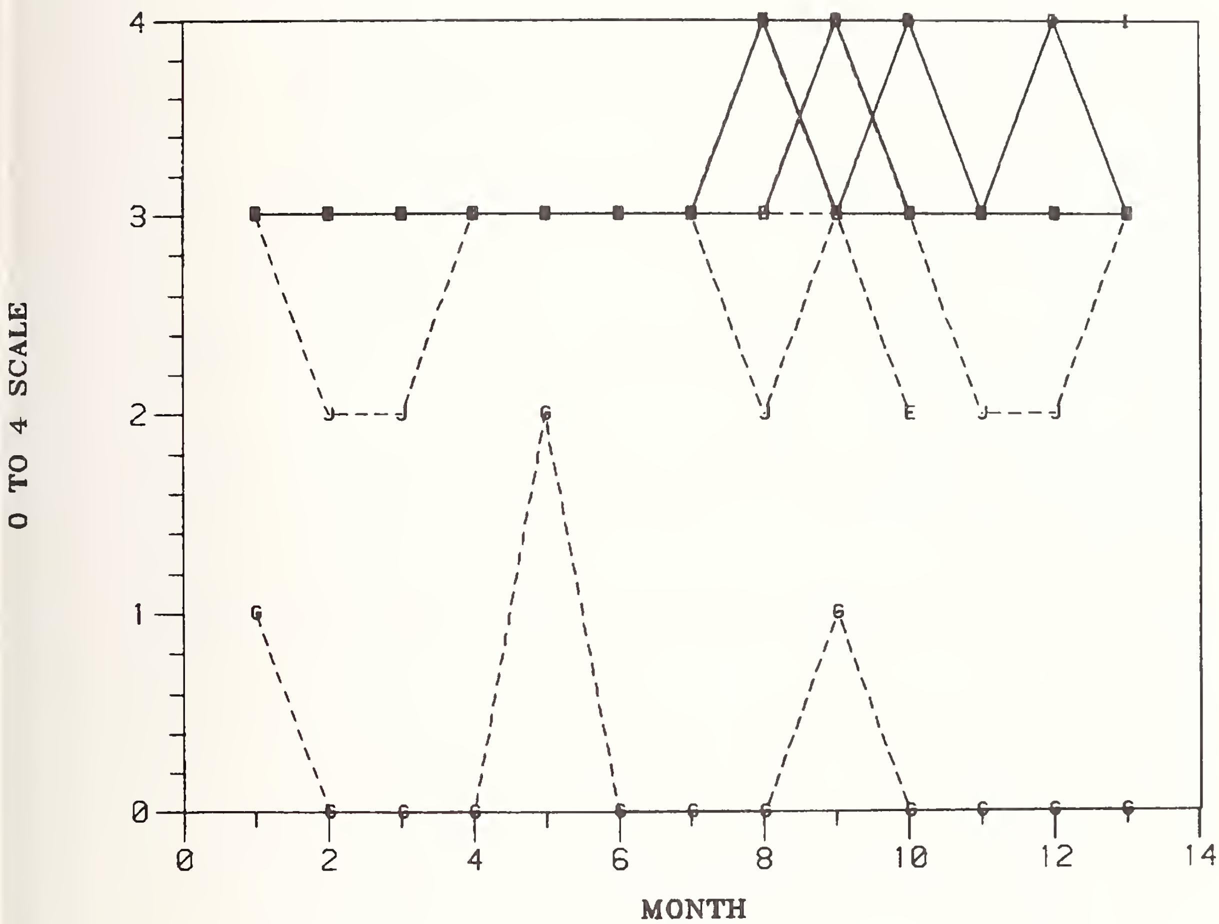
RUST, PROCEDURE B



RUST, PROCEDURE A



RUST, PROCEDURE B



ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: HIGH TEMP COPPER CORROSION (P=PASS,F=FAIL,S=SLIGHT,H=HEAVY)   LABORATORY: Y

DATE	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	--	--	HF	P
APR 80	P	P	P	P	SF	SF	P	P	P	P	-
MAY 80	P	SF	SF	P	SF	SF	HF	P	P	P	-
JUN 80	P	P	P	P	SF	P	SF	P	SF	P	-
JUL 80	P	P	P	P	P	P	P	P	P	P	-
AUG 80	SF	P	P	P	P	SF	P	P	P	P	-
SEP 80	--	--	--	--	--	--	--	--	--	--	-
OCT 80	--	--	--	--	--	--	--	--	--	--	-
NOV 80	--	--	--	--	--	--	--	--	--	--	-
DEC 80	--	--	--	--	--	--	--	--	--	--	-
JAN 81	--	--	--	--	--	-	--	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	--
MAR 81	--	--	--	--	--	-	--	--	--	--	--
MEAN	-	-	-	P	-	-	-	P	-	-	P
STD.DEV.	-	-	-	.0	-	-	-	.0	-	-	.0
MIN	P	P	P	P	P	P	P	P	P	P	P
MAX	SF	SF	SF	P	SF	SF	HF	P	SF	HF	P

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: CD/SE ADDITIVE COMPATIBILITY, WEEK 1, 0 DEG F (C=CLEAR,Z=HAZE,T=TRACE SEDIMENT) LABORATORY: X

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	C	-	C	C/T	C/T	C	C/T	C	C/T	C	C/T
APR 80	C	C	C	C	C/T	C	C	C	C	C	-
MAY 80	C	C	C	C	C	C	C	C	C	C/T	-
JUN 80	C/T	C	C	C	C	C	SZ	C/T	C	C	-
JUL 80	C	C	C	C.	C	C	Z	C/T	C/T	C	-
AUG 80	C	C	C	C	C	C	C	C	C	C	-
SEP 80	C	C	C	C	C	C	C	C	C	C/T	-
OCT 80	C	C	C	C	C	C	C	C	C	C/T	-
NOV 80	C	C	C	C	C	C/T	VSZ	C	C	C/T	-
DEC 80	C/T	VSZ	VSZ	VSZ	C	VSZ	VSZ/T	C/T	C/T	C	-
JAN 81	C	VSZ/T	VSZ	C/T	VSZ	-	SZ	C/T	C	C/T	-
FEB 81	C/T	VSZ/T	C/T	VSZ/T	VSZ/T	-	VSZ/T	C/T	C/T	C/T	C/T
MAR 81	C	C	C	VSZ	C	-	SZ	SZ	C/T	C	SZ
MEAN	-	-	-	-	-	-	-	-	-	-	-
STD.DEV.	-	-	-	-	-	-	-	-	-	-	-
MIN	C	C	C	C	C	C	C	C	C	C	C/T
MAX	C/T	VSZ/T	VSZ	VSZ/T	VSZ/T	VSZ	SZ	SZ	C/T	C/T	SZ

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: CD/SE ADDITIVE COMPATABILITY, WEEK 1, 32 DEG F (C=CLEAR,Z=HAZE,T=TRACE SEDIMENT) LABORATORY: X

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	C	-	C	C	C	C	C	C	C	C	C/T
APR 80	C	C	C	C	C/T	C	C	C/T	C/T	C	-
MAY 80	C	C	C	C	C	C	C	C	C	C/T	-
JUN 80	C	C	C	C	C	C	C	C/T	C	C/T	-
JUL 80	C	C	C	C	C	C	Z	C/T	C	C	-
AUG 80	C	C	C	C	C	C	C	C	C	C	-
SEP 80	C	C	C	C	C	C	C	C	C	C	-
OCT 80	C	C/T	C	C	C	C	C	C	C	C/T	-
NOV 80	C	C	C	C	C	C	VSZ/T	C	C	C	-
DEC 80	C/T	C/T	C	VSZ/T	C	VSZ/T	VSZ/T	C/T	C/T	C	-
JAN 81	C/T	VSZ/T	C	C/T	VSZ	-	SZ/T	C	C	C/T	-
FEB 81	C/T	C/T	C/T	C/T	C/T	-	VSZ/T	C/T	VSZ/T	C/T	C/T
MAR 81	VSZ/T	C/T	C	VSZ	C/T	-	VSZ/T	VSZ/T	C/T	C	C/T
MEAN	-	-	-	-	-	-	-	-	-	-	-
STD.DEV.	-	-	-	-	-	-	-	-	-	-	-
MIN	C	C	C	C	C	C	C	C	C	C	C/T
MAX	VSZ/T	VSZ/T	C/T	VSZ/T	VSZ	VSZ/T	Z	VSZ/T	VSZ/T	C/T	C/T

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: CD/SE ADDITIVE COMPATABILITY, WEEK 1, RM TEMP (C=CLEAR,Z=HAZE,T=TRACE SEDIMENT) LABORATORY: X

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	C/T	-	C	C	C	C	C	C	C	C	C
APR 80	C	C	C	C	C	C/T	C	C/T	C	C	-
MAY 80	C	C	C	C	C	C/T	C	C	C	C	-
JUN 80	C	C	C	C	C	C	C	SZ/T	C	C	-
JUL 80	C	C	C	C	C	C	Z	C	C	C	-
AUG 80	C	C	C	C	C	C	C	C	C	C	-
SEP 80	C	C	C	C	C	C	C	C	C	C	-
OCT 80	C	C	C	C	C	C	C	C	C	C/T	-
NOV 80	C	C	C	C	C	C	VSZ/T	C	C	C	-
DEC 80	C/T	VSZ/T	VSZ/T	VSZ/T	VSZ/T	VSZ	VSZ/T	C/T	C/T	C/T	-
JAN 81	C/T	VSZ/T	C/T	C/T	VSZ	-	SZ/T	C/T	C	VSZ/T	-
FEB 81	VSZ/T	VSZ/T	VSZ/T	VSZ/T	VSZ/T	-	VSZ	C/T	VSZ/T	C/T	VSZ/T
MAR 81	C/T	VSZ/T	C	VSZ	C/T	-	VSZ/T	C/T	C/T	C	C/T
MEAN	-	-	-	-	-	-	-	-	-	-	-
STD.DEV.	-	-	-	-	-	-	-	-	-	-	-
MIN	C	C	C	C	C	C	C	C	C	C	C
MAX	VSZ/T	VSZ/T	VSZ/T	VSZ/T	VSZ/T	VSZ	Z	SZ/T	VSZ/T	VSZ/T	VSZ/T

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: CD/SE ADDITIVE COMPATIBILITY, WEEK 1, 150 DEG F (C=CLEAR,Z=HAZE,T=TRACE SEDIMENT) LABORATORY: X

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	C	–	C	C	C/T	C	C/T	C	C	C	C
APR 80	C	C	C	C	C	C	C	C	C	C	–
MAY 80	C	C	C	C	C	C	C	C	C	C/T	–
JUN 80	C	C	C	C	C	C	C	C/T	C/T	C/T	–
JUL 80	C/T	C	C	C	C	C	Z	C	C	C	–
AUG 80	C	C	C	C	C	C	C/T	C/T	C	C	–
SEP 80	C	C	C	C	C	C	C	C/T	C	C	–
OCT 80	C	C	C	C	C	C	C	C	C	C/T	–
NOV 80	C	C	C	C	C	C	VSZ/T	C	C	C/T	–
DEC 80	C/T	C/T	C/T	C/T	C/T	C/T	VSZ/T	C/T	C/T	C/T	–
JAN 81	C/T	C/T	C/T	C/T	C/T	–	SZ/T	C/T	C/T	C/T	–
FEB 81	C/T	C/T	C/T	C/T	C/T	–	VSZ/T	C/T	C/T	C/T	C/T
MAR 81	C/T	C/T	C/T	C/T	C/T	–	SZ	C/T	C/T	C/T	C/T
MEAN	–	–	–	–	–	–	–	–	–	–	–
STD.DEV	–	–	–	–	–	–	–	–	–	–	–
MIN	C	C	C	C	C	C	C	C	C	C	C
MAX	C/T	C/T	C/T	C/T	C/T	C/T	SZ	C/T	C/T	C/T	C/T

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: CD/SE ADDITIVE COMPATABILITY, WEEK 4, 0 DEG F (C=CLEAR,Z=HAZE,T=TRACE SEDIMENT) LABORATORY: X

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	C/T	-	C	C/T	C/T	C	C/T	C/T	C/T	C	C/T
APR 80	C	C	C	C	C	C	C	C	C	C	-
MAY 80	C	C/T	C/T	C	C	C	C	C/T	C/T	C/T	-
JUN 80	C/T	C	C	C	C	C/T	C	SZ/T	C	C	-
JUL 80	C	C	C	C	C	C/T	Z	C	C/T	C	-
AUG 80	C	C	C	C	C	C	C	C	C	C	-
SEP 80	C/T	C	C/T	C	C	C/T	C	C/T	C/T	C/T	-
OCT 80	C	C	C	C	C	C	C	C	C	C/T	-
NOV 80	C/T	C	C	C	C/T	C/T	VSZ	C	C	C/T	-
DEC 80	C/T	VSZ/T	C/T	C/T	C/T	C/T	VSZ	SZ/T	C/T	C	-
JAN 81	C	VSZ	C	C	VSZ	-	VSZ/T	C/T	C	C/T	-
FEB 81	C/T	C	C/T	C/T	C/T	-	VSZ/T	C/T	C/T	C/T	C/T
MAR 81	C/T	C	C/T	VSZ	C/T	-	SZ	C/T	C/T	C/T	C/T
MEAN	-	-	-	-	-	-	-	-	-	-	-
STD.DEV.	-	-	-	-	-	-	-	-	-	-	-
MIN	C	C	C	C	C	C	C	C	C	C	C/T
MAX	C/T	VSZ/T	C/T	VSZ	VSZ	C/T	SZ	SZ/T	C/T	C/T	C/T

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: CD/SE ADDITIVE COMPATABILITY. WEEK 4, 32 DEG F (C=CLEAR, Z=HAZE, T=TRACE SEDIMENT) LABORATORY: X

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	C/T	-	C	C	C	C/T	C/T	C	C	C/T	C/T
APR 80	C	C	C	C	C	C	C	C	C	C	-
MAY 80	C/T	C	C	C/T	C	C	C	C/T	C	C/T	-
JUN 80	C	C	C	C	C	C/T	C	SZ/T	C	C/T	-
JUL 80	C	C	C	C	C/T	C	Z/T	C/T	C/T	C	-
AUG 80	C	C	C	C	C	C	C	C	C	C	-
SEP 80	C/T	C	C/T	C	C	C/T	C	C/T	C	C/T	-
OCT 80	C/T	C/T	C/T	C	C/T	C	C	C/T	C	C/T	-
NOV 80	C/T	C	C	C	C	C/T	VSZ/T	C	C/T	C/T	-
DEC 80	C/T	C/T	C/T	C/T	C/T	C/T	VSZ/T	C/T	C/T	C	-
JAN 81	C/T	VSZ/T	C/T	C/T	C/T	-	VSZ/T	C/T	C/T	C/T	-
FEB 81	C/T	C/T	C/T	C/T	C/T	-	VSZ/T	C/T	C/T	C/T	C/T
MAR 81	C/T	VSZ/T	C/T	VSZ/T	C/T	-	SZ	C/T	C/T	C/T	C/T
MEAN	-	-	-	-	-	-	-	-	-	-	-
STD.DEV.	-	-	-	-	-	-	-	-	-	-	-
MIN	C	C	C	C	C	C	C	C	C	C	C/T
MAX	C/T	VSZ/T	C/T	VSZ/T	C/T	C/T	Z/T	SZ/T	C/T	C/T	C/T

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: CD/SE ADDITIVE COMPATIBILITY, WEEK 4, RM TEMP (C=CLEAR,Z=HAZE,T=TRACE SEDIMENT)   LABORATORY: X

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	C/T	-	C	C	C	C	C	C	C	C/T	C
APR 80	C	C	C	C	C	C	C	C/T	C	C	-
MAY 80	C/T	C	C/T	C/T	C/T	C/T	C/T	C/T	C/T	C	-
JUN 80	C	C	C	C	C/T	C/T	C/T	SZ/T	C	C	-
JUL 80	C	C	C	C	C	C	Z	C/T	C/T	C	-
AUG 80	C/T	C	C	C	C/T	C/T	C	C/T	C	C	-
SEP 80	C	C	C/T	C	C	C/T	C	C	C	C/T	-
OCT 80	C/T	C	C/T	C/T	C/T	C/T	C	C/T	C	C/T	-
NOV 80	C/T	C	C/T	C	C/T	C/T	SZ/T	C/T	C/T	C/T	-
DEC 80	C/T	VSZ/T	C/T	C/T	C/T	C/T	SZ/T	C/T	C/T	C/T	-
JAN 81	C/T	VSZ/T	C/T	C/T	VSZ/T	-	SZ/T	C/T	C/T	C/T	-
FEB 81	C/T	C/T	C/T	C/T	C/T	-	VSZ/T	C/T	C/T	C/T	C/T
MAR 81	C/T	C/T	C/T	C/T	C/T	-	SZ	C/T	C/T	C/T	C/T
MEAN	-	-	-	-	-	-	-	-	-	-	-
STD.DEV.	-	-	-	-	-	-	-	-	-	-	-
MIN	C	C	C	C	C	C	C	C	C	C	C
MAX	C/T	VSZ/T	C/T	C/T	VSZ/T	C/T	SZ	SZ/T	C/T	C/T	C/T

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: CD/SE ADDITIVE COMPATIBILITY, WEEK 4, 150 DEG F (C=CLEAR, Z=HAZE, T=TRACE SEDIMENT) LABORATORY: X

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	C/T	-	C/T	C/T	C/T	C	C/T	C/T	C/T	C/T	C/T
APR 80	C	C	C	C	C	C/T	C/T	C/T	C	C/T	-
MAY 80	C/T	C/T	C/T	C/T	C/T	C/T	C/T	C/T	C/T	C/T	-
JUN 80	C/T	C	C	C	C/T	C/T	C/T	C/T	C/T	C/T	-
JUL 80	C/T	C	C/T	C	C/T	C/T	C/T	C/T	C/T	C/T	-
AUG 80	C	C	C/T	C	C/T	C/T	C/T	C/T	C	C/T	-
SEP 80	C/T	C	C/T	C/T	C/T	C/T	C/T	C/T	C/T	C/T	-
OCT 80	C/T	C/T	C/T	C/T	C	C/T	C/T	C/T	C	C/T	-
NOV 80	C/T	C/T	C/T	C/T	C/T	C/T	C/T	C/T	C/T	C/T	-
DEC 80	C/T	C/T	C/T	C/T	C/T	C/T	C/T	C/T	C/T	C/T	-
JAN 81	C/T	C/T	C/T	C/T	C/T	-	VSZ/T	C/T	C/T	C/T	-
FEB 81	C/T	C/T	C/T	C/T	C/T	-	VSZ/T	C/T	C/T	C/T	C/T
MAR 81	C/T	C/T	C/T	C/T	C/T	-	SZ	C/T	C/T	C/T	C/T
MEAN	-	-	-	-	-	-	-	-	-	-	-
STD.DEV.	-	-	-	-	-	-	-	-	-	-	-
MIN	C	C	C	C	C	C	C/T	C/T	C	C/T	C/T
MAX	C/T	C/T	C/T	C/T	C/T	C/T	SZ	C/T	C/T	C/T	C/T

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: STORAGE STABILITY, APPEARANCE AS RECEIVED (SEE APPENDIX II) LABORATORY: M

DATE	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
	A	B	C	D	I	E	F	G	H	J	K
MAR 80	C	–	C	C	C	C	C	C	C	C	C
APR 80	C	C	T/TS*	C	C	C	C	T*	C	C	–
MAY 80	C	C	C	C	C	C	C	C*	C	C	–
JUN 80	C	C	C	C	C	C	C	C*	C	C	–
JUL 80	C	C	C	C	C	C	C	C	C	C	–
AUG 80	C	C	C	C	C	C	C	C	C	C	–
SEP 80	C	C	C	C	C	C	C*	C	C	C	–
OCT 80	C	C	C	C	C	C	C	C	C	C	–
NOV 80	C	C	C	C	C	C	C	C	C	C	–
DEC 80	C	C	C	C	C	C	C	C	C	C	–
JAN 81	C	C	C	C	C	–	C	C	C	C	–
FEB 81	C	C	C	C	C	–	C	C	C	C	C
MAR 81	C	C	C	C	C	–	C	C	C	C	C
MEAN											
STD.DEV.											
MIN											
MAX											

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: STORAGE STABILITY, CCLOR AS RECEIVED (SEE APPENDIX II) LABORATORY: M

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	L1.5	-	L1.0	L1.0	L2.5	L3.0	4.5	5.0	6.0	3.5	L3.0
APR 80	1.5	1.0	.5	.5	2.5	2.5	4.0	6.0	6.0	L4.0	-
MAY 80	L1.5	L1.5	.5	L1.5	2.5	2.0	3.5	5.5	5.5	3.0	-
JUN 80	L1.5	L1.5	.5	.5	L2.5	L3.0	4.5	6.0	6.0	L3.5	-
JUL 80	L2.0	L1.5	L1.0	L1.0	L2.5	L3.0	3.5	7.0	5.5	L3.0	-
AUG 80	L1.5	L1.5	.5	L1.0	L2.5	2.5	4.5	7.0	6.5	4.5	-
SEP 80	L2.0	L1.5	L1.0	L1.0	2.5	L3.0	L4.5	5.5	5.5	L3.5	-
OCT 80	L2.0	1.5	L1.0	.5	L2.5	L3.0	3.5	5.5	6.5	4.5	-
NOV 80	L2.0	1.5	L1.0	.5	L2.5	2.5	4.0	5.0	6.0	4.5	-
DEC 80	2.0	1.5	L1.0	L1.0	L2.5	L3.0	4.5	5.0	6.5	L5.0	-
JAN 81	1.5	L1.5	.5	L1.0	2.5	-	3.5	4.0	5.5	4.0	-
FEB 81	L2.0	L2.0	.5	.5	L2.5	-	L3.5	5.0	6.5	6.5	6.0
MAR 81	L2.0	L3.5	L1.0	L1.0	L2.5	-	3.0	4.5	5.5	4.0	6.5
MEAN	1.77	1.67	.77	.85	2.50	2.75	3.92	5.46	5.96	4.12	5.17
STD.DEV.	.26	.62	.26	.32	.00	.35	.53	.88	.43	.94	1.89
MIN	1.5	1.0	.5	.5	2.5	2.0	3.0	4.0	5.5	3.0	3.0
MAX	2.0	3.5	1.0	1.5	2.5	3.0	4.5	7.0	6.5	6.5	6.5

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: STORAGE STABILITY, SEDIMENT AS RECEIVED (SEE APPENDIX II) LABORATORY: M

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.000	–	<.001	<.001	.000	<.001	.002	.000	<.001	.000	.001
APR 80	.000	.000	.010	.000	.000	.000	<.001	.800	.000	.002	–
MAY 80	.000	.000	.000	.000	.000	.000	.000	.640	.000	<.001	–
JUN 80	.000	.000	.000	.000	.000	.001	.001	.080	.000	.000	–
JUL 80	.000	.000	.000	.000	.000	.000	.002	.000	.000	.000	–
AUG 80	.000	.000	.000	.000	.000	.001	.001	.002	.002	.003	–
SEP 80	.000	.000	.000	.000	.000	.080	.002	.002	.000	.000	–
OCT 80	.000	.000	.000	.000	.000	.000	.000	.001	.000	.001	–
NOV 80	.000	.000	.000	.000	.000	.000	<.001	<.001	.000	.001	–
DEC 80	.000	.000	.000	.000	.000	.000	.000	.000	.000	<.001	–
JAN 81	.000	.000	<.001	.000	.000	–	<.001	<.001	.000	.000	–
FEB 81	.000	.000	.000	.000	.000	–	.002	<.001	.000	<.001	<.001
MAR 81	.000	.000	.000	.000	.000	–	.001	.100	.000	<.001	<.001
MEAN	.0000	.0000	.0009	.0001	.0000	.0083	.0011	.1252	.0002	.0008	.0010
STD.DEV.	.0000	.0000	.0028	.0003	.0000	.0252	.0008	.2680	.0006	.0009	.0000
MIN	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.001
MAX	.000	.000	.010	.001	.000	.080	.002	.800	.002	.003	.001

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: STORAGE STABILITY, APPEARANCE AFTER COLD STORAGE AT 40 F FOR 1 YEAR(SEE APPENDIX II)   LABORATORY: M

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	C/MF-1.	-	C	C/LF-2	C	C/TS-12	C/LF-1	C/TF-6	TF-10	MS-1	LF-1
APR 80	C	O/TS-1	TS-0	MF-1	C	C/TS-10	O-1	C/HS-0	T-1	MF-1	-
MAY 80	C	O-1	C	C	C	C/TS-1	T-1	LF-1	TF-9	T-1	-
JUN 80	C	LF-1	C	C	C	CT/TS-5	MF-1	MS-1	C	LF-1	-
JUL 80	LF-1	LF-1	C	C	C	C/LS-5	O-1	LF-1	T-2	T/TS-1	-
AUG 80	C	O-1	C	C	C	T-1	F/TS-1	C	T-1	O-1	-
SEP 80	C	LF-1	C	C	C	TS-2	O-1	C	T/TS-1	LF-1	-
OCT 80	C	C	C	C	C	LS-9	O-1	MF-1	O-1	LF-1	-
NOV 80	C	C/TS-2	C	C	C	C	O-1	LF-1	O-1	O-1	-
DEC 80	C	LF-1	C	C	C	C/LS-1	O-1	C	T-11	MF-1	-
JAN 81	C	C	C	C	C	-	O-1	TF-1	C	TF-1	-
FEB 81	C	C	C	C	C	-	O-1	C	C	LF-1	T-1
MAR 81	C	LF-2	C	C	C	-	O-1	LS-1	C	TF-1	LF-1
MEAN											
STD.DEV.											
MIN											
MAX											

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: STORAGE STABILITY, COLOR AFTER AMBIENT STORAGE FOR 1 YEAR (SEE APPENDIX II) LABORATORY: M

		VIRGIN BASESTOCK			REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	L 1.5	-	L 1.0	L 1.0	L 2.5	L 3.0	5.0	5.5	6.0	4.5	L 3.0
APR 80	L 1.5	1.5	.5	.5	2.5	L 3.0	4.5	6.5	6.0	L 5.0	-
MAY 80	L 1.5	L 1.5	.5	L 1.5	2.5	L 2.5	4.5	5.5	L 6.0	3.0	-
JUN 80	L 1.5	L 1.5	.5	.5	L 2.5	L 3.0	5.0	L 7.5	6.0	L 4.0	-
JUL 80	L 2.0	L 1.5	L 1.0	L 1.0	L 2.5	L 3.0	4.5	L 8.0	L 6.0	L 4.0	-
AUG 80	L 2.0	L 2.0	L 1.0	L 1.0	L 2.5	L 3.0	5.0	D 8.0	6.5	L 6.0	-
SEP 80	L 2.0	L 1.5	L 1.0	L 1.0	L 2.5	L 3.0	L 4.5	6.0	6.0	4.5	-
OCT 80	L 2.0	L 2.0	1.0	L 1.0	2.5	L 3.5	4.0	6.5	6.5	5.5	-
NOV 80	L 2.0	L 2.0	L 1.0	L 1.0	L 2.5	L 3.0	5.0	6.0	6.0	L 5.5	-
DEC 80	2.0	L 2.0	L 1.0	L 1.0	L 2.5	3.0	5.0	5.5	6.5	6.0	-
JAN 81	L 2.0	L 2.0	L 1.0	L 1.0	L 2.5	-	L 5.0	L 5.0	L 6.0	L 6.0	-
FEB 81	2.0	2.0	L 1.0	L 1.0	3.0	-	L 4.0	5.5	6.0	7.0	6.5
MAR 81	L 2.0	L 3.5	L 1.0	1.0	2.5	-	4.0	5.0	6.0	4.5	7.5
MEAN	1.85	1.92	.88	.96	2.52	3.00	4.62	6.19	6.12	5.04	5.67
STD.DEV.	.24	.56	.22	.25	.16	.24	.42	1.05	.22	1.09	2.36
MIN	1.5	1.5	.5	.5	2.2	2.5	4.0	5.0	6.0	3.0	3.0
MAX	2.0	3.5	1.0	1.5	3.0	3.5	5.0	8.0	6.5	7.0	7.5

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: STORAGE STABILITY, SEDIMENT AFTER AMBIENT STORAGE FOR 1 YEAR (SEE APPENDIX II) LABORATORY: M

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.000	-	.000	.000	.000	.000	<.001	.000	<.001	.000	.000
APR 80	.000	.000	.004	.000	.000	.000	.000	1.000	.000	.002	-
MAY 80	.000	.000	.000	.000	.000	.000	.000	1.200	.000	.000	-
JUN 80	.000	.000	.000	.000	.000	.001	.000	.012	.000	.000	-
JUL 80	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	-
AUG 80	.000	.000	.000	.000	.000	.001	.000	.001	.000	.001	-
SEP 80	.000	.000	.000	.000	.000	.002	.001	<.001	.000	.000	-
OCT 80	.000	.000	.000	.000	.000	.000	.000	<.001	.000	.001	-
NOV 80	.000	.000	.000	.000	.000	.000	<.001	<001	.000	<.001	-
DEC 80	.000	.000	.000	.000	.000	.000	.000	.000	.000	<.001	-
JAN 81	.000	.000	.001	.000	.000	-	.000	<.001	.000	.000	-
FEB 81	.000	.000	.000	.000	.000	-	.002	.000	.000	<.001	<.001
MAR 81	.000	.000	.000	.000	.000	-	.000	.100	.000	.001	.000
MEAN	.00000	.00000	.00038	.00000	.00000	.00040	.00031	.17823	.00008	.00062	.00000
STD.DEV.	.00000	.00000	.00112	.00000	.00000	.00070	.00063	.41203	.00028	.00065	.00000
MIN	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
MAX	.000	.000	.0040	.000	.000	.0020	.0020	1.2000	.0010	.0020	.000

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: STORAGE STABILITY, APPEARANCE AFTER SUNLIGHT STORAGE FOR 1 YEAR (SEE APPENDIX II) LABORATORY: M

DATE	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	--	D	I	E	F	G	H	J	K
MAR 80	--	-	T/LS-1	--	LF/LS-4	T/MS-2	C/TS-5	MF/MS-2	--	LS-1	LF/LS-1
APR 80	--	T/LS-1	T/MS-1	T/MS-1	O/LS-8	C/LS-1	--	C/HS-1	LS-4	TS-1	-
MAY 80	--	LS-1	LS-1	C/TS-12	LS-9	C/TS-6	C/TS-6	LS-1	TF-7	TS-8	-
JUN 80	T/MS-3	T-1	O/TS-1	LF/LS-1	LS-9	TS-1	T/LF-1	LS-1	--	LS-1	-
JUL 80	--	F/LS-1	O/TS-1	LS-1	O-1	T-2	C/TS-1	TS-1	--	C/TS-2	-
AUG 80	--	TF/TS-4	O-1	--	LF/LS-2	C/LS-1	TS-7	TS-7	--	TS-3	-
SEP 80	--	TS-8	O-1	O/MS-2	T-10	C/LS-1*	TS-8	--	--	LS-2	-
OCT 80	--	TS-5	TF/TS-1	--	O/LS-1	--	--	--	--	TS-8	-
NOV 80	--	TS-9	TS-5	--	TS-2	--	--	TS-7	--	TS-11	-
DEC 80	--	TS-5	LS-4	--	TS-1	LF-2	--	--	--	--	-
JAN 81	--	T/TS-4	LS-2	--	--	-	--	LS-1	--	--	-
FEB 81	--	--	TS-4	T/TS-1	TS-10	-	T/TS-1	--	--	--	TS-6
MAR 81	--	--	LS-2	T/MS-1	TS-9	-	T-3	LS-3	--	LS-1	T/MS-1
MEAN											
STD.DEV.											
MIN											
MAX											

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: STORAGE STABILITY, APPEARANCE AFTER SUNLIGHT STORAGE FOR 1 YEAR (SEE APPENDIX II) LABORATORY: M

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	C	-	P-S	C	P-S	P-S	C	P	C	P	P-S
APR 80	C	P-S	P-S	P-S	P-S	C	C	P	P-S	C	-
MAY 80	C	C	P	C	P-S	P-S	C	P	C	P	-
JUN 80	P-S	P-S	P-S	P-S	P-S	C	P-S	C	C	P-S	-
JUL 80	C	P-S	P-S	C	P-S	P-S	P-S	P	C	P-S	-
AUG 80	C	P-S	P-S	C	P-S	P-S	P	P-S	C	P-S	-
SEP 80	C	TS	P-S	P	TH	C	TS	C	C	P	-
OCT 80	C	TS	P-S	C	P-S	C	C	C	C	TS	-
NOV 80	C	TS	TS	C	P	C	C	P	C	TS	-
DEC 80	C	TS	P	C	C	P	C	C	S	C	-
JAN 81	C	TS	P-S	C	C	-	C	TS	S	C	-
FEB 81	C	C	P	S	TS	-	TS	C	C	C	TS
MAR 81	C	C	P-S	P	TS	-	TS	TS	C	P	P-S
MEAN											
STD.DEV.											
MIN											
MAX											

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: STCRAGE STABILITY, COLOR AFTER SUNLIGHT STORAGE FOR 1 YEAR (SEE APPENDIX II) LABORATORY: M

	VIRGIN BASESTOCK				: REF :	RE-REFINED BASESTOCKS					
DATE :	A	B	C	D	I	E	F	G	H	J	K
MAR 80 :	4.5	-	7.5	L 3.5	L 7.0	8.0	5.0	D 8.0	6.5	6.5	L 6.5
APR 80 :	L 3.0	5.5	7.0	L 4.0	5.5	4.5	5.5	6.0	D 8.0	5.5	-
MAY 80 :	L 2.5	4.0	3.0	3.0	L 5.5	7.5	5.0	6.0	7.0	4.0	-
JUN 80 :	L 5.0	5.5	8.0	L 4.0	5.5	4.0	7.5	L 6.5	6.5	D 8.0	-
JUL 80 :	L 3.5	8.0	8.0	L 4.5	7.0	7.5	D 8.0	7.5	6.5	8.0	-
AUG 80 :	L 3.5	L 5.5	5.0	L 3.5	6.5	7.5	7.5	D 8.0	6.5	D 8.0	-
SEP 80 :	L 4.5	L 3.5	6.5	L 4.0	L 5.5	5.5	L 5.0	6.0	D 8.0	D 8.0	-
OCT 80 :	2.5	4.0	L 5.5	4.0	7.5	L 5.5	5.5	7.0	D 8.0	6.0	-
NOV 80 :	L 2.5	L 4.0	L 3.0	3.0	8.0	5.0	5.5	6.5	D 8.0	6.0	-
DEC 80 :	L 3.0	4.0	L 3.0	L 3.5	5.0	4.5	5.5	6.5	8.0	7.0	-
JAN 81 :	2.5	L 4.0	3.5	3.0	L 5.0	-	5.0	6.0	D 8.0	5.5	-
FEB 81 :	L 2.5	4.0	L 3.0	L 3.5	5.0	-	5.0	L 6.5	6.0	7.0	6.5
MAR 81 :	L 3.0	5.5	L 3.0	2.5	5.5	-	L 4.5	5.5	6.0	7.0	8.0
MEAN :	3.27	4.79	5.08	3.62	6.02	5.95	5.73	6.62	7.15	6.65	7.00
STD.DEV. :	.88	1.27	2.10	.76	1.02	1.52	1.15	.79	.85	1.23	.87
MIN :	2.5	3.5	3.0	2.5	5.0	4.0	4.5	5.5	6.0	4.0	6.5
MAX :	5.0	8.0	8.0	5.6	8.0	8.0	8.0	8.0	8.0	8.0	8.0

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: STORAGE STABILITY, SEDIMENT AFTER SUNLIGHT STORAGE FOR 1 YEAR (SEE APPENDIX II) LABORATORY: M

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.000	–	.004	<.001	.001	.600	.001	1.000	<.001	<.001	.060
APR 80	.000	<.001	.010	1.000	.016	.000	<.001	.900	.050	.002	–
MAY 80	.000	<.001	.000	.000	.006	.580	.000	<.001	.000	.001	–
JUN 80	.200	<.001	.020	.200	.008	<.001	.800	<.001	.000	1.000	–
JUL 80	.000	.001	.060	.022	.012	.500	.300	.004	.000	.160	–
AUG 80	.000	.002	.002	.000	.220	.600	.000	.004	.000	.400	–
SEP 80	.000	.000	.000	.040	<.001	.000	.000	<.001	.001	.160	–
OCT 80	.000	.000	<.001	.000	.400	.000	.000	.000	.000	.001	–
NOV 80	.000	.000	.001	.000	.540	.000	<.001	<.001	.000	.001	–
DEC 80	.000	.000	.002	.000	.000	.000	.000	.000	<.001	<.001	–
JAN 81	.000	000	.022	.000	.000	–	.000	<.001	<.001	.000	–
FEB 81	.000	<.001	.000	.500	.000	–	.006	<.001	.000	<.001	.000
MAR 81	.000	.000	.020	.900	.001	–	.001	<.001	.000	.002	.400
MEAN	.01538	.00058	.01092	.20485	.09269	.22810	.08538	.14731	.00415	.13308	.15333
STD.DEV.	.05547	.00067	.01698	.36016	.18000	.29554	.23008	.35683	.01378	.28592	.21572
MIN	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
MAX	.2000	.0020	.0600	1.0000	.5400	.6000	.8000	1.0000	.0500	1.0000	.4000

VII

OXIDATION AND WEAR BENCH TEST PERFORMANCE

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: RBCT. OIL + 0.3%W DBPC (MIN) ASTM D2272 LABORATORY: M

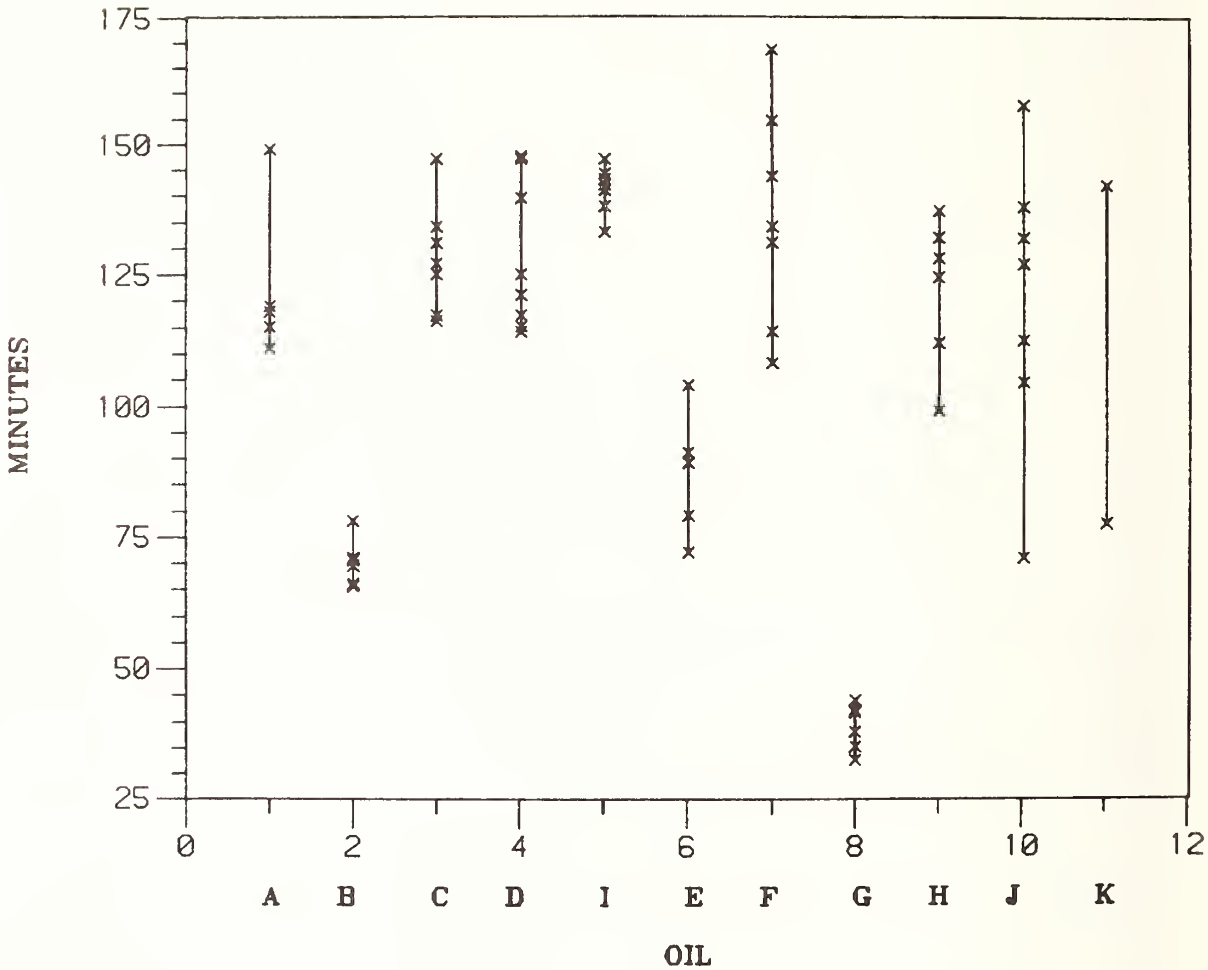
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	149.	-	147.	125.	142.	89.	131.	44.	132.	132.	142.
APR 80	--	78.	--	121.	--	104.	114.	--	--	--	-
MAY 80	--	--	147.	--	138.	--	--	38.	--	--	-
JUN 80	118.	71.	--	--	--	79.	--	--	128.	--	-
JUL 80	--	--	125.	115.	--	--	108.	35.	--	138.	-
AUG 80	115.	66.	134.	114.	144.	72.	134.	32.5	112.	71.	-
SEP 80	--	--	116.	117.	133.	--	--	--	99.	--	-
OCT 80	--	70.5	--	--	--	--	168.5	42.	--	112.5	-
NOV 80	111.	--	131.	147.	--	91.	--	--	--	--	-
DEC 80	--	--	--	--	143.	--	--	44.	124.5	104.5	-
JAN 81	--	69.5	117.	147.5	--	-	143.5	--	-	127.	-
FEB 81	119.	65.5	127.	139.5	147.	-	--	41.5	137.	--	77.5
MAR 81	--	--	--	--	141.	-	154.5	41.5	-	157.5	--
MEAN	122.40	70.08	130.50	128.25	141.14	87.00	136.21	39.81	122.08	120.36	109.75
STD.DEV.	15.19	4.51	11.90	14.23	4.53	12.23	21.41	4.23	14.12	27.75	45.61
MIN	111.0	65.5	116.0	114.0	133.0	72.0	108.0	32.5	99.0	71.0	77.5
MAX	149.0	78.0	147.0	147.5	147.0	104.0	168.5	44.0	137.0	157.5	142.0

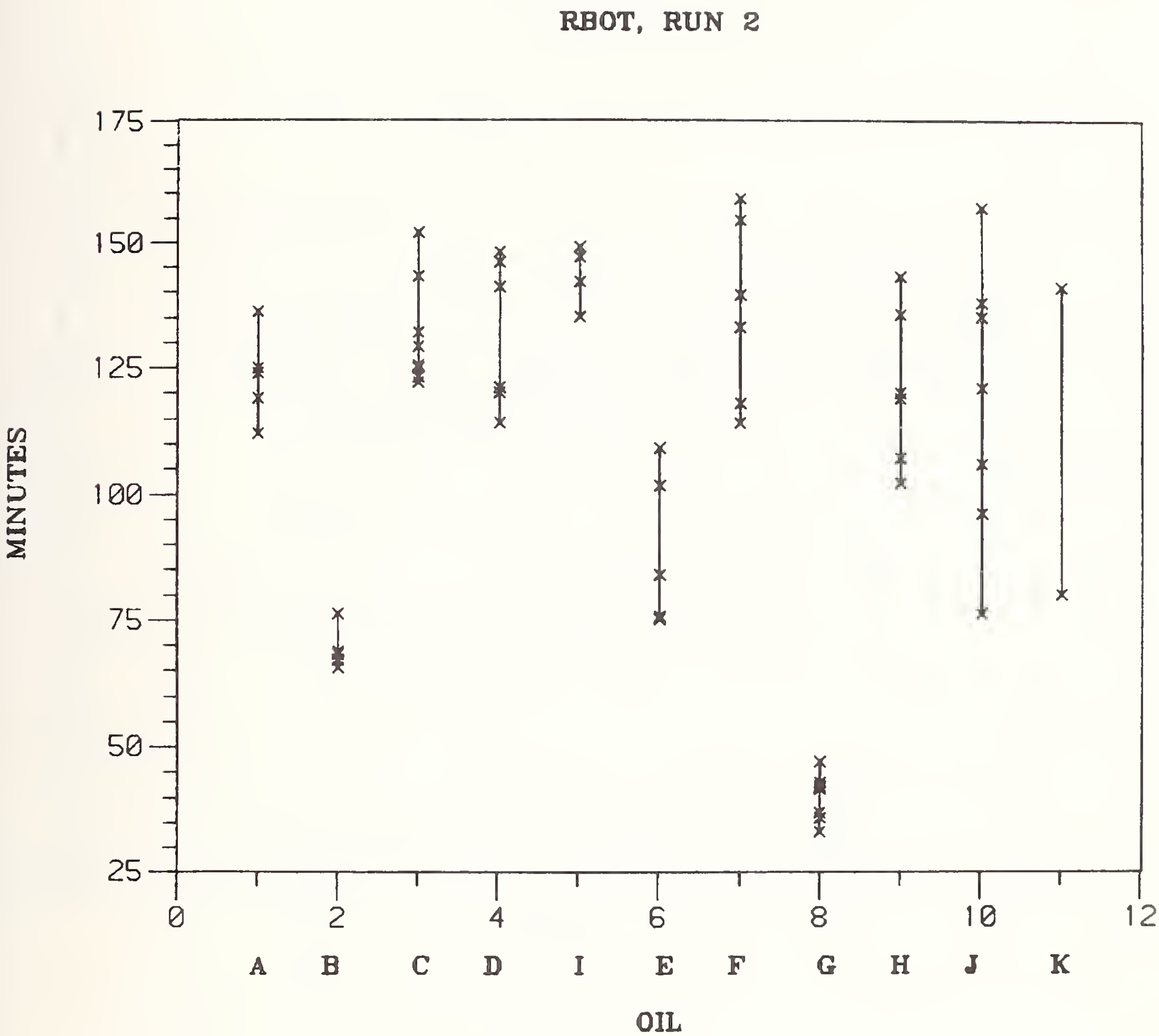
ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: RBOT, OIL + 0.3%W DBPC, RUN 2 (MIN) ASTM D2272 LABORATORY: M

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	136.	-	152.	121.	142.	84.	133.	43.	120.	138.	141.
APR 80	--	76.	--	121.	--	109.	114.	--	--	--	-
MAY 80	--	--	143.	--	135.	--	--	37.	--	--	-
JUN 80	119.	68.	--	--	--	75.5	--	--	143.	--	-
JUL 80	--	--	129.	114.	--	--	118.	36.	--	135.	-
AUG 80	112.	67.	125.	120.	142.	75.	133.	33.	107.	76.	-
SEP 80	--	--	122.	121.	135.	--	--	--	102.	--	-
OCT 80	--	68.5	--	--	--	--	159.	41.5	--	96.	-
NOV 80	125.	--	125.5	148.	--	101.5	--	--	--	--	-
DEC 80	--	--	--	--	149.	--	--	47.	119.	106.	-
JAN 81	--	68.5	123.	141.	--	-	139.5	--	--	121.	-
FEB 81	124.	65.5	132.	146.	147.	-	--	42.	135.5	--	80.
MAR 81	--	--	--	--	149.	-	154.5	43.	--	157.	--
MEAN	123.20	68.92	131.44	129.00	142.71	89.00	135.86	40.31	121.08	118.43	110.50
STD.DEV.	8.81	3.65	10.69	13.59	6.02	15.49	16.88	4.57	15.85	27.72	43.13
MIN	112.0	65.5	122.0	114.0	135.0	75.0	114.0	33.0	102.0	76.0	80.0
MAX	136.0	76.0	152.0	148.0	149.0	109.0	159.0	47.0	143.0	157.0	141.0

RBOT, RUN 1





RBOT, RUN 2
MINUTES
175
150
125
100
75
50
25
0
2
4
6
8
10
12
A
B
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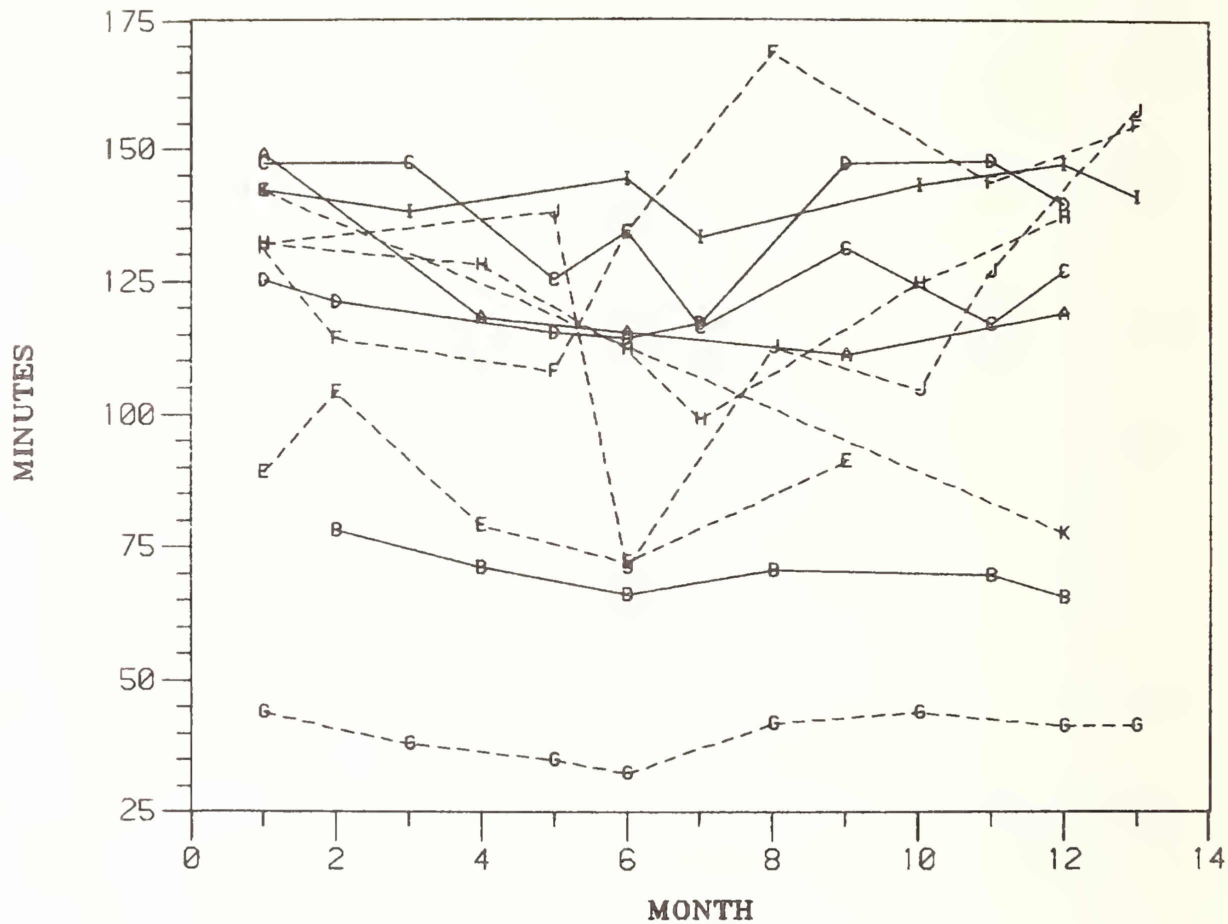
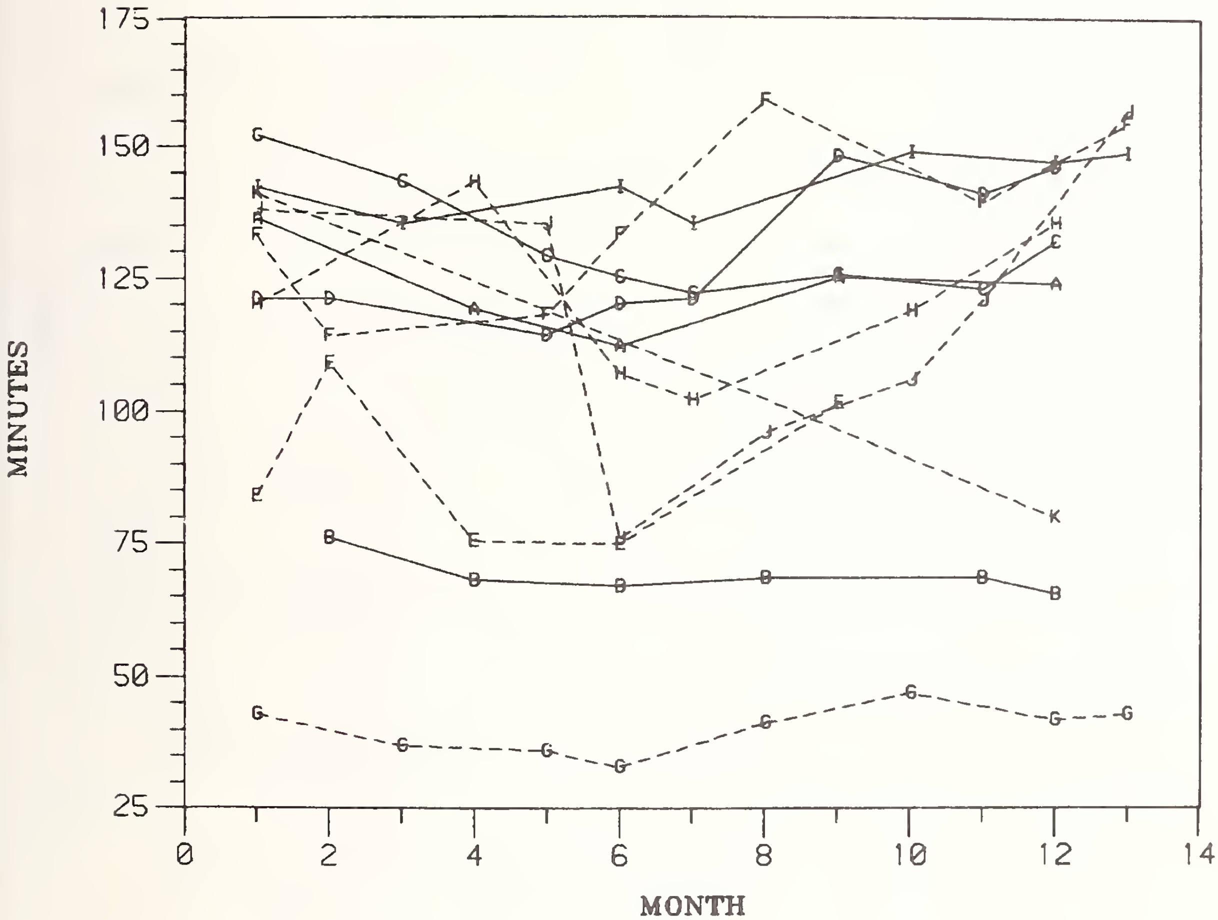
K
OIL

RBOT, RUN 1



RBOT, RUN 2



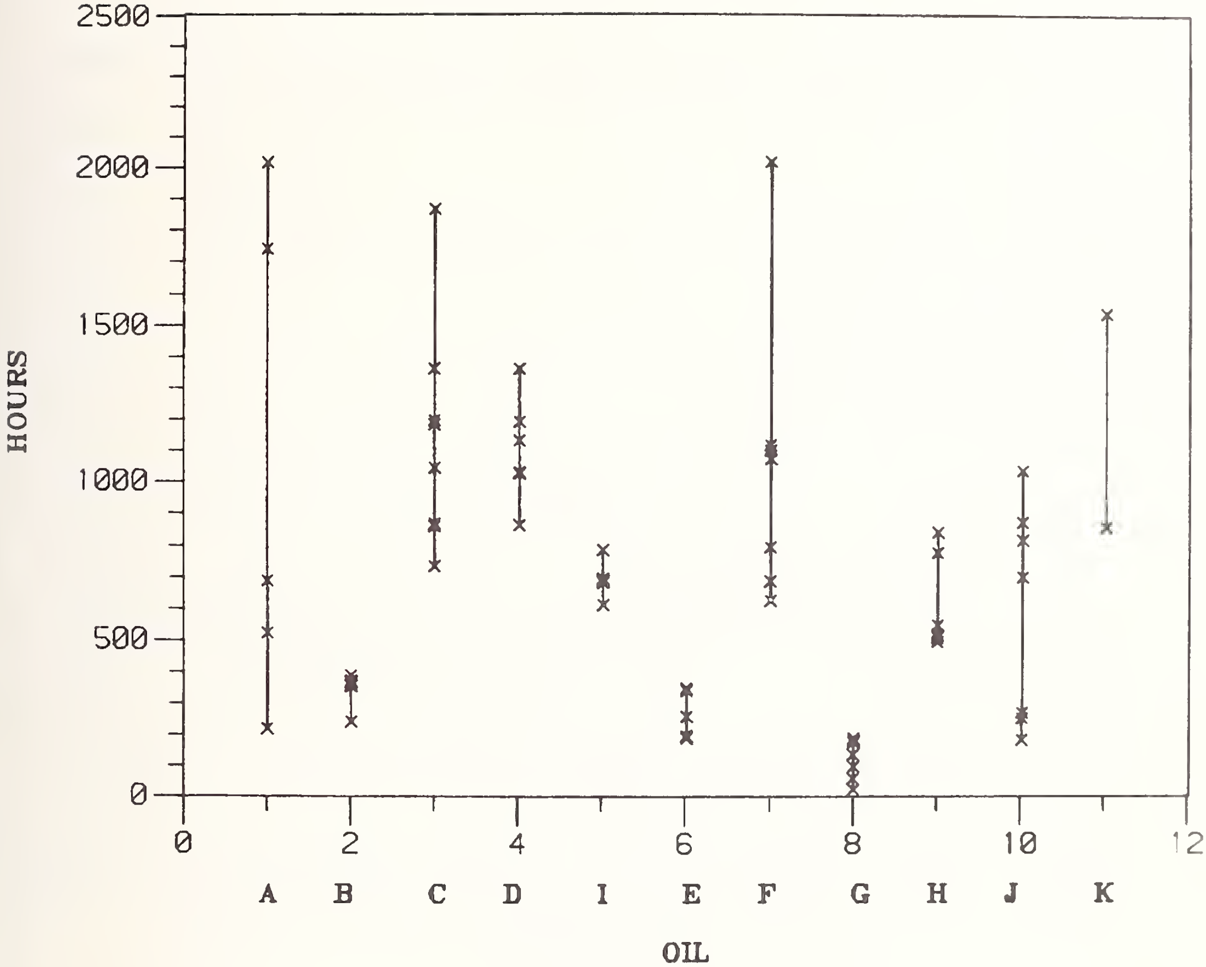
ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: TOST, OIL + 0.3%W DBPC (HRS) ASTM D943

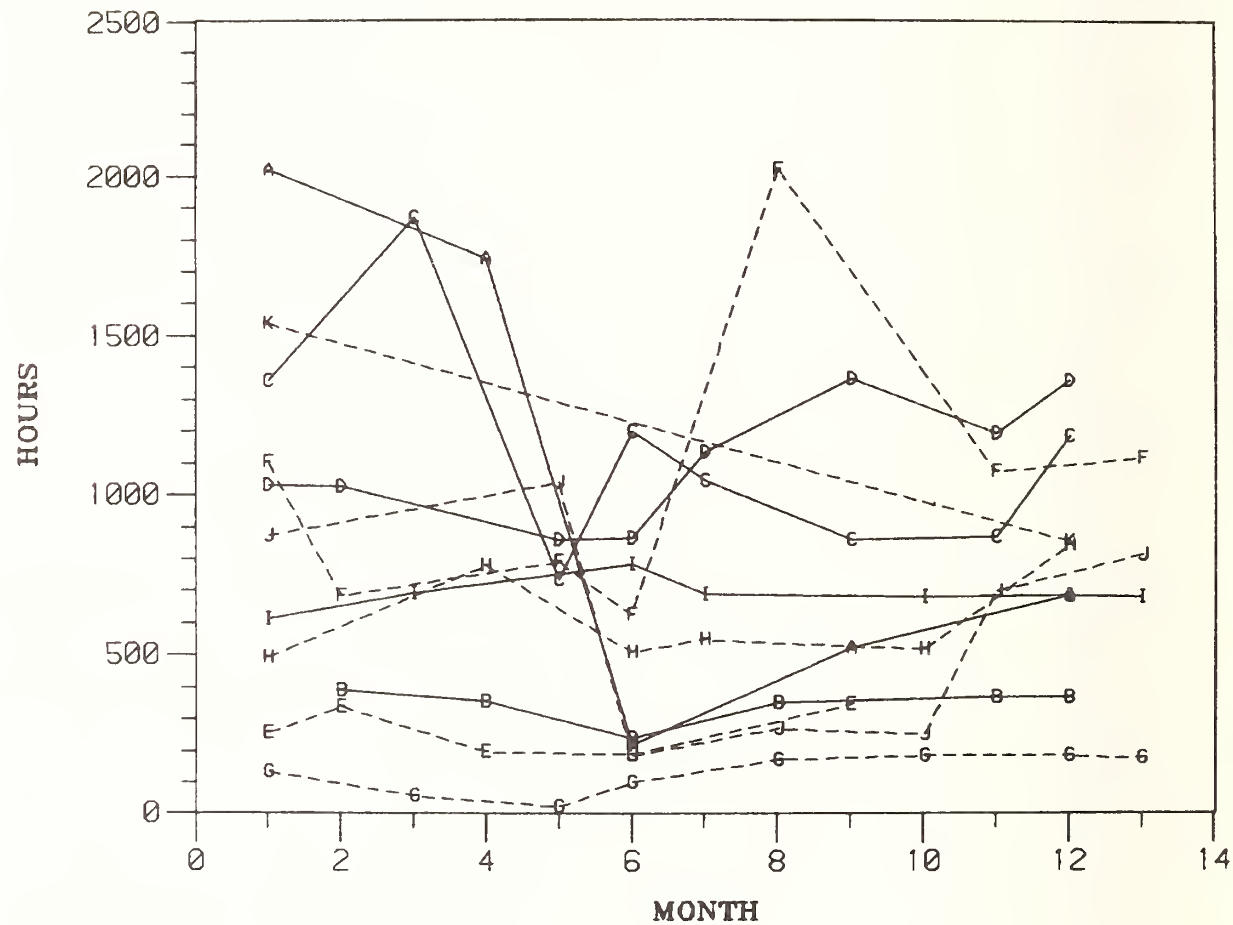
LABORATORY: M

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	>2016.	-	1358.	1029.	612.	257.	1099.	132.	492.	869.	1536.
APR 80	--	387.	--	1025.	--	336.	683.	--	--	--	-
MAY 80	--	--	1864.	--	692.	--	--	55.	--	--	-
JUN 80	1738.	353.	--	--	--	196.	--	--	776.	--	-
JUL 80	--	--	733.	859.	--	--	790.	20.	--	1035.	-
AUG 80	217.	238.	1195.	860.	781.	187.	624.	96.	507.	183.	-
SEP 80	--	--	1041.	1130.	686.	--	--	--	547.	--	-
OCT 80	--	349.	--	--	--	--	>2016.	172.	--	268.	-
NOV 80	521.	--	858.	1359.	--	347.	--	--	--	--	-
DEC 80	--	--	--	--	680.	--	--	185.	515.	252.	-
JAN 81	--	367.	867.	1191.	--	-	1072.	--	--	697.	-
FEB 81	683.	365.	1180.	1357.	684.	-	--	184.	840.	--	852.
MAR 81	--	--	--	--	680.	-	1115.	176.	--	812.	--
MEAN	1035.0	343.2	1137.0	1101.3	687.9	264.6	1057.0	127.5	612.8	588.0	1194.0
STD.DEV.	792.7	53.2	359.7	195.9	49.3	75.3	469.7	64.0	153.6	346.4	483.7
MIN	217.	238.	733.	859.	612.	187.	624.	20.	492.	183.	852.
MAX	>2016.	387.	1864.	1359.	781.	347.	>2016.	185.	840.	1035.	1536.

TOST



TOST



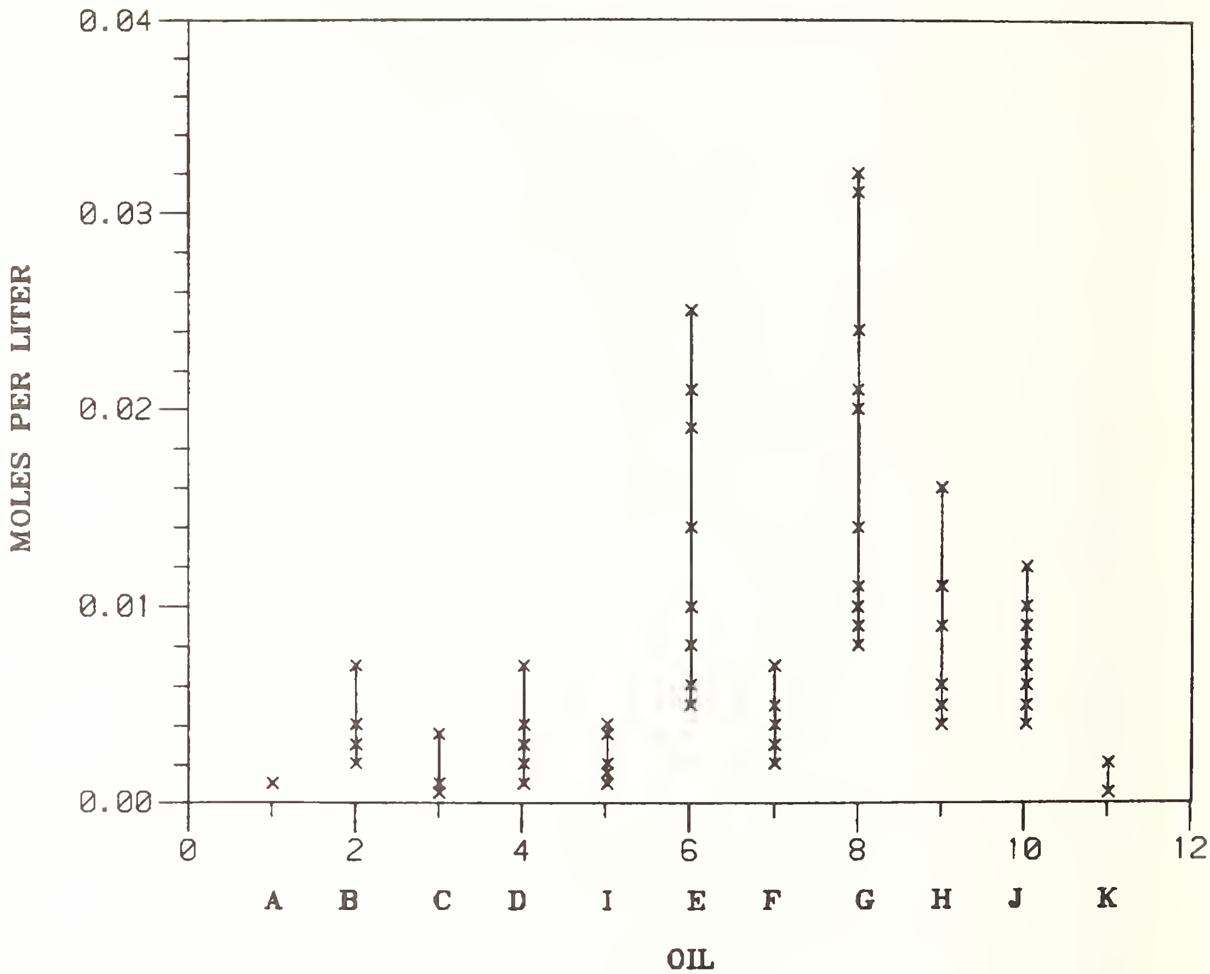
ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: ANTIOXIDANT CAPACITY (MOL/L) FREE RADICAL TITRATION TEST

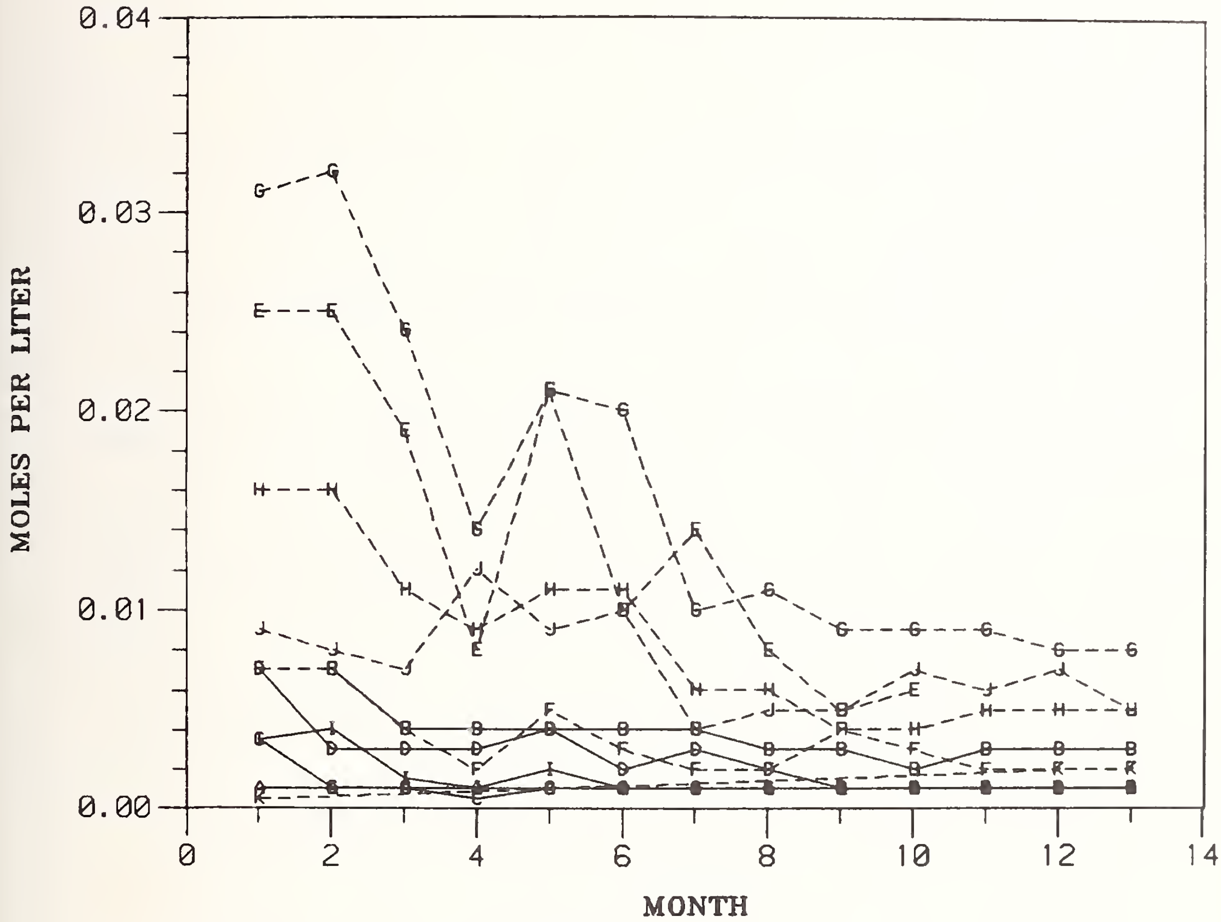
LABORATORY: N

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	.001	-	.0035	.007	.0035	.025	.007	.031	.016	.009	.0005
APR 80	.001	.007	.001	.003	.004	.025	.007	.032	.016	.008	-
MAY 80	.001	.004	.001	.003	.0015	.019	.004	.024	.011	.007	-
JUN 80	.001	.004	.0005	.003	.001	.008	.002	.014	.009	.012	-
JUL 80	.001	.004	.001	.004	.002	.021	.005	.021	.011	.009	-
AUG 80	.001	.004	.001	.002	.001	.01	.003	.02	.011	.010	-
SEP 80	.001	.004	.001	.003	.001	.014	.002	.01	.006	.004	-
OCT 80	.001	.003	.001	.002	.001	.008	.002	.011	.006	.005	-
NOV 80	.001	.003	.001	.001	.001	.005	.004	.009	.004	.005	-
DEC 80	.001	.002	.001	.001	.001	.006	.003	.009	.004	.007	-
JAN 81	.001	.003	.001	.001	.001	-	.002	.009	.005	.006	-
FEB 81	.001	.003	.001	.001	.001	-	.002	.008	.005	.007	.002
MAR 81	.001	.003	.001	.001	.001	-	.002	.008	.005	.005	.002
MEAN	.0010	.0037	.0012	.0025	.0015	.0141	.0035	.0158	.0084	.0072	.0015
STD.DEV.	.0000	.0012	.0007	.0017	.0010	.0078	.0018	.0089	.0043	.0023	.0009
MIN	.001	.002	.0005	.001	.001	.005	.002	.008	.004	.004	.0005
MAX	.001	.007	.0035	.007	.004	.025	.007	.032	.016	.012	.002

ANTIOXIDANT CAPACITY



ANTIOXIDANT CAPACITY

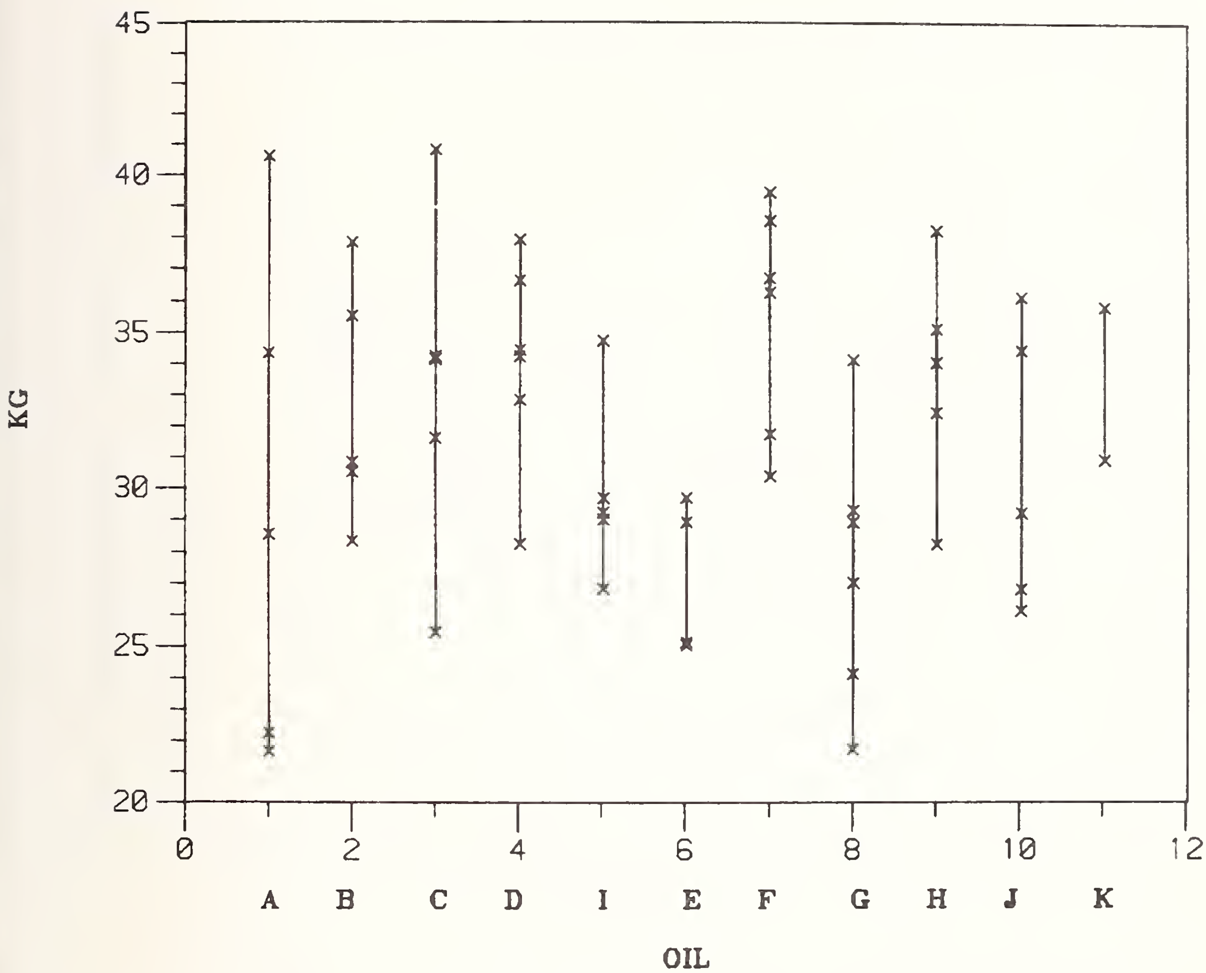


ASTM/NBS BASESTOCK CONSISTENCY STUDY

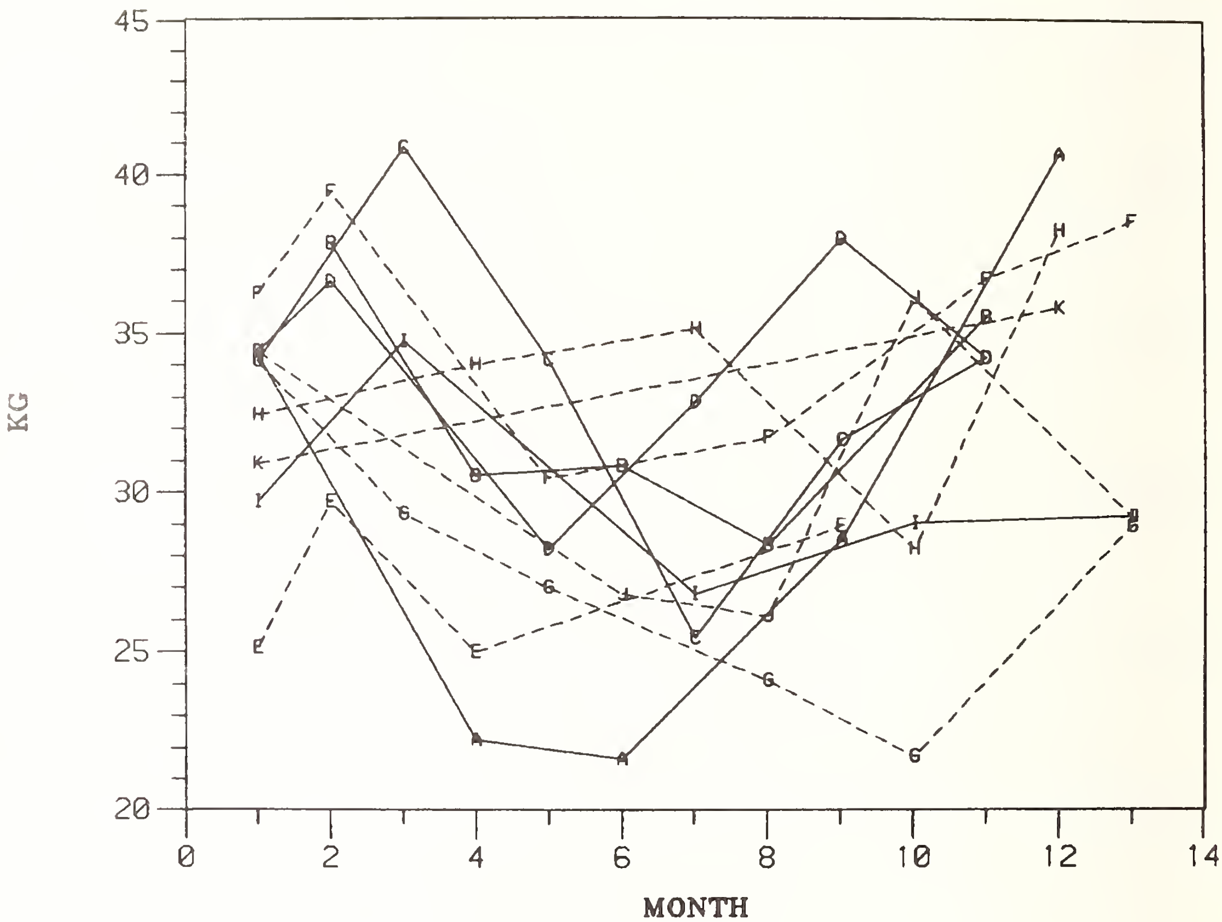
TEST: LCAC WEAR INDEX (KG) ASTM D2783 LABORATORY: Z

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	34.3	-	34.1	34.4	29.7	25.1	36.2	34.1	32.4	34.4	30.9
APR 80	--	37.8	--	36.6	--	29.7	39.4	--	--	--	-
MAY 80	--	--	40.8	--	34.7	--	--	29.3	--	--	-
JUN 80	22.2	30.5	--	--	--	25.0	--	--	34.0	--	-
JUL 80	--	--	34.1	28.2	--	--	30.4	27.0	--	--	-
AUG 80	21.6	30.8	--	--	--	--	--	--	--	26.8	-
SEP 80	--	--	25.4	32.8	26.8	--	--	--	35.1	--	-
OCT 80	--	28.3	--	--	--	--	31.7	24.1	--	26.1	-
NOV 80	28.5	--	31.6	37.9	--	28.9	--	--	--	--	-
DEC 80	--	--	--	--	29.0	--	--	21.7	28.2	36.1	-
JAN 81	--	35.5	34.2	34.2	--	-	36.7	--	--	--	-
FEB 81	40.6	--	--	--	--	-	--	--	38.2	--	35.8
MAR 81	--	--	--	--	29.2	-	38.5	28.9	--	29.2	--
MEAN	29.44	32.58	33.37	34.02	29.88	27.17	35.48	27.52	33.58	30.52	33.35
STD.DEV.	8.11	3.92	4.97	3.38	2.91	2.48	3.65	4.34	3.68	4.51	3.46
MIN	21.6	28.3	25.4	28.2	26.8	25.0	30.4	21.7	28.2	26.1	30.9
MAX	40.6	37.8	40.8	37.9	34.7	29.7	39.4	34.1	38.2	36.1	35.8

LOAD WEAR INDEX



LOAD WEAR INDEX



ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: DSC INDUCTION TIME, OIL + ADDITIVE PKG (MIN) DSC LABORATORY: N

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	10.	-	24.	28.	24.	28.	26.	20.	22.	31.	21.
APR 80	10.	24.	26.	28.	27.	26.	29.	17.	28.	18.	-
MAY 80	9.	29.	29.	32.	30.	30.	28.	18.	22.	28.	-
JUN 80	9.	25.	37.	31.	28.	27.	32.	12.	18.	32.	-
JUL 80	7.	22.	21.	28.	25.	32.	22.	19.	24.	28.	-
AUG 80	6.	24.	22.	22.	25.	33.	26.	13.	26.	30.	-
SEP 80	8.	22.	21.	28.	29.	31.	27.	20.	24.	29.	-
OCT 80	6.	22.	25.	29.	29.	27.	26.	22.	27.	26.	-
NOV 80	7.	21.	20.	25.	24.	30.	38.	18.	22.	27.	-
DEC 80	6.	22.	23.	28.	24.	26.	26.	18.	23.	26.	-
JAN 81	6.	19.	18.	28.	26.	-	37.	17.	25.	42.	-
FEB 81	8.	21.	20.	29.	25.	-	30.	28.	36.	22.	22.
MAR 81	9.	27.	40.	33.	34.	-	38.	17.	24.	28.	24.
MEAN	7.8	23.2	25.1	28.4	26.9	29.0	29.6	18.4	24.7	28.2	22.3
STD.DEV.	1.5	2.8	6.7	2.8	3.0	2.5	5.2	3.9	4.3	5.6	1.5
MIN	6.	19.	18.	22.	24.	26.	22.	12.	18.	18.	21.
MAX	10.	29.	40.	33.	34.	33.	38.	28.	36.	42.	24.

ASTM/NBS BASESTOCK CCNSISTENCY STUDY

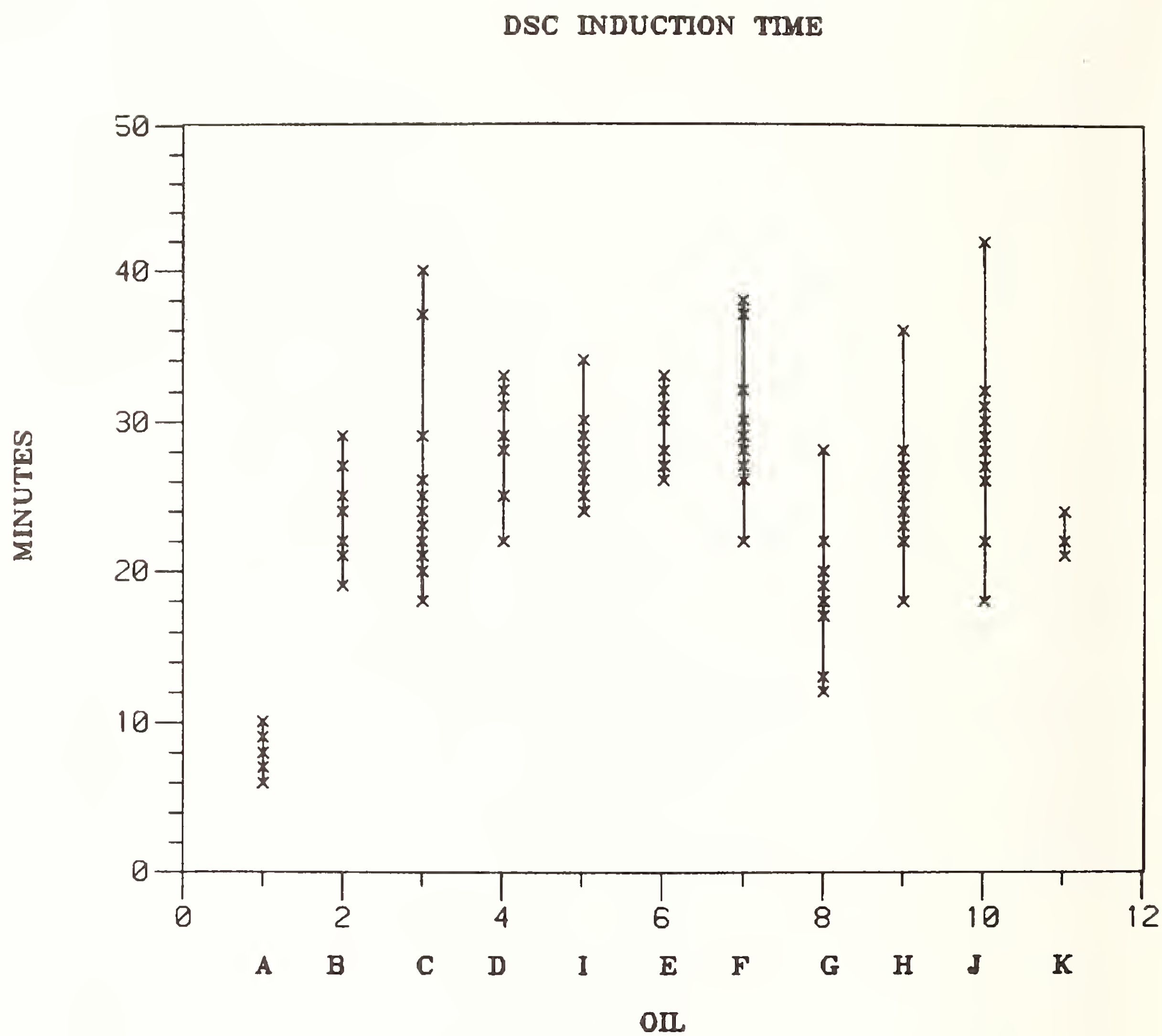
TEST: DSC OXIDATION CNSET TEMP.(DEG C) DSC — LABORATORY: N

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	203.	-	182.	198.	192.	213.	215.	212.	208.	213.	207.
APR 80	205.	188.	182.	198.	190.	208.	216.	210.	215.	212.	-
MAY 80	192.	183.	196.	195.	188.	208.	214.	208.	206.	225.	-
JUN 80	199.	182.	180.	197.	193.	216.	220.	207.	201.	202.	-
JUL 80	201.	185.	180.	199.	190.	219.	208.	211.	205.	220.	-
AUG 80	200.	196.	185.	203.	199.	217.	217.	226.	224.	225.	-
SEP 80	200.	189.	184.	189.	189.	208.	213.	208.	220.	225.	-
OCT 80	204.	189.	180.	203.	194.	213.	218.	211.	220.	220.	-
NOV 80	205.	183.	183.	204.	197.	215.	226.	216.	221.	209.	-
DEC 80	207.	190.	190.	206.	196.	217.	221.	217.	218.	214.	-
JAN 81	198.	185.	180.	193.	191.	-	227.	209.	211.	237.	-
FEB 81	212.	207.	191.	207.	217.	-	214.	220.	233.	211.	203.
MAR 81	191.	195.	180.	198.	189.	-	224.	215.	201.	211.	200.
MEAN	201.3	189.3	184.1	199.2	194.2	213.4	217.9	213.1	214.1	217.2	203.3
STD.DEV.	5.8	7.2	5.2	5.2	7.6	4.1	5.5	5.5	9.7	9.2	3.5
MIN	191.	182.	180.	189.	188.	208.	208.	207.	201.	202.	200.
MAX	212.	207.	196.	207.	217.	219.	227.	226.	233.	237.	207.

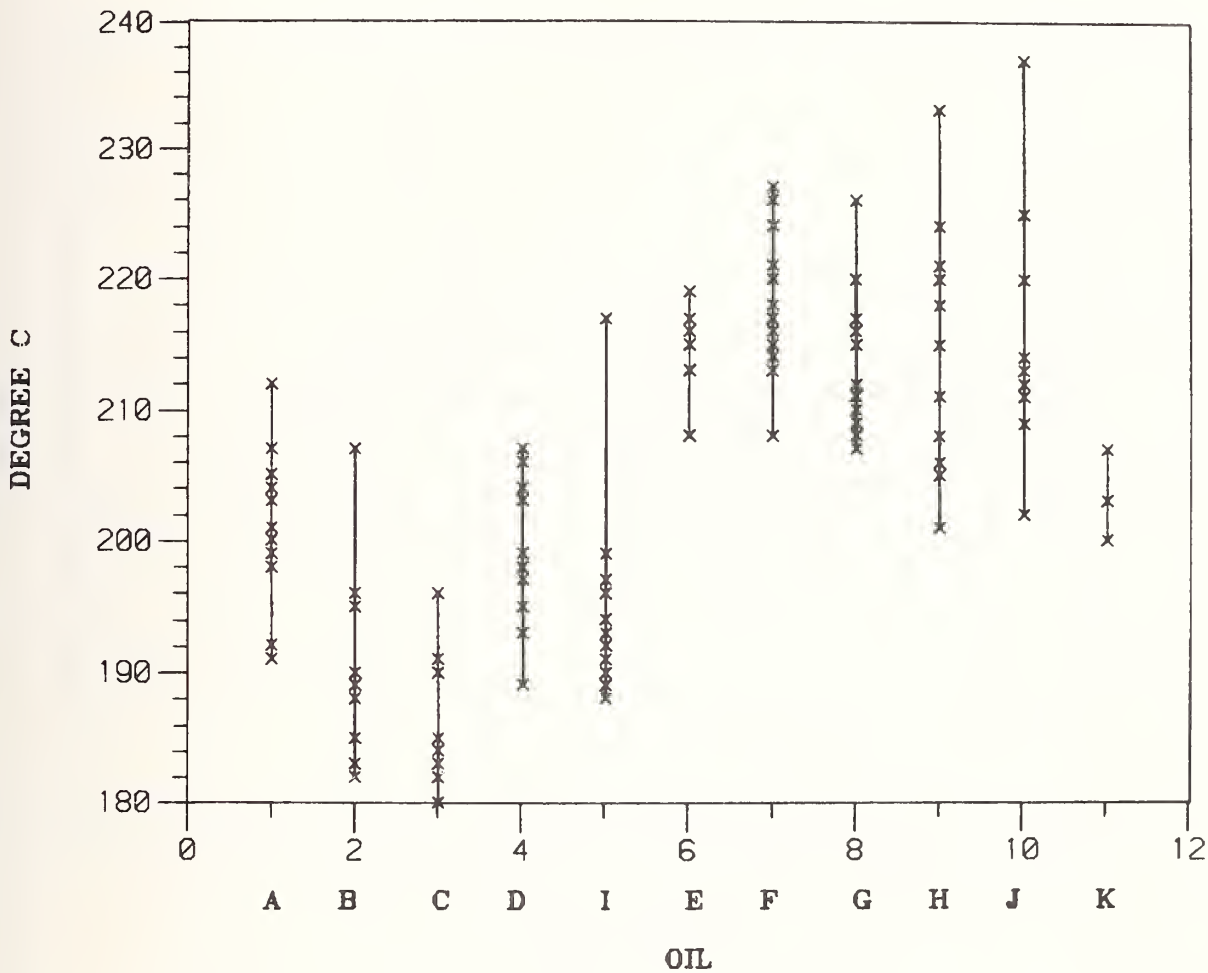
ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: DSC OXIDATION CNSET TEMP., OIL + ADDITIVE PKG (DEG C) DSC LABORATORY: N

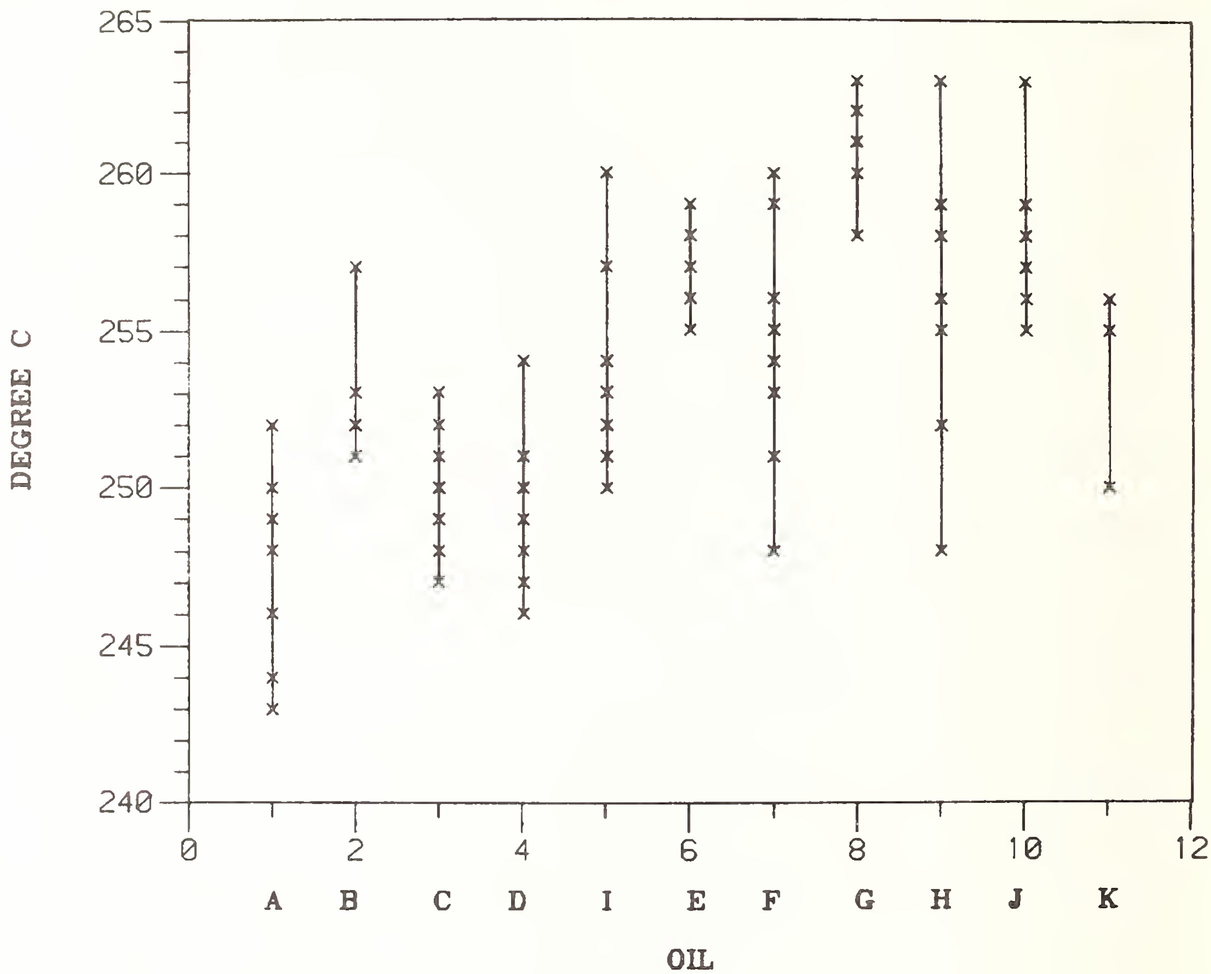
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE :	A	B	C	D	I	E	F	G	H	J	K
MAR 80 :	249.	-	249.	250.	252.	257.	248.	261.	256.	259.	250.
APR 80 :	250.	251.	248.	250.	254.	256.	254.	261.	256.	257.	-
MAY 80 :	248.	252.	247.	247.	250.	256.	254.	261.	255.	257.	-
JUN 80 :	246.	253.	249.	249.	253.	257.	255.	260.	255.	257.	-
JUL 80 :	246.	251.	251.	251.	254.	259.	253.	258.	256.	256.	-
AUG 80 :	243.	253.	248.	246.	251.	258.	251.	262.	258.	258.	-
SEP 80 :	249.	252.	250.	250.	260.	258.	256.	261.	256.	258.	-
OCT 80 :	243.	252.	250.	251.	252.	258.	253.	261.	259.	259.	-
NOV 80 :	244.	253.	249.	250.	254.	257.	259.	261.	258.	258.	-
DEC 80 :	249.	252.	252.	248.	253.	255.	255.	263.	248.	258.	-
JAN 81 :	249.	257.	250.	250.	252.	-	260.	261.	256.	263.	-
FEB 81 :	244.	251.	253.	254.	257.	-	253.	262.	263.	259.	256.
MAR 81 :	252.	253.	250.	251.	254.	-	255.	258.	252.	255.	255.
MEAN :	247.1	252.5	249.7	249.8	253.5	257.1	254.3	260.8	256.0	258.0	253.7
STD.DEV. :	2.9	1.6	1.7	2.0	2.6	1.2	3.1	1.4	3.5	1.9	3.2
MIN :	243.	251.	247.	246.	250.	255.	248.	258.	248.	255.	250.
MAX :	252.	257.	253.	254.	260.	259.	260.	263.	263.	263.	256.


DSC INDUCTION TIME
MINUTES
0
10
20
30
40
50
0
2
4
6
8
10
12
A
B
C
D
I
E
F
G
H
J
K
OIL

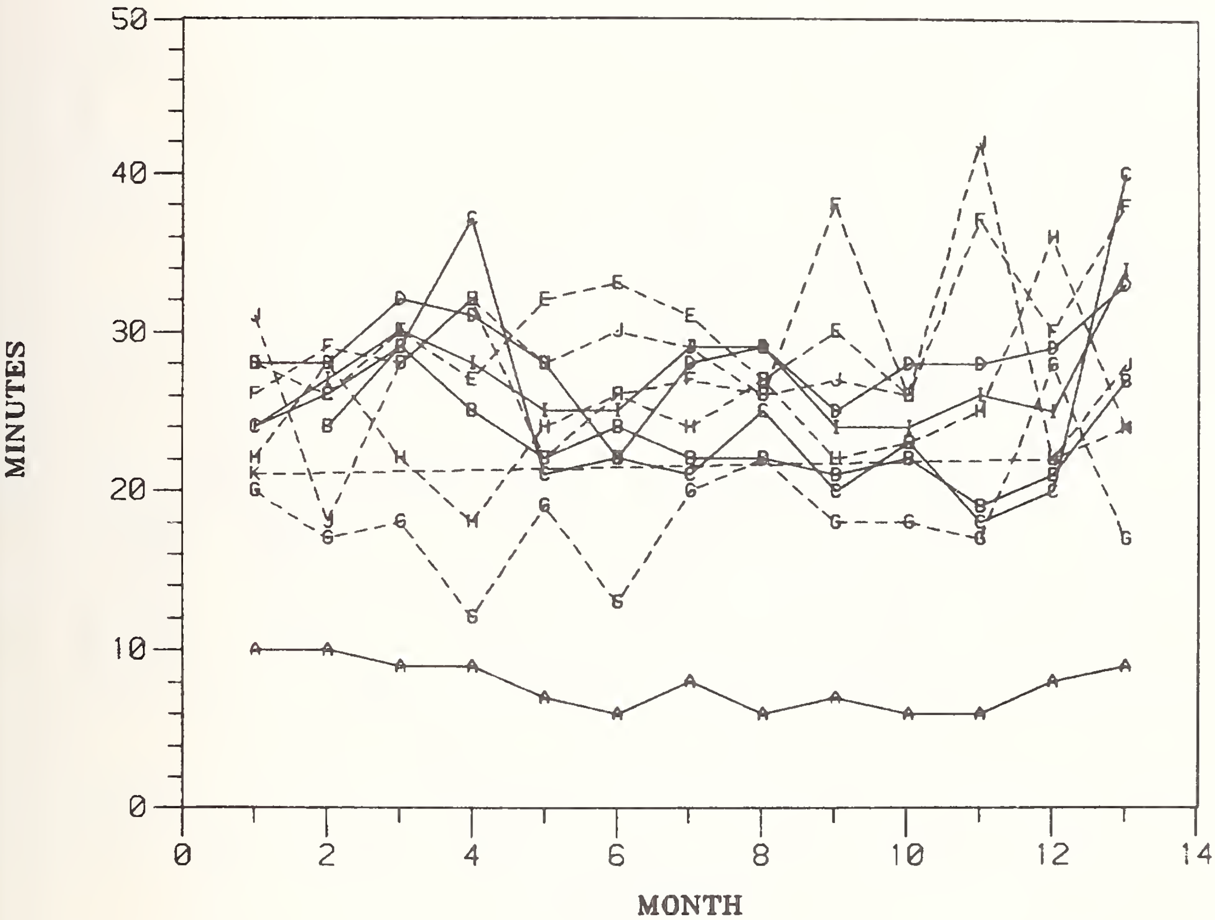
DSC ONSET TEMPERATURE



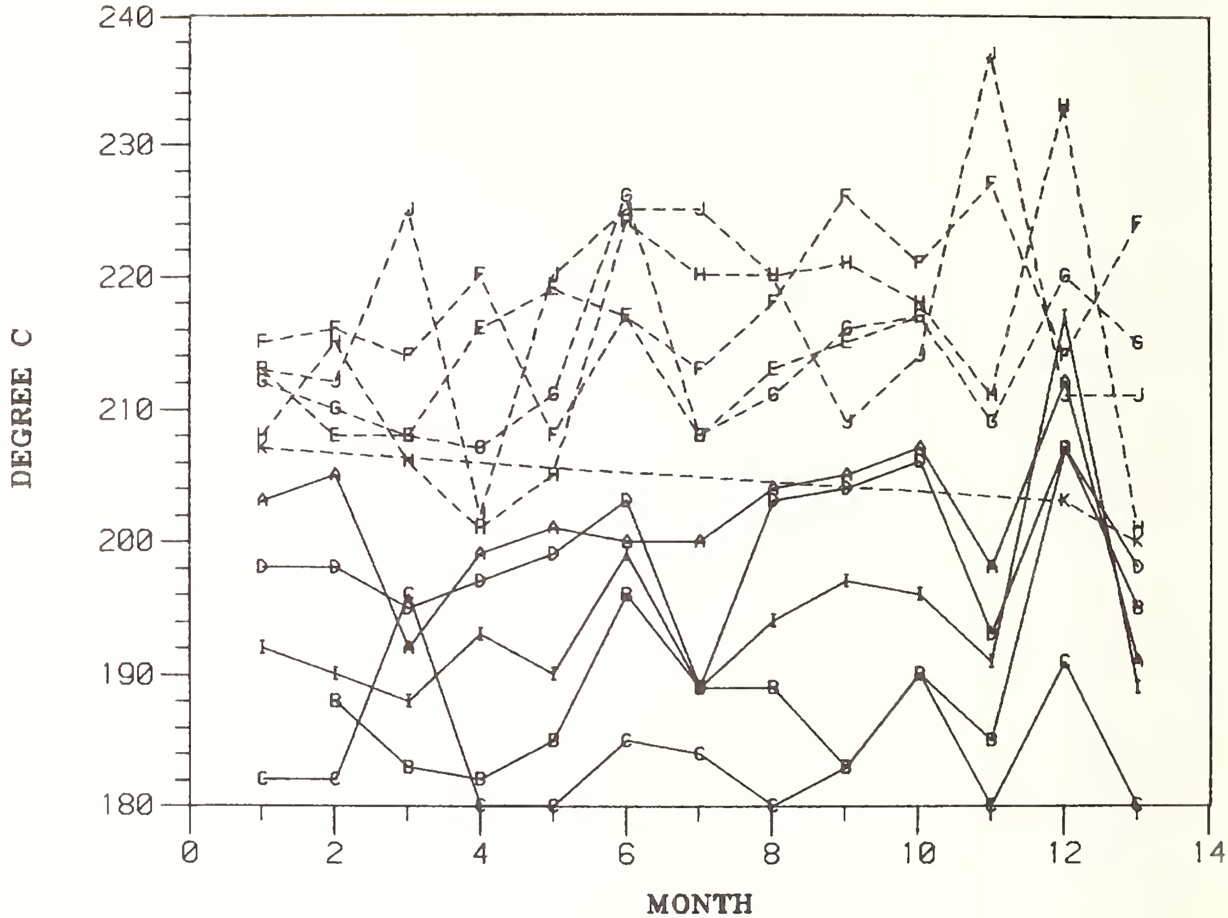
DSC ONSET TEMPERATURE WITH ADDITIVE



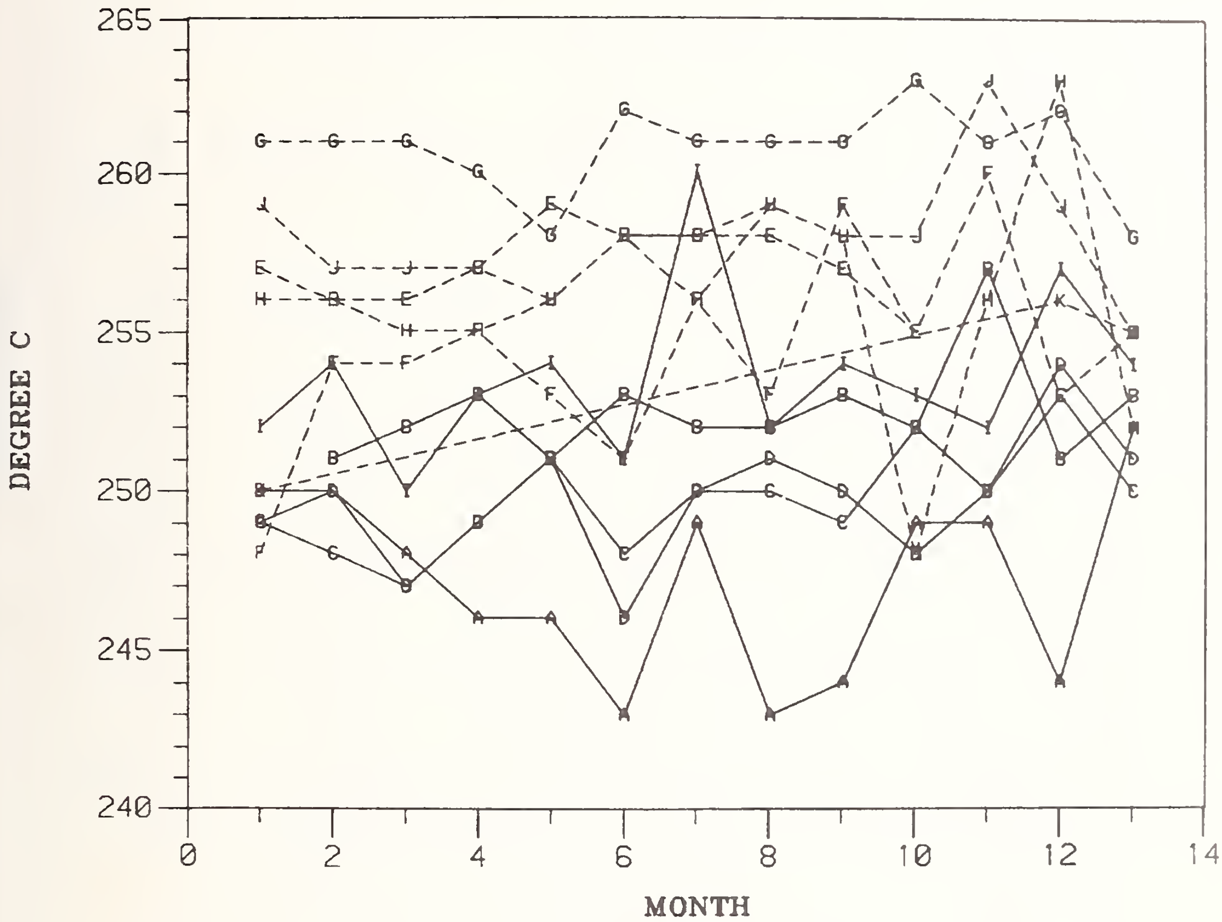
DSC INDUCTION TIME



DSC ONSET TEMPERATURE



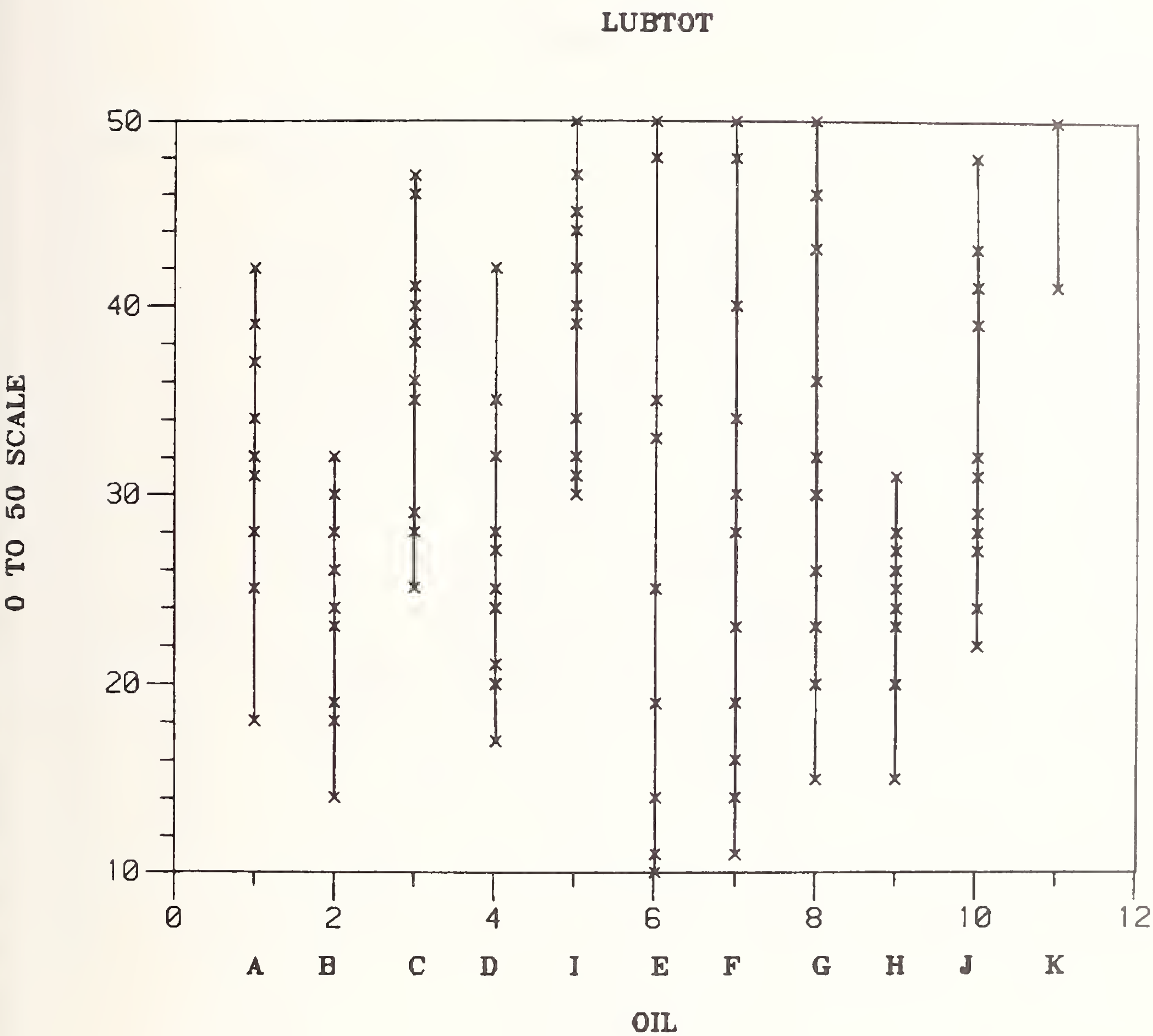
DSC ONSET TEMPERATURE WITH ADDITIVE



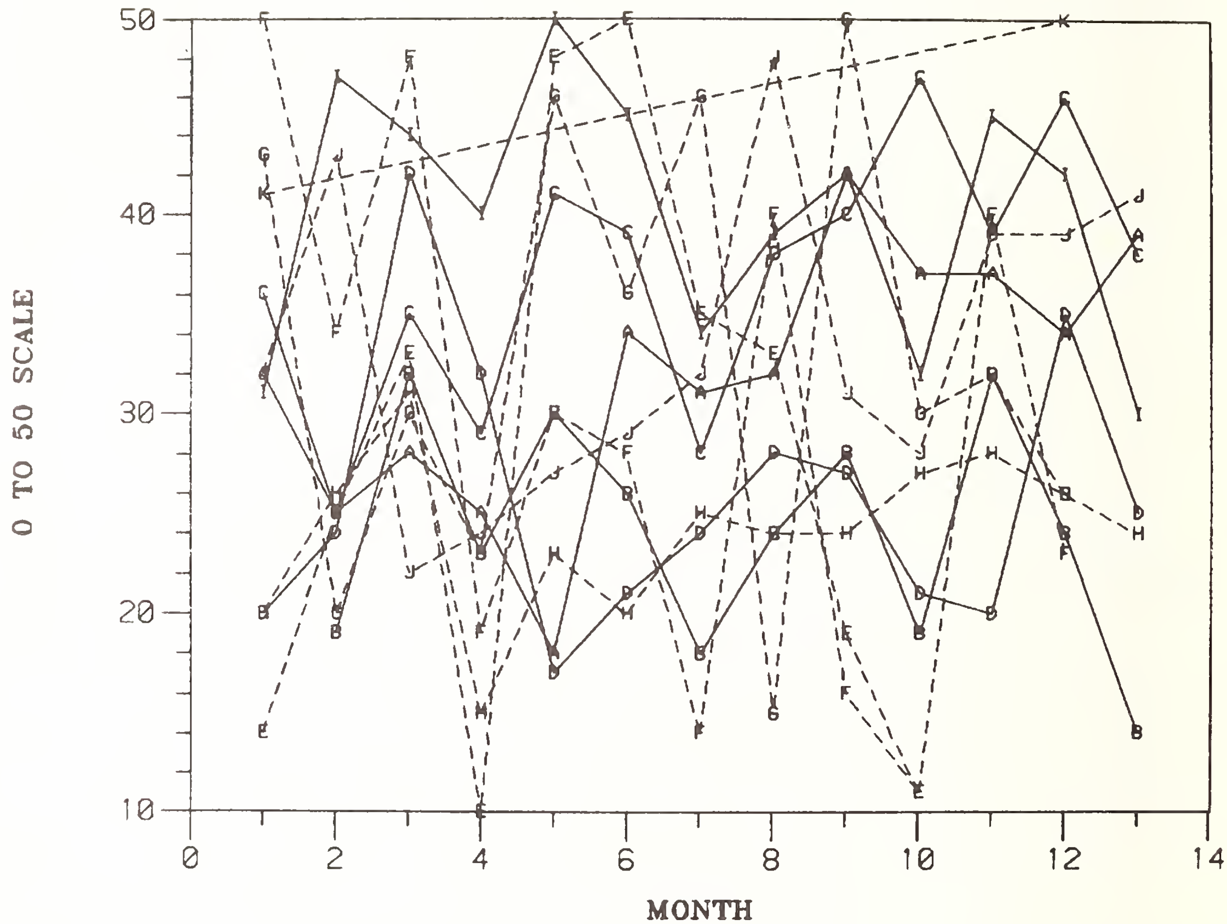
ASTM/NBS BASESTOCK CCNSISTENCY STUDY

TEST: LUBTOT (0=CLEAN,50=MAX DEPOSIT) LUBRICANT THERMAL OXIDATION TEST LABORATORY: L

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	32.	-	36.	20.	31.	14.	50.	43.	20.	32.	41.
APR 80	25.	19.	25.	24.	47.	25.	34.	20.	26.	43.	-
MAY 80	28.	32.	35.	42.	44.	33.	48.	30.	31.	22.	-
JUN 80	25.	23.	29.	32.	40.	10.	19.	23.	15.	24.	-
JUL 80	18.	30.	41.	17.	50.	48.	30.	46.	23.	27.	-
AUG 80	34.	26.	39.	21.	45.	50.	28.	36.	20.	29.	-
SEP 80	31.	18.	28.	24.	34.	35.	14.	46.	25.	32.	-
OCT 80	32.	24.	38.	28.	39.	33.	40.	15.	24.	48.	-
NOV 80	42.	28.	40.	27.	42.	19.	16.	50.	24.	31.	-
DEC 80	37.	19.	47.	21.	32.	11.	11.	30.	27.	28.	-
JAN 81	37.	32.	39.	20.	45.	-	40.	32.	28.	39.	-
FEB 81	34.	24.	46.	35.	42.	-	23.	26.	26.	39.	50.
MAR 81	39.	14.	38.	25.	30.	-	--	--	24.	41.	--
MEAN	31.8	24.1	37.0	25.8	40.1	27.8	29.4	33.1	24.1	33.5	45.5
STD.DEV.	6.6	5.8	6.5	7.0	6.5	14.5	13.2	11.3	4.1	7.9	6.4
MIN	18.	14.	25.	17.	30.	10.	11.	15.	15.	22.	41.
MAX	42.	32.	47.	42.	50.	50.	50.	50.	31.	48.	50.


LUBTOT
0 TO 50 SCALE
50
40
30
20
10
0
2
4
6
8
10
12
A
B
C
D
I
E
F
G
H
J
K
OIL

LUBTOT



ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: OXYGEN UPTAKE,DETERG-INHIB ADDITIVE RESPONSE (HRS. TO 1L O2 ABS.) OXIDATOR TEST LABORATORY: Z

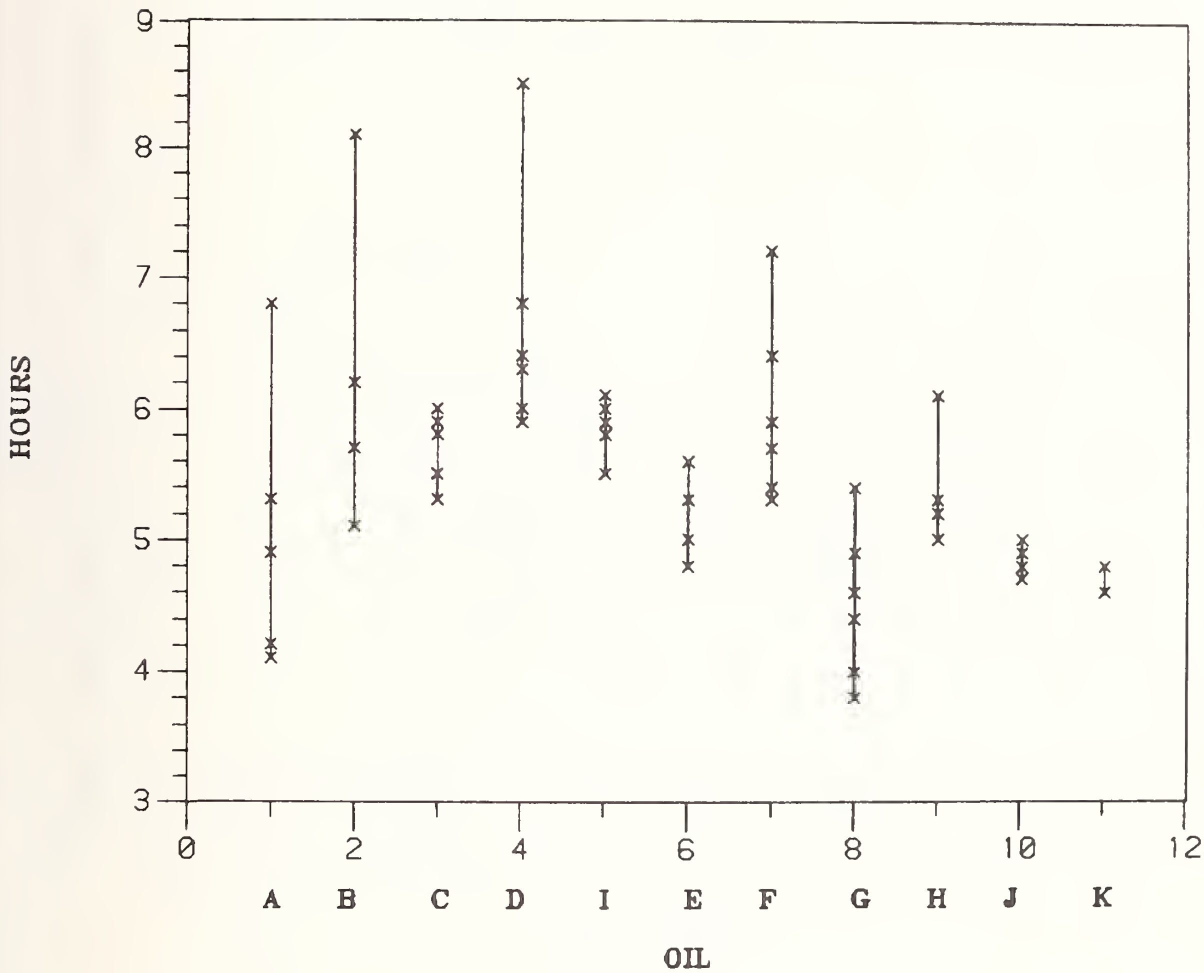
	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	4.9	-	5.8	6.0	5.9	5.6	5.9	4.4	5.2	4.7	4.8
APR 80	--	5.7	--	5.9	--	4.8	5.3	--	--	--	-
MAY 80	--	--	5.8	--	5.9	--	--	4.0	--	--	-
JUN 80	5.3	6.2	--	--	--	5.3	--	--	5.3	--	-
JUL 80	--	--	5.5	6.3	--	--	5.4	3.8	--	--	-
AUG 80	4.1	5.1	--	--	--	--	--	--	--	4.8	-
SEP 80	--	--	5.5	8.5	6.1	--	--	--	5.2	--	-
OCT 80	--	8.1	--	--	--	--	7.2	5.4	--	5.0	-
NOV 80	4.2	--	5.3	6.4	--	5.0	--	--	--	--	-
DEC 80	--	--	--	--	6.0	--	--	4.6	5.0	4.9	-
JAN 81	--	6.2	6.0	6.8	--	-	5.7	--	--	--	-
FEB 81	6.8	--	--	--	--	-	--	--	6.1	--	4.6
MAR 81	--	--	--	--	5.5	-	6.4	4.9	--	4.8	--
MEAN	5.06	6.26	5.65	6.65	5.88	5.17	5.98	4.52	5.36	4.84	4.70
STD.DEV.	1.09	1.12	.26	.96	.23	.35	.71	.59	.43	.11	.14
MIN	4.1	5.1	5.3	5.9	5.5	4.8	5.3	3.8	5.0	4.7	4.6
MAX	6.8	8.1	6.0	8.5	6.1	5.6	7.2	5.4	6.1	5.0	4.8

ASTM/NBS BASESTOCK CONSISTENCY STUDY

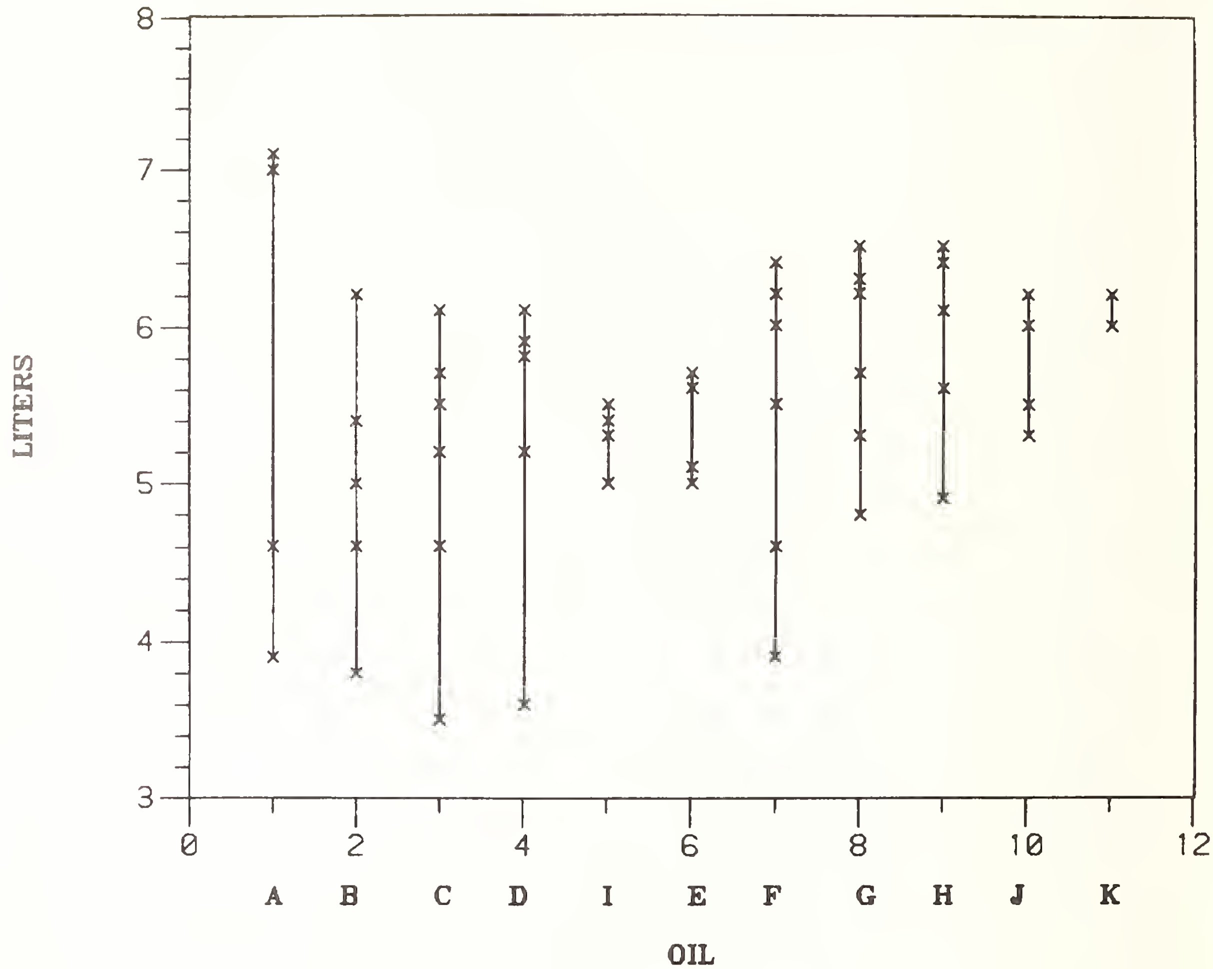
TEST: OXYGEN UPTAKE, DETERG-INHIB ADDITIVE RESPONSE (LITERS O2/10 HRS.) OXIDATOR TEST   LABORATORY: Z

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	4.6	-	5.2	5.2	5.5	5.1	6.2	6.2	6.4	6.2	6.0
APR 80	--	5.0	--	6.1	--	5.7	6.0	--	--	--	-
MAY 80	--	--	3.5	--	5.5	--	--	6.3	--	--	-
JUN 80	7.0	5.4	--	--	--	5.0	--	--	6.5	--	-
JUL 80	--	--	6.1	5.9	--	--	6.4	6.5	--	--	-
AUG 80	7.0	6.2	--	--	--	--	--	--	--	6.0	-
SEP 80	--	--	5.5	3.6	5.4	--	--	--	5.6	--	-
OCT 80	--	3.8	--	--	--	--	3.9	4.8	--	5.3	-
NOV 80	7.1	--	5.7	5.8	--	5.6	--	--	--	--	-
DEC 80	--	--	--	--	5.0	--	--	5.3	6.1	5.5	-
JAN 81	--	4.6	4.6	5.9	--	-	5.5	--	--	--	-
FEB 81	3.9	--	--	--	--	-	--	--	4.9	--	6.2
MAR 81	--	--	--	--	5.3	-	4.6	5.7	--	6.0	--
MEAN	5.92	5.00	5.10	5.42	5.34	5.35	5.43	5.80	5.90	5.80	6.10
STD.DEV.	1.54	.89	.93	.94	.21	.35	.99	.66	.66	.38	.14
MIN	3.9	3.8	3.5	3.6	5.0	5.0	3.9	4.8	4.9	5.3	6.0
MAX	7.1	6.2	6.1	6.1	5.5	5.7	6.4	6.5	6.5	6.2	6.2

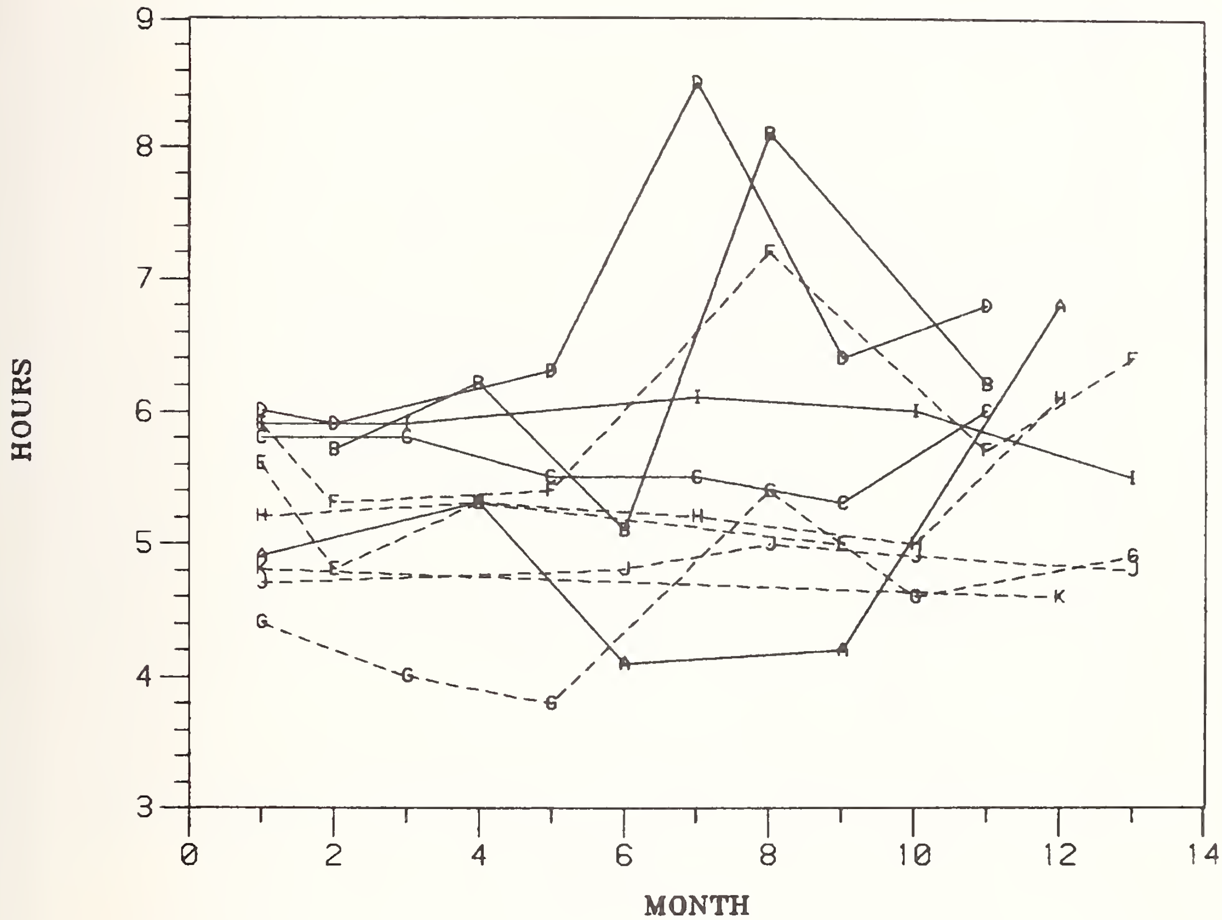
OXYGEN UPTAKE TEST



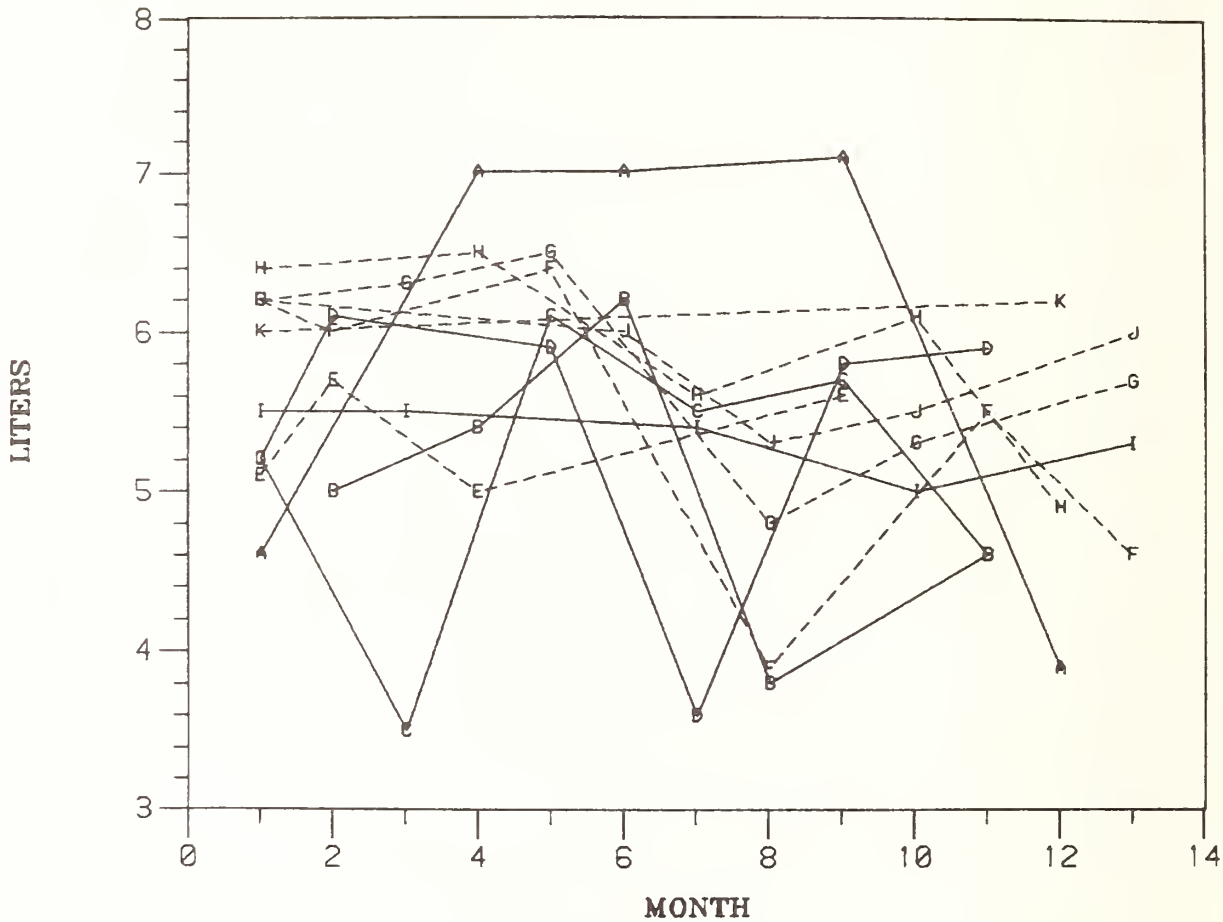
OXYGEN UPTAKE TEST



OXYGEN UPTAKE TEST



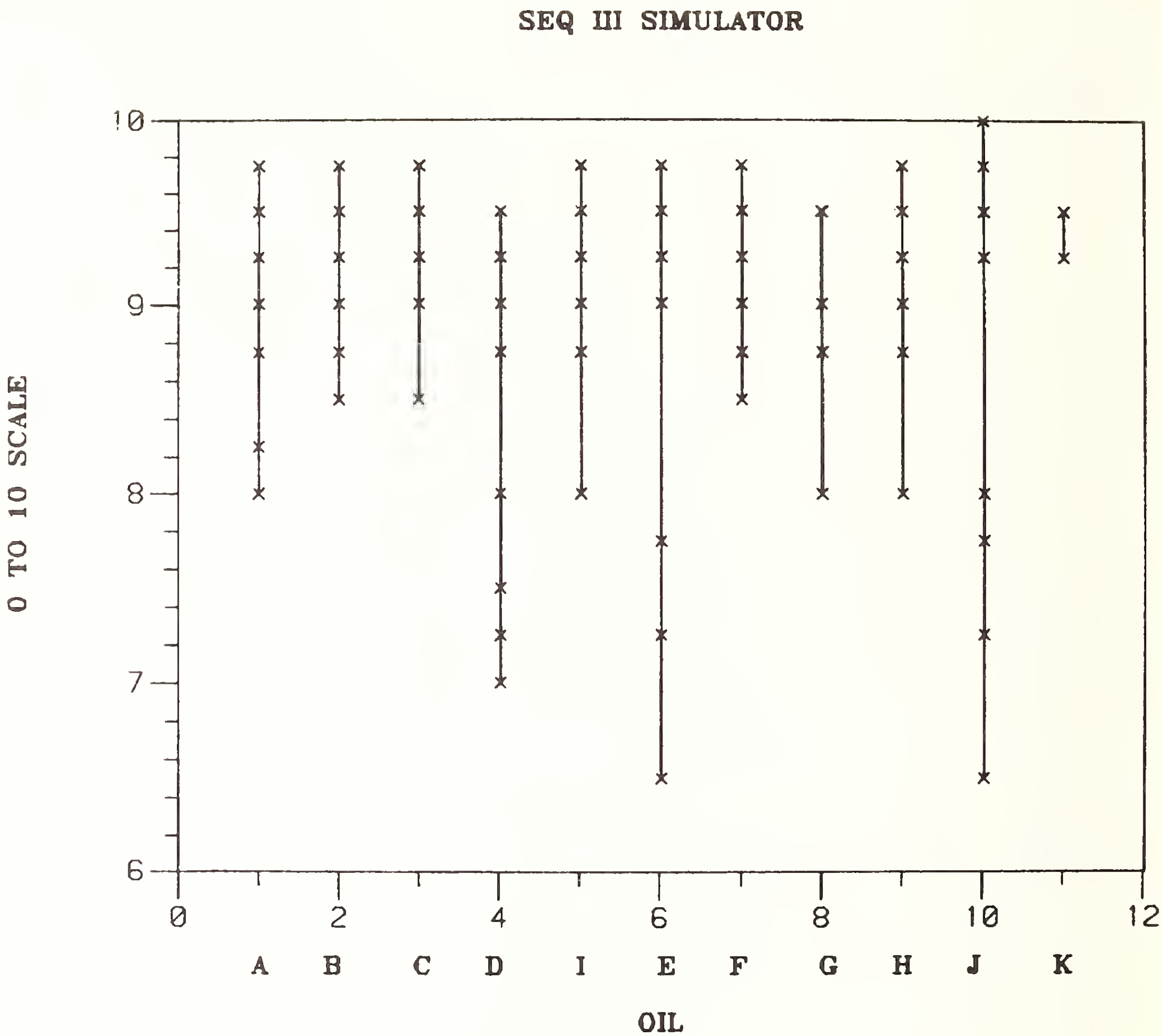
OXYGEN UPTAKE TEST



ASTM/NBS BASESTOCK CONSISTENCY STUDY

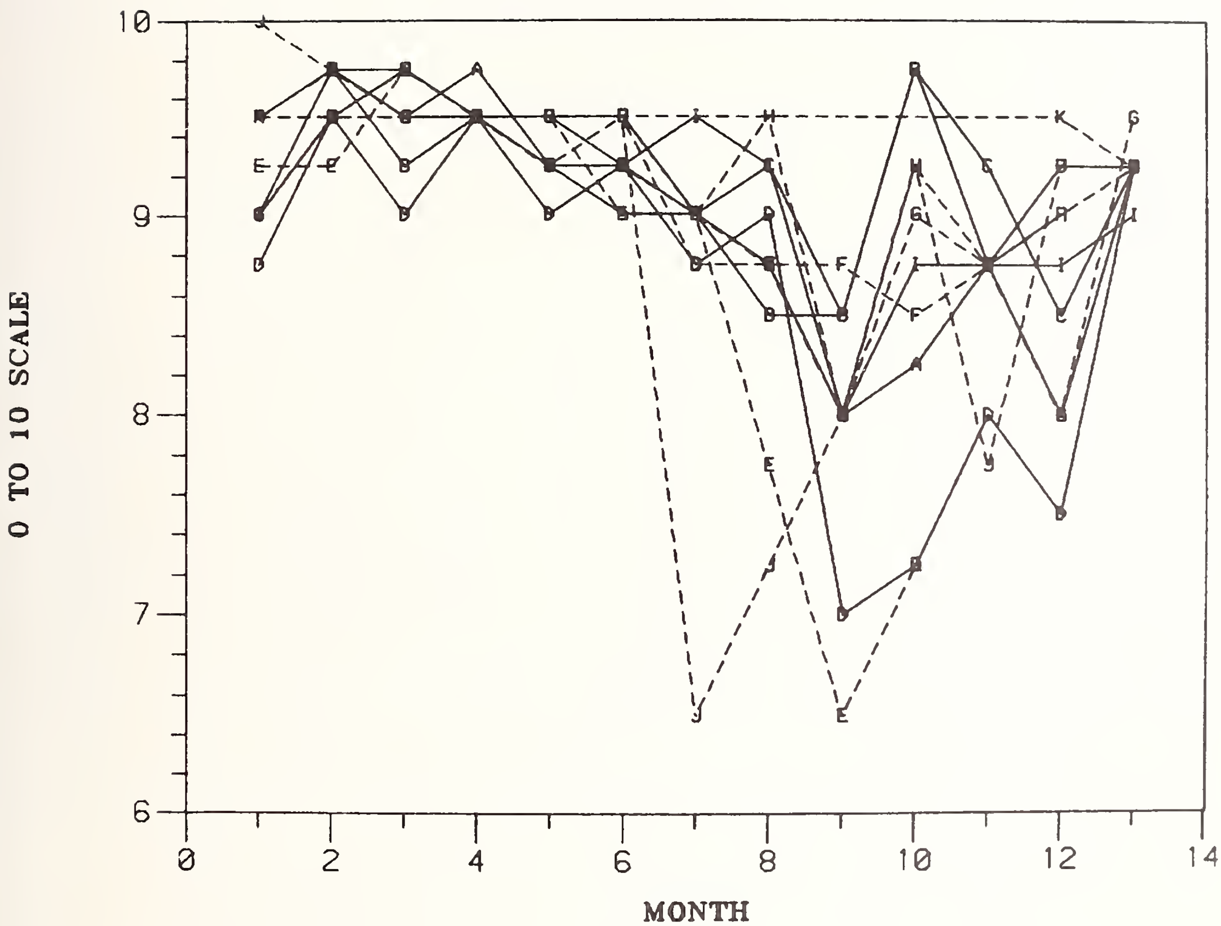
TEST: SEQUENCE III SIMULATOR (0-10 SCALE;10=CLEAN;>6.6=PASSING) LABORATORY: O

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	9.50	-	9.00	8.75	9.00	9.25	9.50	9.00	9.50	10.00	9.50
APR 80	9.75	9.75	9.75	9.50	9.50	9.25	9.50	9.50	9.75	9.75	-
MAY 80	9.50	9.25	9.75	9.00	9.75	9.75	9.75	9.50	9.75	9.50	-
JUN 80	9.75	9.50	9.50	9.50	9.50	9.50	9.50	9.50	9.50	9.50	-
JUL 80	9.25	9.50	9.50	9.00	9.25	9.50	9.25	9.50	9.25	9.50	-
AUG 80	9.00	9.25	9.50	9.25	9.25	9.00	9.50	9.50	9.25	9.50	-
SEP 80	9.00	9.00	9.00	8.75	9.50	9.00	9.00	8.75	9.00	6.50	-
OCT 80	8.75	8.50	9.25	9.00	9.25	7.75	8.75	8.75	9.50	7.25	-
NOV 80	8.00	8.50	8.50	7.00	8.00	6.50	8.75	8.00	8.00	8.00	-
DEC 80	8.25	9.75	9.75	7.25	8.75	7.25	8.50	9.00	9.25	9.25	-
JAN 81	8.75	8.75	9.25	8.00	8.75	-	8.75	8.75	8.75	7.75	-
FEB 81	8.00	9.25	8.50	7.50	8.75	-	9.00	8.00	9.00	9.25	9.50
MAR 81	9.25	9.25	9.25	9.25	9.00	-	9.25	9.50	9.25	9.25	9.25
MEAN	8.981	9.187	9.269	8.596	9.096	8.675	9.154	9.019	9.212	8.846	9.417
STD.DEV.	.608	.428	.426	.863	.463	1.106	.389	.554	.466	1.092	.144
MIN	8.00	8.50	8.50	7.00	8.00	6.50	8.50	8.00	8.00	6.50	9.25
MAX	9.75	9.75	9.75	9.50	9.75	9.75	9.75	9.50	9.75	10.00	9.50



SEQ III SIMULATOR
10
9
8
7
6
0 TO 10 SCALE
0
2
4
6
8
10
12
A
B
C
D
I
E
F
G
H
J
K
OIL

SEQ III SIMULATOR



Appendix I

Sample Numbering System

and

Data Table for Repeated Samples

APPENDIX I

The sampling number system appears in the Table AI-1 below. All sample numbers are preceded by a two letter code BC for identification purposes. Oils A - D and Oil I are virgin base oils. Oils E - H, J and K are re-refined base oils. Each sample number is a separate sample. The laboratories performing the analyses were at liberty to run multiple analyses per sample and report the average value or all values. The data presented in the body of this publication together with the appendices comprise all the test information received from the analytical laboratories.

Duplicate samples (BC7169, BC7174) were sent for analyses for Oil I, March 80. Triplicate samples (BC7248, BC7423, and BC7426) were sent for analyses for Oil F, June 80. Samples BC7423 and BC7426 were sent for analyses approximately eight months after sample BC7248.

In the body of the publication the values listed for Oil I, March 80 and Oil F, June 80 are the average values for the replicate samples. In order for a complete data analysis the value for these five oil samples are listed in Table AI-2 below. They are grouped according to the major divisions listed in the Table of Contents.

TABLE AI-1

ASTM/NBS BASESTOCK CONSISTENCY STUDY
SAMPLE NUMBERING SYSTEM

	VIRGIN BASE OILS				REF	RE-REFINED BASE OILS					
DATE/OIL	A	B	C	D	I	E	F	G	H	J	K
MAR 80	7168	-	7170	7171	7174	7187	7186	7172	7173	7233	7245
APR 80	7199	7202	7201	7198	7200	7204	7203	7205	7197	7240	-
MAY 80	7230	7231	7232	7229	7228	7227	7234	7235	7226	7246	-
JUN 80	7242	7243	7236	7241	7238	7237	7248	7244	7239	7251	-
JUL 80	7255	7256	7249	7257	7252	7254	7250	7258	7253	7272	-
AUG 80	7263	7265	7267	7269	7266	7262	7270	7271	7268	7264	-
SEP 80	7290	7293	7284	7285	7287	7288	7292	7289	7286	7346	-
OCT 80	7343	7337	7340	7341	7345	7342	7339	7338	7344	7373	-
NOV 80	7348	7354	7349	7350	7351	7347	7385	7352	7353	7380	-
DEC 80	7375	7378	7379	7377	7372	7376	7388	7374	7371	7384	-
JAN 81	7387	7381	7383	7382	7390	-	7397	7386	7389	7405	-
FEB 81	7404	7403	7400	7402	7399	-	7421	7401	7398	7414	7413
MAR 81	7417	7419	7420	7422	7415	-	7424	7425	7418	7416	7427

NOTE: SAMPLE NUMBER BC7169 WAS A DUPLICATE SAMPLE FOR OIL I (MAR 80)
SAMPLE NUMBER BC7423 WAS A TRIPLICATE SAMPLE FOR OIL F (JUN 80)
SAMPLE NUMBER BC7426 WAS A TRIPLICATE SAMPLE FOR OIL F (JUN 80)
FOR CASES IN WHICH DUPLICATE OR TRIPLICATE SAMPLES OCCURRED AN AVERAGE VALUE WAS RECORDED

Table AI-2

II. RHEOLOGY

Test		Lab	BC7169	BC7174	BC7248	BC7423	BC7426
Brookfield Viscosity (cP)	0°F	0	3030	3080	5160	4750	4650
	-20°F		23500	28200	28350	29100	29100
	-40°F		SOLID	SOLID	650000	543000	632000
Cold Cranking Simulator (cP)	0°C	P	410	405	610	690	560
	- 5°C		640	625	930	1040	850
	-10°C		1030	1000	1500	1620	1340
	-15°C		1830	1800	2550	2720	2300
	-18°C		2680	2660	4300	4500	3850
	-20°C		3550	3550	5600	5800	5100
	-25°C		7430	7550	11900	12100	11000
	-30°C		16900	16800	S	S	S
	-35°C		S	S	S	S	S
	-40°C		S	S	S	S	S

Test		Lab	BC7169	BC7174	BC7248	BC7423	BC7426
Critical Starting Temp (°C)		P	-20.3	-20.4	-16.6	-16.1	-17.4
Kinematic Viscosity (cSt)	40°C	L	38.93	38.87	57.74	57.44	57.36
	100°C		6.10	6.10	8.31	8.31	8.31
	40°C	P	66.67	38.86	57.45	57.38	57.58
	100°C		6.10	6.08	8.30	8.30	8.31
Viscosity Index (units)		L	101	101	114	115	115
		P	0	101	114	115	115
Mini-Rotary Viscosity (°F)		P	+4.0A	+1.7A	-21.6F	-20.6F	-20.2F

III. PHYSICAL PROPERTIES

Test		Lab	BC7169	BC7174	BC7248	BC7423	BC7426
API Gravity (°API)		L	29.9	29.9	29.5	29.7	29.7
		M	29.8	29.8	--	--	--
Boiling Range Distribution (°C)	0.5	L	335	368	270	271	270
	1		335	376	292	292	294
	5		388	398	356	358	361
	10		402	410	383	384	387
	20		418	427	410	410	412
	30		431	439	428	428	431
	40		442	451	445	443	447
	50		453	461	462	458	463
	60		463	471	477	473	480
	70		474	482	497	491	500
	80		486	494	521	515	528
	90		502	511	560	555	575
	95		517	528	575	575	575
Cloud Point (°F)		M	22	20	20	18	18
Pour Point (°C)		L	-7	-9	-30	-21	-21
Color (ASTM Color Units)		L	2.5	2.5	4.5	5.0	5.0
		M	2.0	2.5	4.5	4.5	4.5
Fire Point (°F)		L	500	495	500	500	490
Flash Point (°F)		L	465	475	460	465	450
Refractive Index (N_D^{20})		N	1.4837	1.4837	1.4840	1.4840	1.4841

IV. CHEMICAL PROPERTIES

Test		Lab	BC7169	BC7174	BC7248	BC7423	BC7426
Carbon Residue		L	0.05	0.10	0.21	0.24	0.23
Sulfated Ash		L	0.00	0.00	0.13	0.13	0.13
Total Metals		R	5	3	276	344	335
Saponification Number		L	0.16	0.17	0.55	0.92	0.92
Total Acid Number		L	0.01	0.01	0.18	0.18	0.18
IR Spectrometry	5.8	W	0	0	0.96	0	0
	6.2		0	0	1.42	2.15	2.0
	8.15		0	0	0	0.3	0.2
	10.3		0	0	0	0	0
DIR Spectrometry	5.8		--	--	1.72	--	0.5
	6.23		--	--	0	--	0

Test		Lab	BC7169	BC7174	BC7248	BC7423	BC7426
Elemental Analysis							
1. Atomic Emission	Ca	R	1	1	74	165	163
	Fe		--	--	--	--	--
	Pb		--	--	--	--	--
	Mg		--	--	--	--	--
	P		<50	<50	100	57	65
	Si		--	--	--	--	--
	Na		1	1	--	1	1
	Sn		2	--	--	--	--
	Zn		1	1	102	120	105
2. Chemiluminescence	N	L	29.00	29.00	27.00	21.00	19.00
3. Neutron Activation	Br	N	<.07	<.07	0.93	0.84	0.90
	Cl		.42	.48	9.2	9.0	9.2
	Na		.98	1.03	0.9	0.82	0.84
	K		<1	<1	1	<1	<1
4. Oxygen Analysis		O	0.18	0.23	0.19	--	--
5. X-ray Fluorescence	S	L	0.66	0.66	0.20	0.19	0.19
	Cl		<0.01	<0.01	<0.01	<0.01	<0.01
Molecular Analysis							
1. Ethylene Glycol		S	<1	<1	<1	--	--
2. Water		N	71	63	288	301	298

V. HYDROCARBON TYPE ANALYSIS

Test		Lab	BC7169	BC7174	BC7248	BC7423	BC7426
Liquid Chromatography							
1. Clay-Silica (ASTM D2007)	Sat	M	73.0	72.2	--	--	--
	Aro		26.4	27.3	--	--	--
	Pol		0.6	0.5	--	--	--
2. Alumina-Silica (ASTM D2549)	Aro	V	26.3	28.5	20.1	20.9	20.5
	Sat		73.7	71.5	79.9	79.1	79.5
	Recovery		98.0	95.9	95.0	96.4	97.3
TLC/FID SAT HC		U	80.0	82.8	84.6	84.6	83.5
ARO HC			17.8	16.2	13.5	14.3	15.0
POL CMPD			2.2	0.9	1.4	1.1	1.5
Highly POL CMPD			ND	0.1	ND	ND	ND
DMSO EXTRACT		U	0.99	1.19	--	1.85	2.27
			0.96	1.22		1.91	2.28
RI			1.5625	1.6109	--	1.5847	1.5790
MS Benzothiophenes		V	D	D	--	--	--
Di-			D	D	--	--	--
($C_nH_{2n-12}S$)			D	ND	--	--	--
NMR L/T HC		V	19	21	16.4	18.1	19.4
Isoprenoid ratio			0.8	0.7	1.14	1.01	0.98
PIB			ND	ND	--	~0.3	ND
UV Aromaticity	mono-ring	L	4.0	4.1	3.1	1.6	1.6
	di-ring		1.6	1.7	1.7	0.9	0.9
	tri-ring		0.3	0.3	0.3	0.1	0.1

VI. GENERAL PERFORMANCE TESTS

Test			Lab	BC7169	BC7174	BC7248	BC7423	BC7426
Demulsibility	Tube 1	H_2O	W	>60	>60	>60	>60	>60
		EM		>60	>60	>60	>60	>60
		BK		>60	>60	>60	>60	>60
	Tube 2	H_2O		>60	>60	>60	>60	>60
		EM		>60	>60	>60	>60	>60
		BK		>60	>60	>60	>60	>60
	Tube 3	H_2O		7	>60	>60	>60	>60
		EM		>60	>60	>60	>60	>60
		BK		>60	>60	>60	>60	>60
	Tube 4	H_2O		>60	8	>60	>60	>60
		EM		>60	11	>60	>60	>60
		BK		>60	>60	>60	>60	>60

Test			Lab	BC7169	BC7174	BC7248	BC7423	BC7426
Filterability	Run 1	mg	W	8.0	16.1	1.9	NF	--
		Time(s)		109.7	128.1	180.6	>1800	--
	Run 2	mg		19.5	7.5	2.1	NF	--
		Time(s)		107.7	124.7	176.6	>1800	--
	Run 3	mg		6.8	3.5	1.9	NF	--
		Time(s)		112.2	124.4	182.3	>1800	--
Foaming Tendency	Seg I		X	330-0	330-0	20-0	0-0	20-0
	II			10-0	0-0	10-0	50-0	40-0
	III			320-0	30-0	20-0	90-0	50-0
Rust	A		X	L	H	M	N	N
	B			H	H	H	H	L
Sediment			M	0.000	0.000	0.000	0.001	0.001
CD/SE Additive Compatibility		WK1,RT	X	C	C	C	C	C
		150°F		C	C/T	C	C/T	C
		32°F		C	C	C	C	C
		0°F		C	C/T	C	SZ	SZ
		WK4,RT		C	C	C/T	C/T	C/T
		150°F		C/T	C/T	C/T	C/T	C/T
		32°F		C/T	C	C	C	C/T
		0°F		C/T	C/T	C/T	C	C

VII. OXIDATION AND ADDITIVE RESPONSE TESTS

Test		Lab	BC7169	BC7174	BC7248	BC7423	BC7426
Antioxidant Capacity		N	0.003	0.004	0.004	0.001	0.001
DSC Induction Time		N	<1	<1	<1	--	--
Onset Temp.			192	192	221	220	219
DSC + Add Induction Time			24	24	34	32	30
Onset Temp.			251	252	255	256	255
Lubtot		L	31	32	19	--	--
Oxygen Uptake	Time 1L Oxy	Z	6.0	5.8	--	--	--
	Total Oxy		5.1	5.9	--	--	--
RBOT	Run 1	M	141	143	--	--	--
	Run 2		142	142	--	--	--
Seq. III Sim		O	9.25	9.00	9.25	9.50	9.50
TOST		M	538	685	--	--	--
Load Wear Index		Z	29.9	29.4	--	--	--

Appendix II

Test Methods and Summaries

APPENDIX II

The test methods used in this study are listed below grouped by major divisions corresponding to the table of contents. When the test method is not readily available or when additional information is necessary for understanding the data presented, the method and/or summary is attached at the end of Appendix II as noted. An asterisk (*) denotes that the method is available on approval from the Chairman of the appropriate ASTM Committee D2-RDD Division.

Test	Method
II. RHEOLOGY	
Brookfield Viscosity at 0, -20, -40 °F (cP)	ASTM D2983 Low-Temperature Viscosity of Automotive Fluid Lubricants Measured by Brookfield Viscometer
Cold Cranking Simulator at 0, -5, -10, -15, -18, -20, -25, -30, -35, -40 °C (cP)	*Modified ASTM D2602 1980 ASTM Proposed Test Method for Apparent Viscosity of Motor Oils Between -40 °C and 0 °C Using the Cold Cranking Simulator (and using scanning mode)
Critical Starting Temperature at 3500 cP (°C)	Calculated from Cold Cranking Simulator data using a regression fit based on the Walther Equation
Kinematic Viscosity at 40, 100 °C (cSt)	ASTM D445 Test for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)
Viscosity Index	ASTM D2270 Calculating Viscosity Index from Kinematic Viscosity
Mini-Rotary Viscometer BPT (°F)	ASTM D3829 Predicting the Borderline Pumping Temperature of Engine Oil Summary explanation attached
III. PHYSICAL PROPERTIES	
API Gravity (°API)	ASTM D287 (or ASTM D1298) Test for API Gravity of Crude Petroleum and Petroleum Products (Hydrometer Method)
Boiling Range Distribution by GC, 0.5, 1, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 95 °C and wt% greater than 575 °C	*Modified ASTM D2887 Test for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography Modified for determination of higher boiling components and data processing
Cloud Point (°C)	ASTM D2500 Test for Cloud Point of Petroleum Oils
Pour Point (°C)	ASTM D97 Test for Pour Point of Petroleum Oils
Color (ASTM Color)	ASTM D1500 Test for ASTM Color of Petroleum Products (ASTM Color Scale)
Fire Point (°F)	ASTM D92 Test for Flash and Fire Points by Cleveland Open Cup
Flash Point (°F)	ASTM D92 Test for Flash and Fire Points by Cleveland Open Cup
Odor Comparisons to 100 Pale and to 100 Neutral	Proprietary Test
Refractive Index (n_D^{20})	ASTM D1218 Test for Refractive Index and Refractive Dispersion of Hydrocarbon Liquids

Test	Method
IV. CHEMICAL PROPERTIES	
Carbon Residue (wt%)	ASTM D524 Test for Ramsbottom Carbon Residue of Petroleum Products
Sulfated Ash (wt%)	ASTM D874 Test for Sulfated Ash from Lubricating Oils and Additives
Total Metals (ppm)	Atomic Emission Spectrometry Summary and Method Attached
Saponification Number (mg KOH/g)	ASTM D94 Test for Saponification Number by Color-Indicator Titration
Total Acid Number (mg KOH/g)	ASTM D664 Test for Neutralization Number by Potentiometric Titration
Elemental Analysis 1. Atomic Emission for Ca, Fe, Pb, Mg, P, Si, Na, Sn, Zn (Ag, Cu, Al, Ba, Ni, Cr, B, V, Mo, Cd, Ti) (ppm)	Atomic Emission Spectrometry Summary and Method Attached
2. Chemiluminescence (N) (ppm)	*ASTM Proposed Test Method for Organically Bound Trace Nitrogen in Liquid Petroleum Hydrocarbons by Oxidative Combustion and Chemiluminescence Detection
3. Neutron Activation for Br, Cl, Na, K (ppm)	Neutron Activation Analysis Summary and Method Attached
4. Oxygen (ppm)	Modified UOP 649-74 Total Oxygen in Organic Materials by Pyrolysis-Gas Chromatographic Technique Summary Attached
5. X-ray Fluorescence for S(Cl) (wt%)	Modified ASTM D2622 Test for Sulfur in Petroleum Products (X-Ray Spectrographic Method) Modified to use energy dispersive instead of wavelength dispersive XRF. Cl procedure similar to S, but with 100 ppm limit of detection.
Molecular Analysis	
1. Ethylene Glycol (ppm)	*ASTM Proposed Test Method for Trace Ethylene Glycol in Used Engine Oil
2. Water (Moisture) (ppm)	Modified ASTM D1744 Water in Liquid Petroleum Products by Karl Fischer Reagent Modification described in Proceedings of the Conference on Measurements and Standards of Recycled Oil-IV, to be published 1983.
Infrared Spectrometry (absorbance)	Infrared Spectrometry Method Attached

Test	Method
V. HYDROCARBON TYPE ANALYSIS	
Liquid Chromatography	
1. Clay-silica (ASTM D2007) for saturates, aromatics and polars (wt%)	ASTM D2007 Test for Characteristics Groups in Rubber Extender and Processing Oils by the Clay-Gel Adsorption Chromatographic Method
2. Alumina-silica (ASTM D2549) for saturates, and aromatics (wt%)	ASTM D2549 Test for Separation of Representative Aromatics and Nonaromatics Fractions of High Boiling Oils by Elution Chromatography
Liquid Chromatography/Mass Spectrometry for saturates, mono-aromatics, diaromatics, poly-aromatics (wt%)	HPLC/MS Method: "Preparative Liquid Chromatography for Fractionation of Petroleum and Synthetic Crude Oils," James W. Vogh and Jane S. Thomson, Anal. Chem., 1981, 53, 1345-1350.
Thin Layer Chromatography/Flame Ionization Detection for saturate, aromatic, polar and highly polar compounds (wt%)	TLC/FID: Thin Layer Chromatography with Flame Ionization Detector Summary of Method Attached
DMSO Extraction/Refractive Index for polycyclic aromatic content (wt%)	IP346 Polyclic Aromatics in Petroleum Fractions by Dimethyl Sulphoxide-Refractive Index Method
Mass Spectrometry for Sulfur compounds (ppm)	High Resolution Mass Spectrometry Summary of Method and Results Attached
Nuclear Magnetic Resonance Spectrometry for isprenoid and linear/total hydrocarbon ratio and PIB units (ppm)	^{13}C Nuclear Magnetic Resonance Spectrometry Summary of Method Attached
Ultraviolet Spectrometry for Mono-di-, and tri-aromatics (%)	Determination of Aromaticity of Fuels and Lubricants by Ultraviolet Spectroscopy, Interim Report AFLRL 103 Feb 1980 (Defense Documentation Center #ADAO 86654) Summary of Method Attached
VI. GENERAL PERFORMANCE TESTS	
Demulsibility	ASTM D1401 Test for Emulsion Characteristics of Petroleum Oils and Synthetic Fluids
Filterability	1) Sediment and Filterability of Industrial Oils Method Attached 2) Proprietary Method
Foaming Tendency	ASTM D892 Test for Foaming Characteristics of Lubricating Oils
High Temperature Copper Corrosion	Proprietary Method
CD/SE Additive Compatibility	Proprietary test, Storage at 70-80 °F of oil treated with a typical SE/CD additive.
Rust	ASTM D665 Test for Rust-Preventing Characteristics of Steam-Turbine Oil in the Presence of Water

Test	Method
Sediment	ASTM D2273 Test for Trace Sediment in Lubricating Oils
Storage Stability Ambient, Cold and Sunlight Storage	Storage Stability Summary of Method Attached

VII. OXIDATION AND ADDITIVE COMPATIBILITY

Test	Method
Antioxidant Capacity (mol-L)	Free Radical Titration Test: Ind. Eng. Chem. Prod. Res. Div. 17, 250(1978) Summary and Method Attached
Differential Scanning Calorimetry	Differential Scanning Calorimetry Summary of Method Attached
Load Wear Index	ASTM D2783 Measurement of Extreme-Pressure Properties of Lubricating Fluids (Four-Ball Method) To evaluate EP properties, oils containing a package which satisfies the U.S. Steel 224 Specification. Load wear index results are considered suspect if they differ by more than 5 kg.
Lubricant Thermal Oxidation Test (LUBTOT)	Lubricant Thermal Oxidation Test Summary Attached
Oxygen Uptake	Oxidator Test Summary of Method Attached
Rotary Bomb Oxidation Test (RBOT)	ASTM D2272 Test for Oxidation Stability of Steam-Turbine Oil by Rotating Bomb
Sequence III Simulator	Proprietary test, scale 0-10 (10 = clean; >6.6 = Passing, a form of hot tube test at elevated temperatures.
Turbine Oil Oxidation Stability Test (TOST)	ASTM D943 Test for Oxidation Characteristics of Inhibited Mineral Oil

SUMMARY EXPLANATION OF MINI-ROTARY VISCOMETER ASTM D3829 METHOD

Border line pumping temperature (BPT) reported in °F also reports whether the oil exhibited air-binding (A) or flow-limited (F) failure mode. In some cases the air-binding BPT and the viscosity (flow-limited) BPT were within 0.5 °F. This is indicated in the data by #sign and the BPTs were averaged. All air-binding failure mode cases correspond to a yield stress of 105 Pa for the 30 g mass. All flow-limited failure mode cases were interpolated at an apparent viscosity of 30 Pa-s.

DESCRIPTION OF INFRARED ABSORPTION METHOD
FOR ANALYSIS OF USED ENGINE OILS

1. INTRODUCTION

1.1 This revision limits the application to oils of known additive composition or behavior to avoid errors in interpretation of test results. It also modifies the recommendations for adsorption cell window materials and eliminates certain details that were incorporated in the original method in an attempt to make it applicable to marine diesel oils. For the latter products a new method is now available entitled "Infrared Analysis of Used Marine Diesel Lubricants." Numerous editorial changes have also been made to help clarify the method.

2. SCOPE

2.1 This method is used to examine used lubricating oils from gasoline, natural gas, and diesel engines (other than marine) by infrared absorption spectroscopy. The method indicates the degree of oxidation and the relative amounts of olefins, nitrates, and nitro compounds. Water may often be determined quantitatively and ethylene glycol is determined quantitatively.

2.2 In general, the method is limited to oils of known composition, containing only additives which do not adsorb at wavelengths of interest (table 1) or additives whose absorption is known not to change significantly relative to the adsorption of the component being measured. Disregard of these limitations may lead to uncertainty or errors in interpretation of test results. For example, the depletion of an additive which adsorbs at 5.85 micrometers may balance the increase in absorbance caused by oxidation of the oils and lead to the erroneous conclusion that little or no oxidation has taken place. Similarly, in certain oils containing phenate additives, decomposition of the phenate may yield a phenol absorption peak which will lead to an erroneously high water value.

3. OUTLINE OF METHOD

3.1 A differential spectrum of the used oils vs. a reference unused oil of the same type is recorded between 2.5 and 15.0 micrometers. Oils which are opaque to infrared radiation are diluted with a similar type of oil to obtain adequate transmittance. Absorbances are measured at specific wavelengths and are related to components as shown in table 1. Water and gasoline fuel dilution are determined by reference to calibration curves.

4. APPARATUS

4.1 Infrared Spectrophotometer, dual beam. A Grubb Parsons G. S. 2A, a Perkin-Elmer Infracord Model 137-B, or a Perkin-Elmer Grating Spectrophotometer Model 221 or 467 is suitable. Other equivalent instruments also can be used.

4.1.1 Consult texts concerning general methodology of infrared absorption analysis for discussions of apparatus, materials, and procedures.

4.1.2 The Infracord Model 137, with the slit width set at 25 and a slow scan speed, was used in developing this method.

4.2 Absorption Cells, fixed thickness, 0.100 ± 0.005 mm pathlength (Note 1). Barium fluoride and silver chloride windows are recommended for this method, but silver chloride may induce interference fringes with some oils. Sodium chloride and potassium chloride windows are acceptable for samples which are nearly free of water; however, extended exposure to moisture will cause fogging (Note 2). Irtran-2 windows are not recommended because the current composition of this material has been found to yield intolerable interference fringes.

Table 1

Specific Infrared Absorption Bands and Used Oil Components

Band Wavelength (micrometers)	Nature of Component	Reported as
2.90	Water	Volume %
6.05	Water	Absorbance/cm
5.85	Oxidation Products	Absorbance/cm
6.10	Olefins (a)	Absorbance/cm
6.10, 7.9, 11.6	Organic Nitrates (b)	Absorbance/cm at each wavelength
6.4	Nitro Compounds (b)	Absorbance/cm
12.40 & 12.80	Gasoline Fuel Dilution (b)	Volume %
9.30 & 9.70	Ethylene Glycol	Present or Absent

(a) Absorbance at 6.10 micrometers indicates olefins only when the 7.9 and 11.6 micrometer bands (organic nitrates) are absent; if the 7.9 and 11.6 micrometer bands are present, olefins cannot readily be determined with certainty.

(b) Not present in diesel oils.

Note 1 - Cell pathlengths between 0.095 and 0.105 mm are satisfactory, but the pair of cells used for an analysis must not differ from each other by more than 0.002 mm. Use the thinner cell for the reference oil.

Note 2 - Use extreme care in handling cells with halide windows. Do not subject barium fluoride windows to mechanical or thermal shock. Do not touch sodium chloride or potassium bromide windows with the fingers, and avoid exposing to the breath or other moist air; store these cells, while not in use, in a desiccator or in a tightly closed jar containing a desiccant. Store silver chloride cells in darkness.

4.3 Hypodermic Syringe, 1 mL.

5. MATERIALS

5.1 Reference Oils. Unused oils containing the proper concentrations of all the additives contained in the formulations of the used oils to be analyzed.

6. PREPARATION OF CALIBRATION CURVES

6.1 Water Content.

6.1.1 Select a sample of used oil of the type to be analyzed which is shown by ASTM D95-IP 74 or an equivalent method to be free of water. Prepare standard blends of this oil containing 0.10, 0.20, 0.50, 1.0, 1.5, and 2.0 volume % water. Disperse the water in the oil by agitating with a high speed mixer or a homogenizer-blender of the waring type.

Note 3 - Complete dispersion of the water in the oils is essential. Stable dispersions are obtained more readily with used oils than with unused oils.

6.1.2 With the spectrophotometer beams unobstructed, adjust the transmittance at 2.5 micrometers to 90% (0.05 absorbance). Fill the cell designated as "reference" with the oil used to make the water blends in Section 6.1.1 and the "sample" cell with one of the standard blends (Note 4). Place each cell in the appropriate light path and scan the spectrum between 2.5 and 4.5 micrometers. Draw a straight baseline from the region of 2.5 micrometers to the region of 4.0 to 4.5 micrometers. Measure the net absorbance at 2.9 micrometers (peaked) and calculate the absorbance/cm for the standard blend as follows:

$$a = \frac{A}{b}$$

where

a = absorbance/cm.

A = net absorbance at 2.9 micrometers, absorbance units.

b = length of cell path, cm.

Note 4 - Cells can be filled conveniently by dispensing oil droplets from the tip of a micro spatula into the cell opening, and drawing the oil into the cell with mild suction. A syringe with a Luer-Lok type tip is also suitable. After filling, inspect the cell for the presence of air pockets. If any are present, remove them with gentle suction or by refilling with the sample.

6.1.3 Repeat Section 6.1.2 for all the prepared standard water blends. On linear-coordinate graph paper, plot the absorbance/cm values against the water contents of the blends and draw a smooth line through the points.

6.2 Gasoline Fuel Dilution.

6.2.1 Accumulate a representative quantity of gasoline fuel diluent by running ASTM D322, "Dilution of Gasoline-Engine Crankcase Oils," on at least 20 different samples of used oil and compositing the distillates. Alternatively, distill one liter of a reference fuel and collect the 90-97% volume fraction. Blend the composite or the 90-97% distillate fraction into unused oil of the type to be tested at the following concentrations: 1.5, 3.0, 6.0, 9.0 and 12.0% volume.

6.2.2 With the spectrophotometer beams unobstructed, adjust the transmittance at 2.5 micrometers to 90% (0.05 absorbance). Fill the "reference" cell with the unused oil, and the "sample" cell with a fuel diluent oil blend (Note 4, Section 6.1.2), and record the spectrum between 11.0 and 15 micrometers. Repeat the scan with each blend.

6.2.3 Draw baselines between 11.2 and 14.1 micrometers on each scan and measure the net values at 12.4 and 12.8 micrometers (Note 5). Add the two values for each blend, convert the sum to absorbance/cm, and plot the values vs. concentrations by volume on linear-coordinate paper. Draw a smooth line through the points.

Note 5 - The fuel dilution is based on the measurement of aromatic bands commonly found in gasoline. Other bands indicative of fuel dilution occur at 11.8, 13.05, 13.55, and 14.4 micrometers. If experience shows that better correlation is obtained by using one or more of these bands in addition to those at 12.4 and 12.8, the procedure may be extended to include them.

7. PREPARATION OF SAMPLE

7.1 Agitate the sample in the original container until all sediment is homogeneously suspended in the oil (Note 6). If the original container is of opaque material, or if it is more than three-fourths full, transfer the entire sample to a clear glass bottle having a capacity at least one-third greater than the volume of the sample. Transfer all traces of sediment from the original container to the bottle by violent agitation of portions of the sample in the original container.

Note 6 - As used oil may change appreciably in storage, test the samples as soon as possible after receipt.

7.2 Some used oils contain sufficient soot, etc. to render them opaque to infrared radiation. If the maximum transmittance at 2.5 micrometers is below 30% (0.5 absorbance), dilute the used oil to a known volume with unused oil having the same formulation. To avoid excessive loss of sensitivity, do not dilute beyond 1:2. Multiply the results obtained by the appropriate dilution factor.

8. PROCEDURE

8.1 Gasoline Engine Oils. Fill the "sample" cell and the "reference" cell with the sample and the corresponding reference oil, respectively (Note 4, Section 6.1.2). With the spectrophotometer beams unobstructed, adjust the transmittance to 90% (0.05 absorbance) at 2.5 micrometers wavelength. Place the cells in the spectrophotometer and record the spectrum between 2.5 and 15 micrometers. Measure the net absorbance for the water peak as described in Section 6.1.2, and for the fuel dilution peaks as described in Section 6.2.3. Measure the net absorbances for peaks at 5.85, 6.05, and 6.1 micrometers, based on a horizontal straight line tangent to the flat baseline of the spectrum in the range 4.5 to 5.2 micrometers and extending to the 7.0 micrometer range. Measure the net absorbance of the peaks at 7.9 and 11.6 micrometers, using the appropriate baseline technique Section 14.2.2). Note the presence or absence of peaks at 9.3 and 9.7 micrometers having approximately equal absorbance intensities which identify ethylene glycol.

8.2 Natural Gas Engine Oils. Fill the cells and adjust the spectrophotometer transmittance as described in Section 8.1. Place the cells in the spectrophotometer and record the spectrum between 2.5 and 12.5 micrometers. Measure the net absorbance at 2.90 micrometers as previously described in Section 6.1.2. Measure the net absorbance of the peaks at 5.85, 6.05, 6.1 and 6.4 micrometers, based on a horizontal straight line tangent to the flat baseline of the spectrum in the area of 4.5 to 5.2 micrometers and extending to the 7.0 micrometers range. Measure the net absorbance of the peaks at 7.9 and 11.6 micrometers by a baseline technique. Absorption peaks of approximately equal intensity occurring at 9.3 and 9.7 micrometers indicate the presence of ethylene glycol.

8.3 Diesel Engine Oils. Fill the cells and adjust the spectrophotometer transmittance as described in Section 8.1. Place the cells in the spectrophotometer and record the spectrum between 2.5 and 12.5 micrometers. Measure the net absorbance at 2.90 micrometers as previously described in Section 6.1.2. Measure the net absorbance of the peaks at 5.85, 6.05, and 6.1 micrometers, based on a horizontal straight line tangent to the flat baseline of the spectrum in the area of 4.5 to 5.2 micrometers and extending to the 7.0 micrometer range. Measure the net absorbance of the peaks at 7.9 and 11.6 micrometers by a baseline technique. Note the presence or absence of peaks at 9.3 and 9.7 micrometers having approximately equal absorbance intensities which identify ethylene glycol. If the transmittance at any wavelength of interest is less than 30%, refer to Section 7.2.

9. CALCULATION AND REPORT

9.1 Convert the net absorbance values into absorbance per centimeter of cell pathlength.

9.2 Determine water and fuel dilution percentages by volume by reference to the respective calibration curves, Section 6.

> Note 7 - In the presence of high oxidation (absorbance at 5.85 micrometers) the water peak at 2.9 micrometers may be influenced by the presence of oxidation products containing -OH and be high.

9.3 Report results as shown in table 1, Section 3.

SUMMARY OF ELEMENTAL ANALYSIS

BY

EMISSION SPECTROMETRIC PROCEDURE

This method covers the determination of twenty-one elements in new and used lubricating oils.

Summary

A graphite disc electrode rotating in a vertical plane partially immersed in the oil sample serves as the lower electrode and provides continuous introduction of the sample into the arc gap. A controlled high-voltage arc between the upper and lower electrodes excites the sample. Spectral light is generated and processed to discrete spectral light beams that are directed to certain photomultiplier tubes. The photomultiplier tubes convert the spectral light to an electrical signal current. The amount of signal current is measured. Utilizing these measurements, the attached mini-computer and peripheral hardware with software packages supplies a complete printout showing percent concentration of the elements desired.

Standard materials are used to calibrate and develop analytical curves. These curves supply the information necessary for converting the analytical data into percent concentration.

Apparatus

The apparatus includes the following:

HA-10 Baird Spectromet 1000 direct reading spectrometer
RS-2 High speed digital readout
SCE-14 Spectrocomp system PDP - 8/A computer
Decwriter for printout

Materials

Materials necessary are:

Disposable sample containers
Electrode rotating discs
Electrode rods

Standards

Standards used are Conostan metallo-organic standards.

Base oil is used for preparing calibration standards.

Conostan C-21 standards are purchased at concentrations of 900, 100, and 50 parts per million (ppm).

The C-21 Standards are blends of equal amounts of the following elements:

Ag	Al	B	Ba	Ca	Cd	Cr
Cu	Fe	Mg	Mn	Mo	Na	Ni
P	Pb	Si	Sn	Ti	V	Zn

Standards are prepared by weight using the purchased standards and base oil to make dilutions. The series of standards used for analytical curves include concentrations covering 0 ppm, 0.1 ppm, 0.2 ppm, 0.5 ppm, 1 ppm, 2 ppm, 5 ppm, 10 ppm, 20 ppm, 50 ppm, 100 ppm, 450 ppm, 900 ppm. A daily adjustment standard is prepared.

Procedure

The optical portion of the spectrometer 1000 is adjusted before use to line up the optics to optimum position. The daily adjustment standard is burned three times or until three sets of results are within the satisfactory limit of variance. The results are averaged and the computer adjusts the curves relative to these results. Next a standard with known levels is run and if significant differences from the values are found the daily adjustment standard is rerun.

Sample handling procedure requires that all samples should be mixed well before removing a portion for analysis. The sample is poured into a new sample container until the container is level full. The full sample container is placed in the holder on the adjustable head of the stage in the rotating disc electrode disc stand. Prior to putting the sample in this stand, one rotating disc electrode and one rod electrode is placed in the holders and the gap is set. The stage is raised until the rotating disc electrode dips about 2 mm into the sample of "oil." The sample containers and electrodes are used once and discarded to prevent contamination. However, the long rod electrodes may be reused by cutting away about 6 millimeters and reshaping the tip. Pushing the start button activates the timing to sequence the system through Flush, Preburn, Expose and Measure modes. During this sequence of modes of the system, data is accumulated, reduced, computed and printed out as element concentration for each of the twenty-one elements for which the readout is programmed.

Report

We report results in parts per million with the following exceptions.

For all elements except silver and phosphorus zero is reported for a readout of less than 0.5. Silver values are reported down to 0.1 mm. Phosphorus readouts below 50 are reported as less than 50 ppm (<50).

Total metals is the summation of all the detected metals plus phosphorus and silicon.

SUMMARY OF THE NEUTRON ACTIVATION ANALYSIS TEST FOR CHLORINE AND BROMINE

In the neutron activation analysis (NAA) test method, the sample is irradiated in a neutron source (usually a nuclear reactor, in order to obtain the required sensitivity) for a period of time and, after withdrawing the sample, the resulting induced radioactivity is measured. This radioactivity is detected and quantitated using a high resolution germanium semiconductor detector. Each element of interest may be uniquely identified through observation of its gamma-ray energy, half-life, and also peak ratios if multiple gamma-rays are produced. The NAA method measures total chlorine and total bromine in an oil sample, regardless of chemical form or location, and does not suffer from significant problems with non-halogen additives or contaminants expected to be in re-refined or virgin lubricating oil basestocks. The sensitivity of NAA for both chlorine and bromine is below 1 μg/g using this analysis method.

The NAA method has been found to be both repeatable and consistent with results from other analytical methods. Although not considered a routine analytical technique, the NAA method is straightforward and analyses can be obtained commercially. Although this procedure is not in ASTM format or highly detailed, it provides sufficient information for an experienced individual to duplicate these analysis.

Experimental Procedure

Samples for Analysis: Oil samples to be analyzed must be representative of the bulk material in order to provide valid data. Non-homogeneous oils must be thoroughly mixed prior to sampling. Used oils and/or heavily contaminated oils should be vigorously shaken in a paint shaker for 20 minutes immediately before subsampling for analysis. To monitor the halogen blank values, a paraffin oil (Fisher Scientific No. O-119) was run in parallel with each set of oil samples.

Sample and Standard Irradiation: Both samples and standards were irradiated in NBSR small screw-top rabbits which had been pre-cleaned with high purity nitric acid. These containers were held in a fixed position by a heat sealed polyethylene snap-top vial which was placed in the bottom of a standard NBSR rabbit for irradiation. All irradiations were done in the RT-4 pneumatic tube facility of the NBSR ($\phi = 1.3 \times 10^{13}$ N-cm ^{2}-s ^{1}) for times from two to ten minutes.

After irradiation, the sample or standard was pipette transferred to a preweighed screw-top glass vial for counting. The sample weights ranged from 2.3 to 2.9 grams. The standards used were two aqueous solutions each of KBr and NaCl with the concentrations shown in Table I.

Table I

Standards Used for Analysis

Compound	Cation (μg/g)	Anion (μg/g)
KBr-I	319.42	692.79
KBr-II	30.86	63.07
NaCl-I	584.41	901.22
NaCl-II	39.36	60.69

Counting Procedure: All samples were counted with the vials placed upright at 10 cm from a Ge(Li) detector. Replicate counts were taken at 20 cm and 30 cm for samples and standards with sufficient activity. Two series of counts were done for each sample, one within the first hour after irradiation to determine the ^{38}Cl activity, and the second a day later to determine to ^{82}Br. For each element, at least two characteristic gamma lines were monitored and in general more than one count was taken in both counting series. The gamma lines and decay half-lives used are shown in Table II.

Table II

Characteristic Radiation Measured

Elem.	Nuclide	Half-Life	$E_{\gamma 1}$, KeV	$E_{\gamma 2}$, KeV	$E_{\gamma 3}$, KeV
Cl	^{38}Cl	37.21 min	1642.42	2167.51	----
Br	^{82}Br	35.30 hr	554.35	776.52	1044.00
Na	^{24}Na	15.00 hr	1368.63	2754.03	----
K	^{42}K	12.36 hr	1524.67	----	----

The analyzer dead time was kept at below 5% and no correction was made for pulse pileup or for the second order effect of the decaying source on the live time. The quantity deemed proportional to element mass was

$$\frac{Ne^{\lambda t_1}}{(1-e^{-\lambda\Delta})(1-e^{-\lambda\tau})}$$

where:

- N = net counts in the gamma peak
- λ = the decay constant
- τ = irradiation time
- Δ = counting live time
- t_1 = time from end of irradiation to the start of count

Results: The measured concentrations of chlorine and bromine in nine oils are given in Table III. The values given are a pooling of the results for the two or more gamma lines measured and for multiple counts of each sample. Only one sample of each oil was measured. The uncertainty quoted for the mean value is the larger of the observed range of the individual determinations and the a priori statistical uncertainty of a single determination. This uncertainty should be a conservative estimate of the (1σ) precision of the values given.

Table III

Typical Elemental Concentration Results for Halogen Analysis in Virgin and Re-Refined Basestocks

Sample#	Cl (μg/g)	Br(μg/g)
AA	0.91 ± 0.06	≤0.06
BB	0.42 ± 0.04	≤0.07
CC	0.12 ± 0.02	≤0.03
DD	0.12 ± 0.02	≤0.03
EE	102.4 ± 1.5	9.4 ± 0.2
FF	7.72 ± 0.15	1.54 ± 0.10
GG	0.48 ± 0.05	≤0.07
HH	29.0 ± 0.5	0.84 ± 0.07
II	37.8 ± 0.5	1.62 ± 0.10
Paraffin Oil	0.12 ± 0.02	≤0.03
Container	3.4 ± 0.1	0.07 ± 0.03

The concentration measured for the Fisher paraffin oil may be considered an upper limit of the procedure blank, which represents possible leaching of the irradiation container by the oils. For bromine, this blank is below the measurement sensitivity of 30 ppb. For chlorine, the apparent 0.12 ppm blank may in fact be a trace impurity in the paraffin oil. As an absolute upper limit on the procedure blank, an empty irradiation container was counted and the results are shown in Table III. It should be noted that these results would occur as a blank only if the entire irradiation container were dissolved into the oil.

Conclusions: (1) The limit of measurement for chlorine and bromine is about 50 ppb, using the present procedure. For bromine, the blank is at or below this level while for chlorine the blank may be as high as 120 ppb.

(2) The post-irradiation transfer of the samples incurs the possible risk of loss of volatile species, which could be serious for either Cl or Br. However, no loss of Cl or Br activity was seen during a large number of analysis, and agreement is good with other analytical techniques for chlorine in samples for which other techniques can be used.

SUMMARY OF TOTAL OXYGEN TEST

METHOD: MODIFIED UOP METHOD 649-74

The sample is pyrolyzed in a helium atmosphere in the presence of carbon. Oxygen is converted to carbon monoxide. A gas chromatograph is used to separate and quantify the evolved carbon monoxide.

The lower limit of detection is 0.1%. Precision = ± 5% of the O_2 content. No correction is made for H_2O.

SUMMARY OF THIN LAYER CHROMATOGRAPHY WITH FLAME IONIZATION DETECTION (TLC/FID)

The separation is performed on a quartz rod coated with stationary phase material (e.g. silica gel or alumina). The rod with the chromatographically separated hydrocarbon types is passed through the flame of a hydrogen/air burner above which is a collector electrode. The ionization effect from the combustion process is converted into a signal from which the chromatogram is recorded.

SUMMARY OF MASS SPECTROMETRY ANALYSIS

High resolution mass spectrometry analysis of the ASTM/NBS BCS oils has been carried out. Such analyses were performed in order to identify any organic impurities such as anti-oxidants, plasticizers, acids, and halo-carbon solvents which may be present in the oil. The experimental conditions are described below.

Experimental Method

The instrument used for these experiments was an AEI MS50 mass spectrometer, operating in electron impact mode at a mass resolution of 1:20,000 under the following conditions; source temperature -250 °C, electron energy -70 eV, electron current ~ 100 μA, accelerating potential - 8000V. 20 μl of sample is heated in an oven which is at 270 °C and the resultant vapor allowed to flow into the mass spectrometer via a small leak. These conditions are designed to yield analysis of a maximum portion of the sample without thermal degradation ("cracking") of the oil occurring and using optimum mass resolution and sensitivity. Under these conditions approximately 85% of the sample was analyzed in most cases. The exceptions were BC7186 (60%), BC7239 (70%), BC7240 (70%) and BC7245 (55%). The figures in brackets represent the amount of sample analyzed. This may indicate that these four oils contain high molecular weight impurities such as polymers.

Basestock

All the oils examined contained the expected paraffinic and aromatic species that contribute to "natural" hydrocarbon oils, although different mixes of paraffinic and naphthenic oils were observed. No evidence was obtained for the incorporation of synthetic oil basestocks in the re-refined oils of a level of greater than 3%. However, some of the oils (BC 7171, BC7239, BC7241 and BC7243) contain abnormally low levels of the C_nH_{2n-11} series of ions which are usually characteristic of benzocyclo-paraffins (mono and di cyclic).

Molecular Weight Range

Under the conditions utilized it is not possible to give any accurate data on molecular weight. However, three of the oils (BC7171, BC7186 and BC7243) were examined using chemical ionisation mass spectrometry. This is a soft ionization technique, which concentrates a larger amount of the ion current in the molecular ion region of the mass spectrum. This enables better data to be obtained on molecular weight, but sacrifices information on compound type. The results show the molecular weight range of three oils examined to be BC 7171, 370-490 amu; BC 7186, 390-520 amu; BC 7243, 340-520 amu.

Sulphur Compounds

Sulphur compounds were detected in some of the oils examined. Doping experiments indicate that the other ten oils probably contain less than 400 ppm of aromatic sulphur compounds. The oils containing sulphur compounds contained up to three types of compounds, benzothiophenes (in BC 7169, 7170, 7172, 7174, 7187, 7237, 7138, 7239, 7244, and 7246) dibenzothiophenes (in BC 7169, 7170, 7172, 7174, 7238, 7244, and 7246) and a series $C_nH_{2n-12}S$ which may be indanothiophenes (in BC 7169, 7237, 7238, 7244, 7245, and 7246). Approximate concentrations for BC 7284, 7372, 7374, 7356, 7415, and 7413 are reported.

Other Organic Compounds

For all but three oils, no compounds containing oxygen or nitrogen were observed. This means that expected impurities such as phenols, amines and organic acids were present at less than 600 ppm in the portion of the sample analyzed. However, we cannot eliminate the possibility that these types of compounds have become bound to polymer or inorganic residues and have, therefore, not been distilled into the mass spectrometer.

All the oils contained less than 500 ppm of antioxidant material, less than 300 ppm of halocarbon solvents and less than 250 ppm of plasticizers such as phthalate esters.

Three oils did contain other organic compounds in addition to the hydrocarbons normally found in oils. BC 7418 has a range of compounds containing nitrogen and a combination of nitrogen and oxygen. This is consistent with the degradation of a PIB-succinimide during the rerefining process. BC 7293 contains sulphonic acids and BC 7248 contains naphthenic acids.

SUMMARY OF ^{13}C NMR ANALYSIS

^{13}C NMR spectroscopy analysis by this technique provides two types of information:

(1) the level of residual polyisobutylene additive(s)

(2) an estimate of differences in carbon types between the base oils.

(1) Analysis for polyisobutylene derivatives

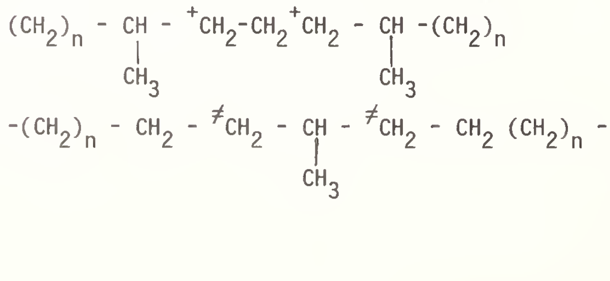
The ^{13}C NMR spectrum of free polyisobutylene (PIB) or its derivatives is dominated by three signals due to the C_4 polymer repeat unit. The $-CH_2-$ signal at $\delta(c)$, 59 ppm is well resolved from the mineral oil background and this has been used to determine the level of polymer in the oil. Most of the samples showed no detectable PIB indicating levels $<0.5\%$ w/w for total carbon in PIB/total carbon in oil. The results for those samples where it was detected are reported, there appears to be a variation in polymer level.

(2) ^{13}C NMR analysis of base oil composition

Previous ^{13}C NMR work on mineral oils and re-refined oils has shown that two parameters can provide information on the origin of the crude oils from which they derive. These are:

(a) the integral of all linear hydrocarbon signals expressed as a proportion (%) of the total aliphatic integral.

(b) the 'isoprenoid ratio' which is the ratio: signal intensity due to ^{+}C/signal intensity due to $^{\neq}C$



The results for the oils are reported. We estimate experimental errors as ±1% (for linear/total, %) and ±0.05 (for isoprenoid ratio).

SUMMARY OF ULTRAVIOLET SPECTROPHOTOMETRY

This analytical method is used in direct oil analysis for the qualitative and semi-quantitative determination of aromatic hydrocarbons. Within this chemical family the method is used for the analysis of mononuclear (at a wavelength of 195 nm), dinuclear (at 225 nm) and trinuclear (at 255 nm) aromatic hydrocarbons.

DESCRIPTION OF SEDIMENT AND FILTERABILITY OF INDUSTRIAL OILS (MEMBRANE FILTRATION METHOD)

1. INTRODUCTION

1.1 This revision includes adaptations for testing hydraulic oils which contain wax.

2. SCOPE

2.1 This method is used primarily (a) to determine insoluble contaminants (sediments) suspended in hydraulic oils (DTE) and way lubricants (Vactra numbered), and (b) to measure the filterability of hydraulic oils. The test is intended for control of oil cleanliness to quality specifications. It can be used to measure the cleanliness and filterability of other products, e.g., circulating oils, turbine oils, etc., and also basestocks.

3. DEFINITION

3.1 Filterability is the time required for a specified volume of sample, neat or diluted, to pass through a micropore filter membrane under standard conditions of dilution, pore size, filter diameter, vacuum, etc.

4. OUTLINE OF METHOD

4.1 A measured volume of sample is diluted with solvent and filtered through a membrane of specified porosity. The amount of sediment that is retained is determined from the increase in weight of the membrane. The filterability is determined by measuring the filtration time.

5. APPARATUS

5.1 Filtration Equipment.

5.1.1 Filter Holder, Pyrex, consisting of a 300 mL funnel, clamp and stainless steel disc support.

5.1.2 Forceps, stainless steel.

5.1.3 Membrane Filters, plain, white, 47-mm diameter.

- 0.3 micrometer.
- 0.8 micrometer.
- 5.0 micrometer.

Assemble the apparatus using either a 500 mL or 1-liter suction flask.

5.2 Drying Oven, explosion proof, capable of maintaining a temperature of 75 ± 2 °C.

5.3 Vacuum Source, capable of maintaining constant vacuum of 125 mm and of 250 mm of mercury.

5.4 Weighing Dishes, aluminum.

5.5 Stop Watch.

5.6 Separatory Funnel, 500 mL, with Teflon plug.

5.7 Wash Bottle, 500 mL.

6. REAGENTS

6.1 n-Pentane (for hydraulic oils.) ASTM specification given in D893, "Insolubles in Used Lubricating Oils." Filter the n-pentane through a 0.3 micrometer membrane into a suction flask, transfer and store in a solvent-rinsed glass container.

Note 1 - Prepare the suction flask and container as follows: Wash with warm, soapy water, and rinse thoroughly with tap water, then with distilled water. Rinse several times with small portions of reagent-grade acetone, and then several times with the filtered solvent.

6.1.1 Periodically determine a solvent blank by filtering 100 mL of n-pentane in the same manner as described for the sample in Section 8, except that a 0.3 micrometer membrane is used. If the increase in weight of the membrane exceeds 0.2 mg per 100 mL, the blank is considered unsatisfactory. Reclean the apparatus and prepare fresh solvent. Repeat the blank determination.

6.2 Sovasol No. 2 or Precipitation Naphtha (for way lubricants).

6.2.1 Filter, store and test the solvent as described in 6.1 for n-pentane.

7. SAMPLE PREPARATION

7.1 Allow the sample to equilibrate to room temperature (24 ± 3 °C). Prior to further handling, shake the container by hand for about 30 seconds to ensure that all sediment, if present, is uniformly distributed.

Note 2 - If wax is present, the time-temperature conditioning of the sample can affect the test results significantly. The presence of wax may not be apparent unless the sample is allowed to stand in a cool state (room temperature) long enough for the wax to crystallize. Samples which are suspected to contain wax, e.g. hydraulic oils, should be held at room temperature for 24 hours, shaken by hand for about 30 seconds and then tested. See Note 6.

8. PROCEDURE

8.1 Hydraulic Oils

8.1.1 Place a 0.8 micrometer membrane in an aluminum weighing dish with the correct side up (Note 3) and dry for 10 minutes in an oven at 75 ± 2 °C. Remove the dish and cool for about 10 minutes in a dust-free area, such as a covered drying block. Remove the membrane from the dish, weigh to the nearest 0.1 mg and record the weight as W_1. Place it correct side up on the stainless steel support, attach the funnel, and clamp together.

Note 3 - The membrane must be placed on the stainless steel mesh filter support with the correct side up. Failure to do this may result in incorrect filter times. In most cases, the membranes as received are packed with the correct side facing up. In other cases, a written statement indicating the correct side is packed with the membranes. Handle the membranes with forceps to avoid disturbing the filtering surface or altering the weight.

8.1.2 Measure 100 mL of the sample with a graduated cylinder into a separatory funnel (Note about 30 seconds. Suspend the separatory funnel in such a manner that the bottom of the stem is approximately 1 inch above the filter membrane. Open the stopcock and introduce the mixture into the filter cup.

Note 4 - If a funnel with a glass stopcock plug is used, lubricate the plug lightly with pure mineral oil.

Note 5 - The use of a separatory funnel is convenient but not mandatory. However, if the oil-solvent blend is mixed in a graduated cylinder (250 mL) and added directly to the filter, a constant level must be maintained in the filter cup.

8.1.3 Apply a vacuum of 125 mm of mercury to the suction flask, and adjust the liquid flow from the separatory funnel to maintain a constant level in the filter cup.

8.1.4 Measure and record the elapsed time required to filter the oil-pentane mixture as follows: Start the watch when the first drop appears through the apparatus. Stop the watch when all the solution has passed through the membrane, i.e., when the membrane first appears dry. Discontinue the test if the filtration is not complete within 30 minutes. Record the elapsed time as "First 100 mL Filter Time."

Note 6 - To determine if a high filtration time is caused by wax (Note 2), heat 250 mL of well-shaken sample to 50 °C, cool to room temperature and allow to stand one hour. Shake 30 seconds and test in the usual way. If the filtration time is substantially less than the value obtained after the 24-hour conditioning, the presence of wax is likely. Report the filtration times determined by the two tests, i.e. after 1-hour and 24-hour conditioning periods, and the sediment measured after 1-hour conditioning.

8.1.5 If a second 100 mL filtering time is specified for the product, repeat 8.1.2, 8.1.3 and 8.1.4, using the same membrane, graduated cylinder and separatory funnel. Record the elapsed time as "Second 100 mL Filter Time."

8.1.6 Rinse the graduated cylinder with about 20 mL of n-pentane and transfer this to the separatory funnel (stopcock open) in such a manner as to rinse the wall. Repeat with two more 20 mL portions of n-pentane. When the filtration is complete, remove the separatory funnel and rinse the wall of the filter cup with about 40 mL of n-pentane from the wash bottle. With the vacuum still applied, remove the filter cup and wash the membrane with about 40 mL of n-pentane from the wash bottle. Direct the stream from the periphery toward the center of the membrane.

Note 7 - Care must be taken to ensure that all the oil is washed through.

8.1.7 Gently remove the membrane with the vacuum still applied. Place it in the oven at 75 °C for 10 minutes, remove and cool in a dust-free area for 10 minutes. Weigh the membrane plus sediment to the nearest 0.1 mg and record as W_2.

8.2 Way Lubricants.

8.2.1 Place a 5.0 micrometer membrane in an aluminum weighing dish and proceed as described in 8.1.1.

8.2.2 Measure 75 mL of the sample into the separatory funnel and add 25 mL of prefiltered Sovasol No. 2 or precipitation napththa. Proceed as described in 8.1.2.

8.2.3 Apply a vacuum of 250 mm of mercury to the suction flask. Proceed as directed in 8.1.3, 8.1.6, and 8.1.7, but substituting Sovasol No. 2 for n-pentane.

9. CALCULATION AND REPORT

9.1 Hydraulic Oils (DTE).

9.1.1 Calculate and report the sediment retained on an 0.8 micrometer membrane as follows:

$$\text{Sediment, mg per 100 mL of oil} = \frac{100(W_2 - W_1)}{V}$$

where:

W_1 = weight of membrane, mg.

W_2 = weight of membrane plus sediment, mg.

V = total volume of oil filtered, mL.

9.1.2 Report the elapsed time under 8.1.4 as "First 100 mL Filter Time." Note 6.

Note 8 - If the test was discontinued after 30 minutes because of plugging, report the filter Time as 30+ minutes without reporting sediment weight.

9.1.3 Report the elapsed time under 8.1.5 as "Second 100 mL Filter Time." (Note 8).

9.2 Way Lubricants (Vactra numbered).

9.2.1 Calculate and report the sediment retained on a 5 micrometer membrane as follows:

Sediment, mg per 75 mL of oil, = $W_2 - W_1$

SUMMARY OF STORAGE STABILITY TEST

Appearance, color and sediment of the samples as received is reported. The appearance code is given herewith. Color is performed according to ASTM D1500. Sediment is analyzed according to ASTM D2273.

Storage Stability

Ambient Storage - One Year

This test simply involved the storage of 50 mL of the oil in a 100 mL brown glass bottle in an enclosed cupboard in the laboratory for one year. Results are tabulated for sediment after one year and color after one year.

Cold Room Stability Test - One Year

Upon receipt the oil is visually examined for clarity and cleanliness. 100 mL of oil are then stored in a 200 mL brown glass bottle in a cold room maintained at 40 °F. The oil is examined visually monthly for precipitation, sedimentation and other changes. The cold room test is terminated after one year.

The results are reported using the code given herewith. No effort was made to identify the precipitates.

Sunlight Stability Test-One Year

Upon receipt the oil is visually examined for clarity and cleanliness. Color test, ASTM D1500, and sediment test, D2273 are also performed. 200 mL of oil are then stored in an 200 mL clear glass bottle in the laboratory on the ledge of the south window receiving the full effects of winter and summer sunlight. The oil is examined visually monthly for precipitation, sedimentation, and color change. In addition after 6 months and one year, 50 mL are removed for an ASTM D1500 color test, and ASTM D2273 trace sediment test. The sunlight test is terminated after one year.

The results are reported here on four sheets:

(1) Sediment after one year, (2) color after one year, (3) appearance after one year, and (4) appearance showing month when precipitation first appeared.

The sunlight stability test is not sufficiently standardized; sunlight is not very reproducible. It is not designed as either a consistency test stable to sunlight nor a quality test because base oils are never put into direct sunlight in this way in glass vessels.

APPEARANCE CODE

OVERALL APPEARANCE DUE TO VERY FINE PARTICLES IN SUSPENSION

C - Clear; no visible evidence of particles in suspension. (a -- also indicates clarity or substantial clarity)
T - Translucent or hazy due to very fine particles in suspension.
O - Opaque or cloudy due to very fine particles in suspension.

EXTENT OF FLOCCULATION DUE TO COARSE PARTICLES (OFTEN AS CLUSTERS) IN SUSPENSION

TH - Trace haziness
TF - Trace flock; 10 to 50 specks approximately.
LF - Light flock; 50 to 100 specks approximately.

HF - Heavy flock; more than 100 specks.
P - Particles in suspension or settled sediment
DEGREE OF SEDIMENT OR STAIN
S - Brown stain on glass
TS - Trace sediment; few particles settled; less than 5% of bottom covered.
LS - Light sediment; about 5% to 50% of bottom covered.
MS - Moderate sediment; about 50% to 100% of bottom covered.
HS - Heavy sediment; marked thickness of sediment, say over 1/16" thick.
MONTH OF FIRST APPEARANCE OF PARTICLES IN SUSPENSION OR AS SEDIMENT
This is indicated by number in box, e.g., "Oil G/March" in the cold storage test shows "C/TF-6", which means that the oil is essentially clear except for trace flocculation that first appeared in the 6th month. A "C" indicates clear oil even after 1 year.

SUMMARY OF THE ANTIOXIDANT CAPACITY TEST PROCEDURE

This test was developed by Dr. Lee Mahoney and others at the Ford Motor Co., and details of the apparatus and procedure can be found in the open literature (Industrial and Engineering Chemistry-Product Res. and Dev. 17, 250 (1978)).

This test method determines the antioxidant capacity of a lubricating oil by measuring the length of an induction period preceding the rapid uptake of oxygen by the test solution when a small quantity of oil is added to the system. This delay time is directly proportional to the antioxidant capacity of the oil. The test solution consists of an oxidizable hydrocarbon, cyclohexene, and a free radical initiator, azobis-isobutyronitrile, in a n-hexadecane-chlorobenzene solution. The principle of the method is based upon the titration of the antioxidant species present in the oil by peroxy radicals formed at a constant rate from the thermal decomposition of the initiator in the presence of dissolved oxygen. At the end-point of the titration the solution begins to rapidly absorb oxygen by a chain process. The decrease in oxygen pressure is monitored.

All of the chemicals used in this method needed to be further purified by recrystallization, distillation and/or adsorption techniques. This includes the cyclohexene, chlorobenzene, n-hexadecane, azobis-isobutyronitrile, 2,6 di-t-butyl-4-methylphenol and 4,4'-methylene bis (2,6-di-t-butylphenol). Further, it is necessary to calibrate the delay time with different known concentrations of various antioxidants. At that time, measurement of the antioxidant capacity of various re-refined and virgin lubricating oil base stocks, formulated with a "standard" additive package, were made. It may be noted also that this test can be evaluated both before and after the oils have undergone a bench oxidation test.

SUMMARY OF DIFFERENTIAL SCANNING CALORIMETRY METHODS

(Literature references "Characterization of Lubricating Oils by Differential Scanning Calorimetry," J.A. Walker and W. Tsang, SAE paper No. 801383, Fuels and Lubricants Meeting, Baltimore, MD, Oct. 20-23, 1980).

High pressure differential scanning calorimetry (DSC) has been used to characterize the oxidative stability of formulated as well as virgin and recycled lubricating base stocks. At pressures of 0.7 - 3.4 MPa (50-500 psig) air or O_2, and temperatures near 200 °C, degradation occurs with significant generation of heat. Experiments conducted in the temperature programmed mode give recognizably different thermograms as well as onset temperatures for various lubricating oils. In the isothermal mode induction time measurements were carried out with ASTM Engine Test Standard Reference Oils (RO) which contain antioxidants and appear to correlate with multicyclinder engine sequence test results. Under the same experimental conditions virgin base (VB) and recycled base (RB) stocks degradate too quickly to measure the induction time.

The speed, accuracy and experimental configuration of DSC measurements suggest its use not only for elucidating fundamentals on the mechanism of hydrocarbon oxidation but also as a standard test method.

The present studies are aimed at exploring the possibility of using DSC as a standard test method for evaluating the oxidative stability of luricating oil, and further to use the technique to study the basic mechanisms involved in hydrocarbon oxidation processes.

2. Experimental

All experiments were made using a DuPont Model 990 Thermal Analyzer with a model 910 high pressure differential scanning calorimeter module. [a] The experimental procedure involves placing a 1 to 2 mg sample in an open aluminum pan, setting the pressure and the flow rate of the purged gas - air, oxygen, or nitrogen - and then commencing the experiment either by running the temperature up to a preselected value, holding it at this point and observing the reaction heat as a function of time (isothermal experiment), or by scanning at a programmed temperature rate and measuring the incremental heat change as a function of temperature rapidly raised to the isothermal temperature. At that time O_2 was introduced and the time scan started simultaneously.

A great deal of attention was given to finding the conditions that yielded an optimum amount of reproducible information and indeed it proved to be possible to increase the precision by an order of magnitude in comparison with the earlier work. The conditions and procedures that were used for these studies are summarized below.

A Modified Procedure for Measuring Oxidative Stability by Induction

Time Method

Introduction:

A fundamental property of automotive lubricating oil is its ability to resist oxidation. This property can give some indication as to its expected lifetime. To enhance performance antioxidants are among the materials added to oils.

Procedure:

1. One to two milligrams of sample are placed in an open aluminum sample pan which is placed in the cell on the sample pedestal with an empty aluminum pan on the reference pedestal. The cell is closed and the pressure cover is secured by three bolts tightened finger tight.

2. The cell is pressurized to 349 KPa (50 psig) with oxygen and purged by opening the vent valve. The process is repeated with vent valve closed but with the exit valve open to allow a flow of 50 cm^3/min of oxygen for about 30 sec.

3. The pressure [b] is then raised to 3.4 MPa (500 psig) the exit needle valve is adjusted for dynamic flow of 50-100 cm^3/min.

4. The initial temperature dial is set 10 °C below the desired isothermal temperature and the iso button is depressed. When the uncontrol light goes out the temperature dial is reset to the isothermal temperature (185 °C in this case).

5. When the uncontrol light goes out again, the start switch is depressed and the recorder pen is lowered simultaneously.

6. The scan continues until the antioxidant is consumed and is signified by an exothermic peak which rises sharply from the base.

The time lapse between zero time and the extrapolated onset of the exotherm is the induction time.

If one allows the time base scan to continue until the exotherm returns to the baseline, the heat generated by the reaction can be determined by the following formula:

$$\Delta H = \frac{A}{B} (60BE\Delta qs)$$

where A = Peak area in (cm^2)   M = Sample mass in (mg)
B = Time base setting in (min/cm)
E = Cell calibration coefficient dimensionless (approx. 1.000)
Δqs = y-axis range setting in mcal sec ^{1}/in
ΔH = Heat of reaction J/g (mcal/mg)

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[a] Certain commercial materials and equipment are identified in this paper in order to specify adequately the experimental procedure. In no case does such identification imply recommendation or endorsement by the National Bureau of Standards, nor does it imply the material or equipment identified is necessarily the best available for the purpose.

[b] For this general procedure, therefore, the pressure and temperature are dictated by the stability of the material.

A Modified Procedure of Oxidative Onset Temperature

Introduction:

This is a general procedure and adaptable to inhibited oils. The onset temperature is a measure of the temperature at which oxidative degradation occurs.

Procedure:

1. One or two mg of sample are placed in an open aluminum sample pan which is then placed in the cell on the sample pedestal with an empty aluminum pan on the reference pedestal.

2. The cell is pressurized to 700 KPa (100 psig) [c] with air and the flow is adjusted to 50-100 cm^3/min. Purging is not necessary for air. The heat control is set of 20 °C/min.

3. The cell is equilibrated at 100 °C for 2 mins. The heat switch is then depressed and the recorder pen lowered.

4. The scan is continued until the antioxidant is consumed, which is signified by a sharply rising exothermic peak. The onset temperature is the temperature at which the extrapolated onset intersects the baseline.

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[c] The pressure is arbitrary.

All experiments were carried out with flow rates of 50-120 cm^3/min (NTP). This was necessary to continually remove reaction products and to assure maximum contact between the sample and the reactive gas. The pressures used in these experiment are a reflection of the need to obtain sharp onsets as well as maintaining details in the thermograms.

THERMAL OXIDATION LUBE OIL TESTER

Summary of LUBTOT Test

LUBTOT is a modified JFOT test for investigating luricant deposition. This bench test has been developed to provide initial screening for ground vehicle engine and gear lubricants. It is a high temperature stability test with a hot spot temperature of 316 °C and an oil sump temperature of 93 °C. The test has a six hour duration using an oil flow rate of 180 mL/hr and an air flow rate of 10 mL/hr. The oil is pushed upward outside a heated steel tube and the steel tubing is rated for color and deposits.

A considerable number of tests were performed with the LUBTOT at controlled conditions in order to generate data for subsequent correlations with available engine test data. LUBTOT tests were performed using numerous qualified specification products, several re-refined candidate MIL-L-46152 products, and re-refined basestocks without additives. Results showed the test can discriminate lubricant quality level with reasonable repeatability.

The test method developed thus far does correlate with some of the Caterpillar single-cyclinder reference tests; however, it does not correlate with the 1-D, 1-H, and 1-H2 test results performed on selected reference oils. Further development work is needed to attempt to correlate the LUBTOT results with the two main reference tests, namely: the Caterpillar 1-G2 and the 1-H2 tests. LUBTOT tests should be performed on oils that have "failed" the Cat 1-G2 and 1-H2 reference tests. These data will assist in developing an effective test procedure for "screening" candidate lubricants.

A limited number of tests were performed with re-refined oil basestocks and formulated oil. The LUBTOT appears to be able to measure the consistency of basestock oils and determine the effectiveness of the formulated oils evaluated.

LUBTOT appears to be an effective test device for evaluating lubricants regarding oil deposits that are formed under a set of controlled test conditions.

REFERENCES

1. Hsu, S.M., "Review of Laboratory Bench Test in Assessing the Performance of Automotive Crankcase Oils, Lubrication Engineering 37, 722-731, 1981.

2. Cuellar, J.P., Montalvo, D.A. and Baber, B.B., "Studies with Synthetic Lubricants in the Hot Wall Deposition Rig," Air Force Aero Propulsion Laboratory (AFAPL) Technical Report 72-25, 1972, Wright-Patterson Air Force Base, Ohio.

3. D'Orazio A.J., Karpovich, P.A. and Nowack, D.J., "A Study of the Factors Affecting Deposition Characteristics of Synthetic Lubricants for Gas Turbine Engines," Naval Air Propulsion Test Center (NAPTC), Technical Report PE-71, 1976, Trenton, New Jersey.

SUMMARY OF OXIDATOR TEST

The Oxidator test is similar in principle to a method described by Dornte in 1936 (1) and by Denison in 1944(2). The stability of an oil is measured by the time required for consumption of a fixed volume of oxygen at 171 °C. The oil is vigorously stirred to saturate it with gas. The pressure of oxygen is kept at one atmosphere by a gasometer immersed in water. Alternate evacuations and fillings with oxygen charge the system with oxygen.

Results are reported as hours for 100 grams of oil to absorb one liter of oxygen. The actual test uses 25 grams of oil, and the results are corrected to 100 grams.

Procedure B

Used for evaluating base oils that will be used to formulate engine oils. An engine oil-type catalyst is used. Oil temperature is 171 °C.

The engine oil-type catalyst is made up of metal napthenates patterned after the normal distribution of metals in used crankcase oils after leaded gasoline engine tests. This catalyst introduces soluble copper, iron, manganese, lead, and tin.

When this method is used for evaluating base oils for engine oil samples would be formulated with an engine oil additive. Thus, the results would indicate response to a detergent-inhibitor package rather than oxidation stability of the neat base oils. Based on results with three different reference oils, the 95% confidence interval is about ± 5% of the actual results.

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(1) Dornte, R.W., Ind. Eng. Chem. 28, p 26 (1936).

(2) Denison, G.H., Jr., Ind. Eng. Chem. 36, p 477 (1944).

Appendix III

Additional Data

The following tables list additional data supplementary to the hydrocarbon analysis data in section V. These data include the percent recovery information for gradient elution chromatographic methods. The data are useful for analysis and interpretation of the hydrocarbon type results presented in section V.

Additional metal analysis data is also presented here.

Appendix III also provides a place to add new data which is considered to be necessary to evaluate the consistency of lubricating oil basestocks.

TEST: Metals (PPM) Atomic Emission Spectrometry [T3] LABORATORY: R

For all the Samples none of the following metals were detected except as noted.

Silver

Copper

Aluminum: BC7399, Oil I, Feb. 81, 1 ppm

Barium: BC7471, Oil J, Feb. 81, 1 ppm; BC7416, Oil J, Mar. 81, 1 ppm
BC7421, Oil F, Feb. 81, 1 ppm

Nickel

Chromium

Boron

Vanadium: BC7231, Oil B, May 80, 1 ppm

Molybdenum

Manganese

Cadium

Titanium: BC7198, Oil D, Apr. 80, 2 ppm; BC7200, Oil I, Apr. 80, 2 ppm
BC7202, Oil B, Apr. 80, 2 ppm

Phosphorus: BC7228, Oil I, May 80, <50 ppm; BC7227, Oil E, May 80, <50 ppm
BC7248, Oil F, June 80, <50 ppm

Iron: BC7338, Oil G, Oct. 80, 3 ppm; BC7205, Oil G, Apr. 80, <1 ppm
BC7244, Oil G, June 80, <2 ppm; BC7262, Oil F, Aug. 80, <1 ppm
BC7288, Oil F, Sept. 80, <1 ppm; BC7347, Oil F, Nov. 80, <1 ppm

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: RECOVERY (WT%) ASTM D2549

LABORATORY: V

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	98.3	–	99.4	99.4	97.0	96.6	95.9	95.8	97.3	97.5	96.2
APR 80	97.7	96.7	95.5	99.1	98.4	96.3	97.2	96.0	95.4	97.0	–
MAY 80	98.9	97.5	97.4	98.0	97.5	97.4	96.6	93.0	95.6	97.2	–
JUN 80	98.8	98.7	96.2	98.2	96.1	95.1	97.3	94.7	95.0	96.8	–
JUL 80	98.8	95.9	97.5	98.9	98.3	97.0	95.8	95.8	96.6	96.9	–
AUG 80	98.1	95.5	96.1	97.4	99.2	97.1	99.1	96.6	94.9	95.5	–
SEP 80	99.9	98.6	97.0	96.1	98.8	98.5	97.5	98.3	95.4	96.2	–
OCT 80	97.5	97.8	98.0	99.1	98.8	98.2	98.2	97.5	96.8	97.4	–
NOV 80	97.5	97.3	96.1	98.0	95.8	95.0	94.6	94.6	96.6	98.1	–
DEC 80	98.4	96.9	97.0	98.3	97.7	97.0	94.5	96.7	95.5	94.9	–
JAN 81	95.1	96.2	95.7	95.5	94.6	–	95.8	95.0	95.3	97.3	–
FEB 81	96.2	94.1	96.9	96.3	96.0	–	98.3	95.4	94.3	99.9	99.1
MAR 81	98.1	97.9	99.4	99.4	98.5	–	99.6	97.0	99.1	98.4	96.9
MEAN	97.95	96.92	97.09	97.98	97.44	96.82	96.95	95.88	95.98	97.16	97.40
STD.DEV.	1.23	1.34	1.26	1.30	1.43	1.14	1.61	1.39	1.27	1.26	1.51
MIN	95.1	94.1	95.5	95.5	94.6	95.0	94.5	93.0	94.3	94.9	96.2
MAX	99.9	98.7	99.4	99.4	99.2	98.5	99.6	98.3	99.1	99.9	99.1

ASTM/NBS BASESTOCK CONSISTENCY STUDY

TEST: TOTAL RECOVERY (%) HPLC/MS

LABORATORY: T

	VIRGIN BASESTOCK				REF	RE-REFINED BASESTOCKS					
DATE	A	B	C	D	I	E	F	G	H	J	K
MAR 80	--	-	--	--	--	--	--	99.00	99.10	--	99.48
APR 80	--	--	--	--	--	97.80	98.90	--	--	--	-
MAY 80	--	--	97.60	--	98.20	--	--	--	--	--	-
JUN 80	98.30	--	--	--	--	--	--	--	99.40	--	-
JUL 80	--	--	98.40	--	--	--	98.10	--	--	--	-
AUG 80	98.70	--	--	--	--	97.80	--	--	--	99.04	-
SEP 80	--	--	--	--	99.40	--	--	--	99.60	--	-
OCT 80	--	--	--	--	--	--	99.90	99.10	--	--	-
NOV 80	98.88	--	--	--	--	99.98	--	--	--	--	-
DEC 80	--	--	--	--	101.19	--	--	--	99.14	--	-
JAN 81	--	--	100.31	--	--	-	99.52	--	--	--	-
FEB 81	--	--	--	--	--	-	--	--	--	--	99.81
MAR 81	--	--	--	--	--	-	--	98.85	--	99.70	95.64
MEAN	98.627	.000	98.770	.000	99.597	98.527	99.105	98.983	99.310	99.370	98.310
STD.DEV.	.297	.000	1.392	.000	1.505	1.259	.787	.126	.235	.467	2.318
MIN	98.30	.00	97.60	.00	98.20	97.80	98.10	98.85	99.10	99.04	95.64
MAX	98.88	.00	100.31	.00	101.19	99.98	99.90	99.10	99.60	99.70	99.81

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11. ABSTRACT (*A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here*)

ASTM and NBS co-sponsored a Basestock Consistency Study (BCS) to assess the quality consistency of lubricating base oils. This study, which is the first of its kind, will impact on developing basestock characterization methodology and on efficient utilization of energy resources as well as their conservation through recycling.

The purpose of this publication is to present the ASTM/NBS BCS data for data analysis.

Monthly production samples from 6 re-refiners and 4 refiners were analyzed by 14 laboratories for a 13-month period. The results of over 55 tests are divided according to 6 major categories: rheology, physical properties, chemical properties, hydrocarbon type analysis, general performance tests, and oxidation and wear bench tests. The data are presented in tabular and graphical form, which is quite amenable to further data analysis.

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additive response; basestock; chemical properties; consistency; data; lubricants; oil; petroleum; physical properties; re-refining

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