Quality Assurance Program for Materials Testing Methods and Procedures

Phase I

Final Report

Abbreviated Version

Prepared for

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By

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Problem Statement

The Federal-Aid Highway Program Manual, Volume 6, Engineering and Traffic Operations, Chapter 4, Construction and Maintanence, Section 2 Construction; Subsection 7, Sampling and Testing of Materials and Construction (referred to as FHPM-6-4-2-7) dated January 22, 1987 establishes general requirements for the sampling and testing of materials and construction on Federal-aid highway projects. Arizona Department of Transportation in an effort to update its Quality Assurance program to meet these requirements has formulated this research project. This program consists of extracting materials from projects in the form of samples and performing a battery of tests on each of these samples. The number of samples and the appropriate value or values resulting from these test is the center of this research.

There are three types of samples drawn: project acceptance samples, correlation test samples and independent assurance samples. The number of project acceptance samples drawn are a function of the project type and size. Each of these project samples are selected and tested by the Department to determine if the project is conforming to specifications. Correlation test samples are selected from the acceptance samples by choosing every fifth acceptance sample and splitting it into two samples, one for the project accepatnce and one for the correlation test. This sample is also called a split sample.

The independent assurance samples are drawn by individuals unrelated to the contractor or the state. Test results obtained from these samples are meant to check on the reliability of the results obtained in the acceptance sampling and testing. The number of samples drawn for the assurance test is directly proportional to the number of acceptance samples drawn.

According to FHPM-6-2-7, the frequency for independent assurance tests should be approximately 10 percent of the frequency of the project acceptance tests. ADOT, however, has been allowed a 2.5 percent frequency rate due to the split sample correlation program. One central question to this research is does this sampling rate for assurance tests provide the information necessary to make an independent check on the reliability of the results obtained in the acceptance sampling and testing. In other words, are there enough samples to make this determination and how "close" must the sample test results be in order to be considered "the same?"

There are several tasks that lead up to the overall objective of this research as outlined in the communication authored by Mr. S. Tritsch (see Appendix A). These include a review of the literature, ADOT's present acceptance test program and identification of what constitutes a measure of comparison between (1) the split sample test results obtained in the District lab and those obtained in the Project lab, and (2) a population of acceptance tests results and independent assurance

tests results. In addition, a criteria needs to be identified for determining what constitutes an independent test result. This would include examining both the Federal and ADOT sampling rates of 10 and 2.5 percent, respectively.

Activities During Phase I

The primary focus of this first phase has been to determine the adequacy of the historical test data in answering the fundamental statistical problems of this research. These center around the identification of a measure of comparison and independence in sampling and testing results. A research team of Dr. Norma Hubele (Industrial and Management Systems Engineering) and Dr. John Zaniewski (Civil Engineering) and a graduate student, Mr. Chin-Yuh Lin, worked together for a two month period in Phase I. This work included the creation of data files on the University computing system that contained the historical test results provided by Mr. John Eisenberg. These files included coded information on projects, samples, test results and related data. Copies of the layout of the records in these files is shown in Appendix B. There are 863,380 records in this file. Table 1 gives a breakdown of the types of records, identified by their first two columns of the record.

In order to determine the adequacy of the data for this research objective, it was necessary to study the "Sampling Guide Schedule" contained in Appendix C. This, in essence, defines the tests and sampling procedures for the various materials. An important prerequisite to analyzing the data was finding the location of results of these test stored in the individual historical computer records. Appendix D gives the necessary logic and field location on the different records for each of the different tests. This proved to be a fairly intensive task and still there remains a few test results that have not been located. The primary deficiency of the preliminary review of the data base was a failure to define the logic for selecting the data for the coarse aggregates for concrete. The ASU team will need further assistance from ADOT personnel for identifying these data during the next phase of the project.

Once the test results for the various materials were located on the computer records, summary statistics were compiled. Again, the objective was to provide information to understand the nature of the data and to judge the adequacy of the data in answering the central research question. Appendix E (continuing over many pages) displays the findings of this effort. The information is organized in roughly the same order as the Sampling Guide Schedule. ("Abbreviated Version" contains only a subset of the contents of Appendix E.)

Since it was assumed that the testing laboratory and the purpose of the test may influence the results, most of the data is subdivided by "lab" and "pur" (purpose). For example, in the tables the first entry is for subgrade material, coded SG, with proctor density test results found in columns 39-42 of a "P2"

Table 1

Listing of Types of Records Found in Historical Data File

First Two Characters	Number of Records	Percent of Total
M2	181,281	21.0
M1	158,276	18.3
P2	140,490	16.3
P1	140,008	16.2
M4	18,408	2.1
P3	13,369	1.5
PR	11,290	1.3
M3	10,660	1.2
2	10,171	1.2
A1	9,288	1.1
K1	8,900	1.0
K4	8,886	1.0
K3	8,885	1.0
FR	8,764	1.0
K5	8,620	1.0
A3	8,234	1.0
A2	8,037	0.9
K6	7,834	0.9
C1	7,313	0.8
C2	7,309	0.8
C3	7,308	0.8
C4	7,290	0.8
K2	6,956	0.8
U	6,855	0.8
S	6,535	0.8
C5	6,180	0.7
S1	5,958	0.7
I	5,778	0.7
1M	5,125	0.6
M5	5,098	0.6
K7	4,630	0.5
H3	3,246	0.4
1S	2,938	0.3
C6	2,722	0.3
S2	1,857	0.2
U1	1,844	0.2
1A	1,049	0.1
U6	1,028	0.1
H1	940	0.1
H2	940	0.1
H4	681	0.1
ML	508	0.1
1C	309	0.0
S3	305	0.0
PD	283	0.0
1F	254	0.0

Table 1 (Cont.)

First Two Characters	Number of Records	Percent of Total
1N	154	0.0
1E	139	0.0
1B	124	0.0
1	90	0.0
D	68	0.0
S5	45	0.0
C	42	0.0
SP	38	0.0
NB	14	0.0
S4	9	0.0
2S	8	0.0
2M	3	0.0
AS	1	0.0
CO	1	0.0
EN	1	0.0
MW	1	0.0
TM	1	0.0
1P	1	0.0

card numbering 6,846 observations. These observations subdivided by laboratory are 6,221 were recorded at the project lab, 58 at the district lab, none at the central lab and 567 entries had a 'blank' in the lab field on the computer record. Alternately, the 6,846 may be subdivided by "pur" (purpose) with 391 having a purpose of "P" represently proctor and 6,455 having a purpose of "D" representing density. With these counts a fairly good picture can be formed of the volume of data available for analysis.

The second half of the table contains a finer count of the records by a cross of laboratory and purpose labelled "lab/pur" and "#". For the 6,846 proctor density test results on subgrade material there are 343 computer records from the project lab when the purpose was proctor density, whereas there are 5,878 records from the project lab when the purpose was recorded as density test, 48 records from the district lab when the purpose was proctor, and so forth.

When these counts exceeded 100 records, then summary statistics were computed and a histogram was drawn. The statistics given are estimates on the mean, the standard deviation ("std"), the minimum, the maximum, the 25th percentile and the 75th percentile. The estimate of the mean and standard deviation ("std") give the location and spread, respectively, of the data. These numbers are heavily influenced by the minimum ("min") and maximum ("max") values found in the data. Some of these extreme values, in fact, are not theoretically possible (e.g., the largest proctor test value of 412.3), thus indicating some problems with the quality of the data. The 25th percentile ("25%") and the 75th percentile ("75%") locates 50 percent of the data between these endpoints, therefore eliminating the extreme values.

The histogram for most of the materials and test follows the statistics. These graphs are labeled "frequency bar chart" with a short cryptic title of the material and test identifiers. The scaling of these plots is heavily influenced by the extreme values. However, the frequency does provide some information as to the number of very low and very high values in the data.

Conclusions

There are two basic conclusions formed as a result of this data analysis:

<u>There are some test results that need to be identified and possibly disregarded. Data from nearly every test show the existence of extreme</u> values that are theoretically impossible. The tendency is to label these "outlier" or "mistakes" and to disregard them. It is recommended that each of these instances be examined and a well-founded appropriate action be taken, either to disregard them in the analysis or to include them.

For certain tests and materials it will be necessary to use project specific information, thus reducing the amount of data available and increasing the effort necessary in the analysis. One of the objectives of Phase I was to determine if there is enough data in the historical files to answer the statistical research questions. Answering this question required somewhat of an iterative procedure of understanding the problem statement and examining what exists in the data files. The tables and figures shown in this report reflect some of the information uncovered during this procedure.

This procedure also has uncovered the realization that there are some categories of tests and materials in which the historical data should not be combined across projects. For example, consider the analysis of mineral aggregate for asphalt cement. It is well known that different projects adhere to different specifications, in this example, it may be 3.6 to 4.2 or 6.0 to 6.6. One would expect that the distribution of the test results between specification limits would be somewhat normally distributed, each with their own location and spread statistics related to the specification limits. This concept is represented in Figure 1a. When the data is combined across projects such as that shown in Figure 1b then an estimate on the mean and standard deviation is a combined estimate not revelant to any one set of specifications. These statistics would probably not be representative or useful. For those tests and materials that are closely tied to very different specification limits, a project by project analysis may be necessary. Clearly, this increases the effort required to carry out the research objective.

Proposal for Follow-on Phases

We recommend that we adopt an incremental approach to reaching our research objective. Phase I was very successful in illuminating the requirements and constraints surrounding this effort. Consequently we recommend the following:

Phase II:

Statement of Work

The research objective outlined in Mr. S. Tritsch's correspondence and included in Appendix A of this report will be performed for the following materials and tests:

(F) Aggregate Base
- proctor density
- field density
- crushed faces
- PI
- gradation 1.5"
- gradation 1"
- gradation #8
- gradation #200.

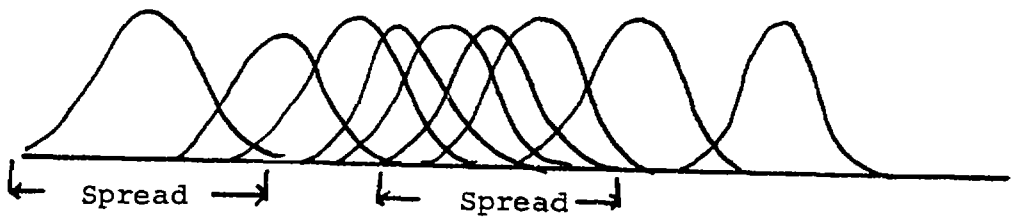

Figure 1a

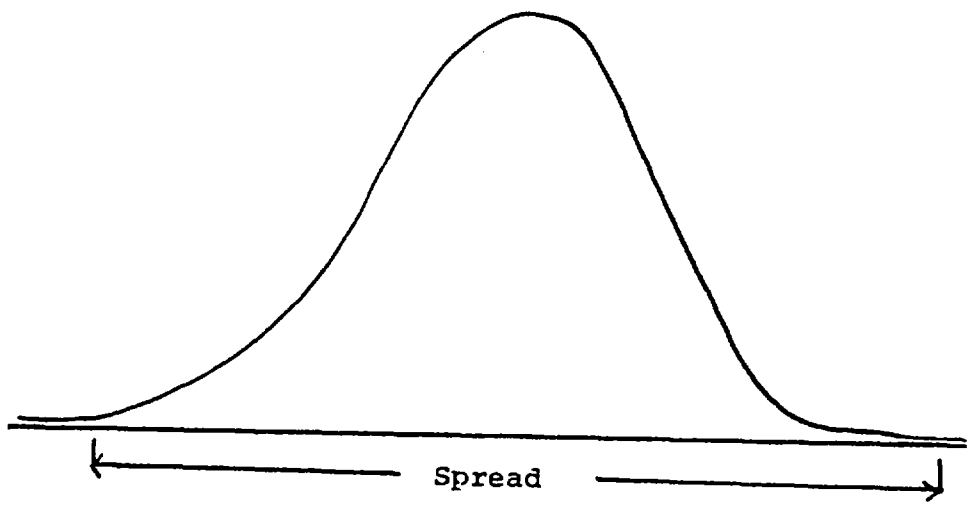

Figure 1b

(L) Mineral Aggregate for Asphaltic Concrete
- gradation 1"
- gradation 3/4"
- gradation 1/2"
- gradation #8
- gradation #40
- gradation #40
- gradation #200

(W) Fine Aggregate Portland Cement Concrete
p, s, b, u
- gradation 3/8"
- gradation #4
- gradation #16
- gradation #50
- gradtion #100
- gradtion #200

(Y) Portland Cement Concrete Pavement
- comp. str. 28
- slump
- entrained air

(Z) Portland Cement Concrete Structure
- comp. str. 28
- slump
- entrained air

(A5) Asphaltic Concrete Materials Gradation Tabulation
- asphalt content
- gradation 3/8"
- gradation #8
- gradation #40
- gradation #200

(A6) Asphaltic Concrete Pay Factor Tabulation
- asphalt content
- gradation 3/8"
- gradation #8
- gradation #40
- gradation #200

(A9) Asphaltic Concrete Friction Course
- asphalt content
- gradation #4
- gradation #8
- gradation #200
- moisture content

This subset of materials was chosen with the understanding that its analysis will lead to the development of a methodology that may be extended to other materials and tests. The numbers in the parentheses preceeding the materials reference the table location of statistics reported in Appendix E. The "Abbreviated Version" of this report contains only a limited number of these

tables. (Mr. S. Tritsch has a copy of the full appendix which numbers 196 pages.)

All these materials will require a project-by-project analysis, as discussed above. Consequently, the first step in the analysis of Phase II will be to determine if there exist a large enough sample size for the project-by-project analysis. Furthermore,

As part of Phase II, if it is deemed appropriate by both the researchers and ATRC, a proposal will be made to extend the research to other materials and tests in Phase III.

Deliverable

A final report containing the documentation of the findings of this study, a description of the methodology of the research and the recommended procedures and measures of comparison to be used in the acceptance and independent assurance testing of the above materials. Also, if appropriate, a proposal for follow-on phases.

Timetable and Budget

The following requirements need to be supplied by ATRC for the 1988 calendar year:

Total faculty man-months 4.75
    Industrial and Management Systems Engineering....2.5
    Civil Engineering 2.25

Graduate Student Support ..... 20 hours/week for 36 weeks

The work has an expected completion date of December 31, 1988.

Appendix A

Original Proposal

HPR-PL-1(31)Item273

QUALITY ASSURANCE PROGRAM FOR MATERIALS TESTING METHODS AND PROCEDURES

PROBLEM STATEMENT

The Arizona Department of Transportation is updating its Quality Assurance Program in order to meet the requirements of FHWA Federal-Aid Highway Program Manual (FHPM); Volume 6, Engineering and Traffic Operations; Chapter 4, Construction and Maintenance; Section2, Construction; Subsection 7, Sampling and Testing of Materials and Construction; dated January 22, 1987. FHPM 6-4-2-7 establishes general requirements for the sampling and testing of materials and construction on Federal-aid highway projects.

Three major revisions to the previous manual deal with the Letter of Certification. The letter now states:

1. **The results of the tests on acceptance samples indicate....were in conformity with the approved plans....** The previous statement was "reasonably close" conformity....

2. **The results of sampling and testing for acceptance compare favorably with the results of the independent assurance sampling and testing.** This statement implies that an independent assurance sampling and testing program is functioning as intended; however, what do the results of the independent assurance tests really mean in regard to acceptance and overall quality of the materials incorporated into the project?

3. **Exceptions to the plans and specifications are explained on the back or an attached sheet.** An exception is considered to be any material represented by an acceptance test that is shown to not meet the criteria contained in the plans and specifications.

Per FHPM 6-4-2-7, the frequency for independent assurance tests should be approximately 10 percent of the frequency of the acceptance tests. ADOT's acceptance test criteria (including the Sampling Guide Schedule maintained by the Materials Section) has been approved by the FHWA. Additionally, approval has been granted to ADOT to allow a 2.5 percent frequency rate for independent assurance samples versus acceptance samples.

FHPM 6-4-2-7 states the results of the independent assurance samples and test are used for the purpose of making independent checks on the reliability of the results obtained in acceptance sampling and testing and not for determining the quality and acceptability of the material and workmanship directly. The question then becomes, what is an acceptable independent assurance test result in relation to the acceptance criteria? Is there a range for the independent assurance test, or is it simply pass or fail, based on the statistical framework of the acceptance test program? If there is a range, what should it be?

In Federal Register, Vol. 51, No. 216, November 7, 1986, p. 40416, a comment was made in regard to precision statements for independent assurance sampling and testing. The response was that the assurance tests are to check the reliability of the acceptance test results; therefore it is not necessary to have statistically proven precision statements to perform this function. **The FHWA has recommended, and continues to believe, that a range should be used as a guide when precision statements do not exist.**

RESEARCH OBJECTIVE

The objective of the research project is to determine a statistical range of acceptable values when comparing an independent assurance test result (based on a frequency of 2.5 percent and 10 percent of the frequency for acceptance tests) to the results of the acceptance tests.

In order to meet the objective, the following tasks shall be addressed:

1. Perform a literature review to ascertain what information is available on comparing independent assurance test results to acceptance test results.

2. Review ADOT's acceptance test program in sufficient detail to fully understand the amount of testing required for the individual materials being sampled.

3. Determine what constitutes a measure of comparison between:

    a. Split samples, i.e., the fifth sample is divided into 2 portions to be tested in the District lab and in the Project Lab.

    b. A population of acceptance tests results and independent assurance tests results.

4. Determine what an acceptable independent test result would be, based on the sample size and criteria used for acceptance, for 26 materials (with characteristics ranging from 1 to 15 for each material) selected by the Department and found in the Sampling Guide Schedule. Elaborate as to whether a range of values is acceptable or if simply pass, fail is sufficient. Base the analysis of the independent assurance tests on a frequency of 2.5 percent and 10 percent of the frequency for acceptance tests.

5. Prepare a final report containing a thorough documentation of the findings of this study and include all conclusions and recommendations.

The Department will provide approximately 1200 historical files on a computer tape and the appropriate documentation to sort and retrieve the data as needed. The historical files should provide the necessary test files from which a statistician can develop a program to use for testing a confidence level and determining what a favorable comparison would be.

EXPECTED IMPLEMENTATION

The results of this project will be incorporated into ADOT's Quality Assurance Program in order to comply with the requirements as outlined in FHPM 6-4-2-7.

FUNDING LEVEL

$75,000

STUDY DURATION

12 months

PREPARED BY

Steven L. Tritsch

SUBMITTED BY

Don Green

DATE _____

PURPOSE CODES:
D = FIELD DENSITY
P = PROCTOR
R = [illegible]

MATERIAL CODES:
SG = SUBGRADE
SB = SPECIAL [illegible]
SM = SELECT MATERIAL
SS = SUBGRADE [illegible]
RM = ROAD MIX
NG = NATURAL GROUND
AL = ADDITIVE MATERIAL
AT = ASPHALT [illegible]
TF = TACK [illegible]
FM = FILTER MATERIAL
TS = TOP SOIL
MX = [illegible]
[illegible] = [illegible]
[illegible] = [illegible]
SC = ASSC
SB = BIT TREATED [illegible]
FR = FIR RAP
C = [illegible]
[illegible] = [illegible]
[illegible] = [illegible]
[illegible]

DATE _____

FM = FILTER MATERIAL
GR = GRANULATED NUMBER
TS = TOP SOIL
BF = BACKFILL
CM-MS = COVER MATERIAL FOR MEMERANE SEAL
FA-NM = FINE AGGREGATE FOR PNEUMATICALLY PLACED MORTAR

MATERIAL CODES:
SG = SUBGRADE
SB = SPECIAL BACKFILL
SM = SELECT MATERIAL
SS = SUBGRADE SEAL
RM = ROAD MIX
NG = NATURAL GROUND
BM = BEDDING MATERIAL
AB = AGGREGATE BASE
CM = COVER MATERIAL
BL = BLOTTER MATERIAL
SC = ACSC
AC = ASPHALTIC CONCRETE
CB = CEMENT TREATED BASE
BT = BIT TREATED BASE
RR = RIP RAP
YC = ACYC
MA = MINERAL AGGREGATE
CA = COARSE AGGREGATE
FA = FINE AGGREGATE
EM = EMBANKMENT

ARIZONA DEPARTMENT OF TRANSPORTATION
MATERIALS GRADATION TABULATION

RDWY CODES:
NB = NORTHBOUND
SB = SOUTHBOUND
ETC.
RA = RAMP A
RB = RAMP B
ETC.
FR = FRONTAGE ROAD
XR = CROSS ROAD

☐ K/P _____
☐ VERIFY _____
PAGE _____ OF _____

P = PIT
E = EXCAVATION

SIZE CODES:
B = BLEND SAND
S = SUBSTOCKPILE
I = INTERMEDIATE S.P.
C = COARSE STOCKPILE
K = COARSEST STOCKPILE

0 = COMPOSITE
1 = BIN #1
2 = BIN #2
3 = BIN #3

LAB CODE:
C = CENTRAL LAB
D = DISTRICT LAB
P = PROJECT LAB

PURPOSE CODES
A = ACCEPTANCE
M = MISCELLANEOUS
F = FINAL
C = CONTROL
P = PROGRESS
I = INFORMATION

M	SORT	PROJ. CODE	MAT.	TYPE	PURPOSE	TEST NUMBER	SUFFIX OR LOT #	LAB	SPEC #	SIZE	BIN %	DATE SAMPLED	SAMPLED BY	TIME OF DAY	SAMPLED FROM: LIFT NO	RDWY	STATION	PE	ORIGINAL SOURCE: RDWY	PIT NUMBER OR STATION
1	2	3 4 5 6	7 8	9 10	11	12 13 14 15	16 17	18	19	20	21 22	23 24 25 26	27 28 29 30 31 32 33 34	35 36 37 38	39 40	41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63	64 65	66 67 68 69 70 71	72	73 74	75 76 77 78 79 80
M	1																			
M	1																			
M	1																			
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M	1																			

	PROJ. CODE	MAT.	TYPE	PURPOSE	TEST NUMBER	SUFFIX OR LOT #	LAB	SPEC #	SIZE	% PASS 3 IN.	% PASS 1½ IN.	% PASS 1 IN.	% PASS ¾ IN.	% PASS ½ IN.	% PASS 3/8 IN.	% PASS ¼ IN.	% PASS #4	% PASS #8	% PASS #16	% PASS #30	% PASS #40	% PASS #50	% PASS #100	% PASS #200	PI **	% ASPH	% CR FACES *	FM	% MOIST	DELETE
1	3 4 5 6	7 8	9 10	11	12 13 14 15	16 17	18	19	20	21 22 23	24 25 26	27 28 29	30 31 32	33 34 35	36 37 38	39 40 41	42 43 44	45 46 47	48 49 50	51 52 53	54 55 56	57 58 59	60 61 62	63 64 65	66 67	68 69 70	71 72	73 74 75	76 77 78	79 80
M 2																														
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M 2																														
M 2																														
M 4																														
M 4																														
T																														

* USE FOR SAND EQUIVALENT WITH FINE AGGREGATE, CLASS 6

** USE FOR PLASTICITY INDEX WITH COVER MATERIAL

RESIDENT ENGINEER OR PROJECT SUPERVISOR _____ LABMAN _____

☐ WHITE ☐ YELLOW ☐ BLUE

MATERIALS SECTION

CONCRETE TEST REPORT

KEYPUNCH INSTRUCTIONS:
COLUMNS 3 THROUGH 16 ARE DUPLICATED ON CARDS K2 THROUGH K7

	PROJECT CODE	CLASS	STRN CODE *	CORE BEAM OR CYLINDER #1 **	CORE BEAM OR CYLINDER #2 **	DATE BATCHED MONTH	DAY	YEAR	TICKET NUMBER	TRUCK OR BATCH QUANTITY	TRUCK NO.
K 1	1–5	7	8	9–12	13–16	17	19	21	23–26	27–29 CY	

PLANT OF ORIGIN OR PIT (30–49)

PROJECT NUMBER

AT PLANT

(AT SITE WHEN NO PLANT INSPECTOR)

K 2	DESIGN WT (S.S.D.) LB/CY	MOISTURE ± S.S.D. LB/CY	BATCH WEIGHTS LB/CY
CEMENT	17–19		
SAND	31–34	35–37	38–41
C.A. #1	50–53	54–56	57–60
C.A. #2	61–64	65–67	68–71
WATER	72–74	75–77	78–80

FLY ASH LB/CY (20–22)

	TYPE	AMOUNT	
ADMIX	23–27	28–30	OZ./CY
A.E.A.	42–46	47–49	OZ./CY

BATCH TIME

Max. mfg. rated mix speed		rpm
Min. mfg. rated mix speed		rpm
Actual mix. speed		rpm
Time mixed		min
No. of rev.		

* CLASS S STRENGTH CODE INPUT LAST DIGIT OF THE ITEM NUMBER - SEE SPECIAL PROVISIONS

** ENTER BEAM OR CYLINDER NOS. AT THE SITE

PLANT INSPECTOR'S SIGNATURE _____

K 3	DATE SAMPLED MONTH	DAY	YEAR	SAMPLED BY	QTY IN STRUC REP BY TEST	WATER ADD LB/CY
	17	19	21	23–31	32–36 CY	36–37

C:R (38–39)

STATION			PLACED IN - PART OF STRUCTURE	STRUCT. NO.
40–43	+	44–45	46–54	55–60

SAMPLE TIME

Additional Mix time	
Time mixed at plant	
Total time mixed plant and site	
Mix rev. at Plant	
Mix Rev. at Site	
Total No. of Mix Rev. at Plant & Site	

AT SITE

K 4

ENTRAINED AIR SPEC	17	TO	19–20 %
ENTRAINED AIR CONTENT		21	23 %
SLUMP SPEC	28	TO	33 IN.
MEASURED SLUMP		39	41 IN.

IF NO BATCH WEIGHTS, THERE IS NO FINAL W/C RATIO

FINAL W/C RATIO	24–25	LB/LB	CONCRETE TEMP	26–27 °F.
MAX W/C RATIO	34–35	LB/LB	AIR TEMP	36–38 °F.

FIELD INSPECTOR'S SIGNATURE _____

AT LAB

LAB NUMBER

NOTE:
FOR SCHMIDT HAMMER TEST INPUT THE REQUIRED VALUE IN 64-65; INPUT THE TEST VALUE IN 72-73

K 5

	MONTH	DAY
REC'D DATE	17	20
TIME REC'D IN LAB	39	42
TEST DATE	57	60

AGE 21–23 H = HOURS D = DAYS 24

REQUIRED STRENGTH 61–64 65 PSI

BEAM OR CYLINDER		LOAD		STRESS	
AVE. WIDTH OR DIA.	25–27 IN.	28–33	LB.	34–38	PSI
AVE. DEPTH	43–45 IN.	46–51	LB.	52–56	PSI
LENGTH	66–68 IN.	AVERAGE		69–72 73	PSI

AT LAB

USE FOR 28 DAYS

LAB NUMBER

NOTE:
FOR SCHMIDT HAMMER TEST INPUT THE REQUIRED VALUE IN 64-65; INPUT THE TEST VALUE IN 72-73

K 6

	MONTH	DAY
REC'D DATE	17	20
TIME REC'D IN LAB	39	42
TEST DATE	57	60

AGE 21–23 H = HOURS D = DAYS 24

REQUIRED STRENGTH 61–64 65 PSI

BEAM OR CYLINDER		LOAD		STRESS	
AVE. WIDTH OR DIA.	25–27 IN.	28–33	LB.	34–38	PSI
AVE. DEPTH	43–45 IN.	46–51	LB.	52–56	PSI
LENGTH	66–68 IN.	AVERAGE		69–72 73	PSI

K 7

LAB (17–46)

LAB CODES: P = PROJECT D = DISTRICT C = CENTRAL

USE CAPITAL LETTERS!

REMARKS (18–45, 47–74)

USUAL ITEM NO. FOR STRENGTH CODE
5 = 3000 PSI
6 = 3500 PSI
7 = 4000 PSI
8 = 4500 PSI

LABMAN (7-DAY) SIGNATURE _____

LABMAN (28-DAY) SIGNATURE _____

NOTE: SPACES 3 THROUGH 16 MUST BE COMPLETE ON K1 LINE

ORIGINAL COPY TO LAB
CARBON COPY TO PROJECT FILE
NO COPIES SHOULD BE KEPT AT BATCH PLANT

TC 44-9337 R12-81

December 1987
(31 Pages)

SAMPLING GUIDE SCHEDULE

1. SCOPE

1.1 The purpose of including the sampling frequency schedule in the Materials Testing Manual is to bring together in one reference source the guidelines for the sampling and testing procedures necessary to assure materials quality.

1.2 This sampling schedule supersedes all previous Sampling Guide Schedules and directives.

1.3 The sampling frequency has been established to relate to current production capabilities, staffing abilities and FHWA regulations.

1.4 It is the intent of this schedule to give guidance to personnel responsible for sampling and testing materials, yet allow them reasonable latitude for adapting to specific project needs. The frequency may vary for individual projects or phases of projects in accordance with job conditions such as the uniformity of materials at the source, the methods and equipment used, and weather conditions. The number of samples and the distribution of the locations from which they are taken should be such as to adequately assure or verify that the materials incorporated and construction produced are acceptable in accordance with the plans and specifications. The Engineer may direct that less acceptance sampling be accomplished in particular cases of limited quantities of materials on the project, or for small projects. Conversely, he may direct that a greater amount of acceptance testing than that shown as "minimum sampling frequency" be done when he deems necessary for adequate materials quality control.

1.5 Reliance should not be placed wholly on the results of sampling and testing in determining the acceptability of the materials and construction work. The sampling and testing should be supplemented by sufficient visual inspection of the materials as a whole to determine whether the samples and tests are reasonably representative of the entire mass of materials. In addition, there should be sufficient observation of the actual construction operations and processes to ascertain whether they can be expected to consistently produce uniformly satisfactory results.

2. ACCEPTANCE SAMPLING AND TESTING

2.1 The following tables for sampling frequency apply only to acceptance sampling and testing. Table 9 is an index of the materials referenced to in Tables 1 through 8. Also given in the index is a listing of the corresponding abbreviations when applicable. "Independent Assurance Sampling" and correlation sampling (splits with project and District) are discussed later in this document.

2.2 Acceptance by manufacturer's material certification, will be in accordance with Section 106.05 of the Standard Specifications.

2.3 Small quantities may be accepted on the basis manufacturer's material certification or based upon visual observations of the Engineer. Small quantities may be considered to be approximately 500 cubic yards or less of processed aggregate material or approximately 20 tons of bituminous or portland cement and flyash. A small quantity of portland cement concrete should be considered to be 5 cubic yards or less. The Engineer should exercise careful judgement in the acceptance of small quantities. These considerations must include the significance of the product to the construction as well as the quantity. The recommended sizes of small quantities are to be considered approximate, not maximums.

2.4 Some materials are pre-sampled and pre-approved at the supplier's yard by the District or Central Laboratory and tagged with an ADOT green sticker with the project number, date sampled and lab number on it. For materials that are green tagged, it is not necessary to do any further sampling. However, the proper laboratory should be notified for verification of the materials acceptability.

3. INDEPENDENT ASSURANCE SAMPLING AND TESTING

3.1 Independent assurance sampling and testing will normally be limited to:

3.1.1 Naturally occurring materials such as soils and aggregates, and mixtures containing naturally occurring materials.

3.1.2 Processed aggregates and mixtures containing processed aggregates.

3.2 The independent assurance sampling and testing program is to be separate from acceptance and correlation sampling and testing. Whenever practical the independent assurance sample will be split with the project laboratory. This will provide information relative to the sampling and testing variance.

3.2.1 Independent assurance samples are to be taken and tested by the District Materials Engineer or a designated representative. Should this laboratory be involved with acceptance testing, the independent assurance samples must be tested by the Materials' Section Central Laboratory. All testing must be accomplished with equipment that is not used for project acceptance testing. The results of the independent assurance sampling will be compared by the District Materials Engineer, to the project level splits and acceptance tests to determine if the comparison is favorable.

3.3 The results of tests on independent assurance samples are to be promptly compared with those obtained from acceptance samples representing similar materials and an evaluation made as to the dependability and accuracy of the acceptance sampling and testing. To obtain similar materials, those taking independent assurance samples may take samples at the same time the project takes acceptance samples or split the samples, if desired, but correlation samples are not to be used as independent assurance samples. The results of tests and evaluations made with other comments are to be reported on the "Report of Independent Assurance Sampling and Testing" form (copy attached). As indicated, copies of the completed form shall be sent promptly to the Resident Engineer, Area Engineer, District Engineer, and Materials Section, with a copy retained in the District lab file.

3.4 Independent assurance samples should be obtained early in the production of any particular material type or as soon after processing mixtures as is practical for the particular testing purpose.

3.4.1 The number of independent assurance samples are indicated on the Sample Check List. The frequency is established as at least one for each material

type per project but in no event should the frequency be less than 2.5 percent, as a percentage of the number of acceptance tests. Therefore, if the sample check list does not indicate a material that requires independent assurance sampling, it should be added to the sample check list and tested accordingly.

Independent assurance samples will not be required on small quantities. This decision will be made by the Quality Assurance Branch of the Materials Section and presented on the "Sample Checklist". The Quality Assurance Branch should be contacted regarding any small quantity item not appearing on the "Sample Checklist".

3.4.2 Additional independent assurance samples shall be taken if the results of the acceptance tests and the independent assurance tests vary significantly. As a basis for evaluation, the Materials Section has prepared a Policy and Procedure Directive on the subject of Independent Assurance Sampling and Testing. This P. P. & D. provides ranges for acceptable correlation. Should the results of any comparison exceed those ranges additional investigations must be initiated. The investigations may include the inspection of Project Laboratory facilities, equipment and procedure. In any event, an additional sample must be taken to verify the source of the variance has been eliminated. All measures taken to mitigate a deficiency shall be documented on the "Report of Independent Assurance Sampling and Testing".

4. CORRELATION SAMPLING AND TESTING

4.1 The following supersedes Policy and Procedure Directive 81-5, "Correlation of Sample Test Results".

4.2 Correlation sampling and testing is a separate program from the independent assurance sampling and testing program.

4.3 Two way splits of acceptance samples shall be obtained for testing by project and district laboratory on a regular basis. It is recommended that approximately every fifth sample be split. A prompt comparison and evaluation should be made of test results so that any necessary corrective action may be taken.

TABLE 1 - ACCEPTANCE SAMPLING GUIDE FOR SOILS				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
203	SG Subgrade col. 7-8	Proctor Density P ✓	Roadway	One per soil type
		Compaction P ✓	Roadway	One per 1500'
		Gradation, PI M ✓	Roadway	One per 1500' or change in material
203	EM Embankment	Proctor Density P ✓	In-Place	One per soil type
		Compaction P ✓	In-Place	One per 1500' per lift
203	NG Natural Ground	No tests if EM>5'		
		Proctor Density P ✓	In-Place	One per soil type
		Compaction P ✓	In-Place	One per 1500'
804	TS Top Soil	Gradation, M PI, ~~Soluble Salts, pH~~	In-Place or Source	Certification and one per soil type

TABLE 2 - ACCEPTANCE SAMPLING GUIDE FOR AGGREGATES				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
203 501	SB or BF Structure Backfill or Backfill	Proctor Density	Stockpile	One per source
		Compaction	In-Place	One every 50 CY
		Resistivity, pH	Source or Stockpile	One per source
		Gradation PI	On Job Site	One per 300 CY per source
303	AB Aggregate Base 1,2,3	Abrasion*	Source	One per source
		Proctor Density	Crusher Belt or Stockpile	At start of production, then as Material changes
		Compaction	Roadway	One per lift per 1000'
		Crushed Faces, PI, Gradation	Windrow	One per 2000 T. or one per shift

* If historical values are acceptable, no tests are required.

TABLE 2 - ACCEPTANCE SAMPLING FOR AGGREGATES (Cont'd.)				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
303	AS Aggregate Subbase 4,5,6	Proctor Density	Crusher Belt or Stockpile	At start of production, then as material changes
		Abrasion*	Source	One per source
		Compaction	Roadway	One per lift per 1000'
	4	Crushed Faces, PI, Gradation	Windrow	One per 2000 T. or one per shift
	5,6	Gradation, PI	Windrow	One per 2000 T. or one per shift
303 304 305	AG Aggregate for CB and LC	Gradation, PI, Crushed Faces	Stockpile	One per 2000 T. or one per shift
		Abrasion*	Source	One per source
404	BL Blotter Material	Gradation	Final Stockpile	One per source
404	CM Cover Material	Gradation	Final Stockpile	One per 300 T.
		Crushed Faces, Flakiness Index	Final Stockpile	One per source
		%Carbonate, Abrasion*	Source	One per Source
		Moisture Content, Unit Weight	Trucks at Scale	One per 200 T.
* If historical values are acceptable, no tests are required.				

TABLE 2 - ACCEPTANCE SAMPLING GUIDE FOR AGGREGATE (Cont'd.)				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
405	AG Aggregate for RM	See Special Provisions		
406	MA Mineral Aggregate for AC	Abrasion*, Combined Specific Gravity, %Absorption	Stockpile	One per source
		Crushed Faces, Sand Equivalent	Stockpile	One per 5000 T. minimum of 2 per project
		Gradation	Cold Feed or Bins	One per 500 T. of Asphaltic Concrete Production
406 Alternate Acceptance		Sand Equivalent	Stockpile or Crusher Belt	Discretion of Engineer during Production of Mineral Aggregate. Minimum of 2 per project.
407	MA Mineral Aggregate for FC	%Carbonate, Abrasion,* Specific Gravity	Source or Stockpile	One per source
		Sand Equivalent, Flakiness Index, Crushed Faces	Stockpile	One per 5000 T. minimum of 2 per project
		Gradation	Cold Feed or Bins	One per 500 T. of Asphaltic Concrete production
* If historical values are acceptable, no tests are required.				

TABLE 2 - ACCEPTANCE SAMPLING GUIDE FOR AGGREGATE (Cont'd.)				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
408	MA Mineral Aggregate for RC	Abrasion*	Source	One per source
		Crushed Faces, Sand Equivalent, Gradation	Stockpile	Each days production of MA
		Gradation	Cold Feed or Bins	One per 1000 T. of Recycled Asphaltic Concrete production
409	MA Mineral Aggregate for AC Misc. Structural	Abrasion*	Source	One per source
		Sand Equivalent	Stockpile	One per source
		Gradation	Cold Feed or Bins	At the discretion of the Engineer
411	MA Mineral Aggregate for FC - Misc.	Abrasion*	Source	One per source
		Sand Equivalent, Flakiness Index, Crushed Faces	Stockpile	One per source
		Gradation	Cold Feed or Bins	At the discretion of the Engineer

* If historical values are acceptable, no tests are required.

TABLE 2 - ACCEPTANCE SAMPLING GUIDE FOR AGGREGATE (Cont'd.)				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
416	MA Mineral Aggregate for AC - End Product	Abrasion*	Source	One per source
		Sand Equivalent, Crushed Faces, Combined Specific Gravity, %Absorption	Stockpile	One per source
		Coating Index	Stockpile	One per source or at the discretion of the Engineer
417	MA Mineral Aggregate for FC	Abrasion*	Source	One per source
		Crushed Faces, Flakiness Index, Sand Equivalent, %Carbonate, Specific Gravity	Stockpile	One per source
501	Filter Material for Perforated Pipe	Gradation	Source or Stockpile	One per 300 C.Y. per source
501	Plating Material	Gradation, PI	Source or Stockpile	One per source
501 913	BM Bedding Material for Pipe and Bank Protection	Gradation	Source or Stockpile	One per 300 C.Y. per source
		Compaction	In-Place	One every 50 C.Y.
* If historical values are acceptable, no tests are required.				

TABLE 2 - ACCEPTANCE SAMPLING GUIDE FOR AGGREGATE (Cont'd.)				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
913	RK Rock for Wire Tied Riprap, Gabions, Riprap, (Slope Mattress)	Specific Gravity	Source	One per source
		Gradation (Visual)	Source	One per source
	For Grouted Riprap, Dumped Riprap, Rail Bank Protection	Specific Gravity	Source	One per source
		Gradation and other Requirements See Special Provision	Source	One per source
1006	FA Fine Aggregate for PCC Classes P,S,B,U	Gradation, Sand Equivalent	Batch Plant Conveyer Belt or Stockpile	One every other day
		Mortar Strength	Stockpile	One per source per year
		Soundness when over 4500' Elev.	Source	One per source per year
1006	CA Coarse Aggregate for PCC Classes P,S,B,U	Gradation	Batch Plant Conveyer Belt or Stockpile	One every other day
		Abrasion*	Stockpile	One per source
		Soundness when over 4500' Elev.	Source	One per source per year
* If historical values are acceptable, no tests are required.				

TABLE 3 - ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MATERIAL				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1005	Asphalt Cement	Per Tables 1005-1 or 1005-1A, and 1005-5	*	*
406,407, 408,409, 411,416, 417	For AC, FC, RC		Circulation Line Recommended	Certificate Required and Duplicate Sample per 1/2 Shift (Recommended)
404	For Tack			Certificate Required
1005	Liquid Asphalt Type MC	Per AASHTO M 82 and Table 1005-5	* Distributor Recommended	* Certificate Required and Duplicate Sample per Delivery Unit (Recommended)
405 404	For RM, Prime			
1005	Emulsified Asphalt Type RS-1, CRS-1,RS-2, CRS-2,SS-1 CSS-1	Per Tables 1005-2 and 1005-5	Supplier	See PPD.
404	For Chip Seal, Tack			
1005	Emulsified Asphalt Special Type Diluted SS-1 or CSS-1	Residue	* Distributor Recommended	* Certificate Required and Duplicate Sample per Delivery Unit (Recommended) See PPD.
NOTE: SAMPLES OF BITUMINOUS MATERIAL SHALL BE TAKEN BY THE CONTRACTOR AND WITNESSED BY THE ENGINEER				
* Point of Sampling and Number of Samples Specified by Engineer.				

TABLE 3 - ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MATERIAL (Cont'd.)				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1005	RA Recycling Agent RA-1, RA-5, RA-25 RA-75	Per Tables 1005-3 and 1005-5	* Circulation Line Recommended	* Certificate Required and Duplicate Sample per 1/2 Shift (Recommended)
1005	ERA Emulsified Recycling Agent ERA-1 ERA-5, ERA-25, ERA-75	Per Tables 1005-4 and 1005-5	Supplier	See PPD.
			*Distributor Recommended	*For diluted ERA Certificates required and Duplicate sample per Delivery Unit (Recommended) See PPD.
1005 410	Asphalt Cement for Asphalt Rubber	Per Tables 1005-1 and 1005-1A	Circulation Line Delivery Unit	Certificate Required Duplicate Sample for each shipment - not less than 1 set of samples for each 40 Tons.

NOTE: SAMPLES OF BITUMINOUS MATERIAL SHALL BE TAKEN BY THE CONTRACTOR AND WITNESSED BY THE ENGINEER.

* Point of Sampling and Number of Samples Specified by Engineer.

TABLE 3 - ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MATERIAL (Cont'd.)				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
410	Extender Oil for Asphalt Rubber	Saybolt Viscosity, Flash Point, Molecular Analysis	Circulation Line Delivery Unit	Certificate Required duplicate sample for each shipment - not less than 1 set of samples for each 40 Tons.
410	Kerosene for Asphalt Rubber	Boiling Point	Circulation Line Delivery Unit	Certificate Required Duplicate sample per shipment.
410	Extender Oil - Asphalt Cement Blend for Asphalt Rubber	Absolute Viscosity	Circulation Line Mixing Tank	Duplicate Sample per Batch
410	Rubber for Asphalt Rubber	Sieve Analysis	Stockpile Project	Certificate Required 1 Bag per lot per Type.

TABLE 4 - ACCEPTANCE SAMPLING GUIDE FOR PORTLAND CEMENT CONCRETE

STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
401 1006	Portland Cement Concrete Pavement (PCC Class P)	Compressive Strength, Slump, Entrained Air	At Discharge	Four sets per day when using slip form
				1 set per day using other than slip form
		Thickness*	Roadway	See Std. Spec.
601 1006	Structural Class S & B	Compressive Strength, Slump, Entrained Air	At Discharge**	One set per consecutive 50 CY or fraction thereof per day
				For less than 20 CY at the Discretion of the Engineer
601 1006	Prestressed and Post-tensioned	Compressive Strength, Slump, Entrained Air	At Discharge**	One set per member or for each days production.
601 1006	Portland Cement Structural Concrete for Minor Precast Structures	Rebound Hammer	At Fabrication Yard	One set of readings per precast unit

* THICKNESS MEASUREMENTS TAKEN ON CORES SHOULD BE SUBMITTED TO MATERIALS SECTION TO SERVE AS DATA FOR FINAL RECORD SAMPLING AND TESTING REPORT TO FHWA.

** WHEN CONCRETE IS PUMPED, SAMPLES SHOULD BE TAKEN AT BOTH THE TRUCK AND HOSE DISCHARGE TO DETERMINE THAT THE SPECIFICATIONS ARE MET IN THE STRUCTURE AND TO CORRELATE SLUMP AND AIR-ENTRAINMENT RESULTS. IF CORRELATION IS SATISFACTORY SAMPLING MAY CONTINUE FROM THE MOST CONVENIENT LOCATION WITH OCCASIONAL RETESTING FOR CORRELATION.

TABLE 4 - ACCEPTANCE SAMPLING GUIDE FOR PORTLAND CEMENT CONCRETE(Cont.)				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
912	Shotcrete	Compressive Strength	Test Panels	As per Engineer.
922 1006	Utility, Class U	None		

TABLE 5 - ACCEPTANCE SAMPLING GUIDE FOR MATERIALS USED WITH PORTLAND CEMENT CONCRETE				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
602 1003	Prestressing Steel	Tensile Strength, Diameter	Project	Two 6 Ft. pieces from each reel and Certification.
604	Bearing Pads	Durometer Hardness, Thickness	Project	Certification of Analysis
1003	Welded Wire Fabric	Tensile Strength, Diameter, Spelter	Suppliers Yard or Project	Certification and One 2' X 2' sample per 25 rolls
1003	Epoxy Coated or Uncoated Reinforcement Bars	Tensile Strength, Bending Strength, Elongation, Weight/Ft. (Coating Thickness)		
	Phoenix Sources		Fabrication Plant or Suppliers Yard	One 6 Ft. bar per 20 tons per bar size and Certification. See PPD.
			Project	One 6 Ft. bar per shipment. See PPD.
	Other Sources		Project	One 6 Ft. bar per 20 tons per bar size and Certification. See PPD.

TABLE 5 - ACCEPTANCE SAMPLING GUIDE FOR MATERIALS USED WITH PORTLAND CEMENT CONCRETE (Cont'd.)				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1006	Curing Compound	Water Loss, % Solids	Suppliers Yard or Project	For pre-approved material, Certificate only. For material not pre-approved, Certificate and 1/2 Gal. sample per lot. See PPD.
1006	Hydraulic Cement (All types)	Chemical, Physical		
	Arizona Sources		Plant	Certification and 1 Gal. per weekly. See PPD.
	Other Sources		Commercial Source or Project	Certification and 1 Gal. weekly. See PPD.
				Certification only when used for Mineral Admixture for Asphaltic Concrete

TABLE 5 - ACCEPTANCE SAMPLING GUIDE FOR MATERIALS USED WITH PORTLAND CEMENT CONCRETE (Cont'd.)

STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1006	Fly Ash	Chemical, Physical		
	Arizona Sources		Commercial Source	Certification and 1 Gal. per month. See PPD.
			Project	Certification and 1 Gal. at beginning of production, and then monthly. See PPD.
	Other Sources		Commercial Source or Project	Certification and 1 Gal. weekly. See PPD.
1006	Water	Soluble Salts, pH	Source	One sample per source* (One pint in glass container)

* NO SAMPLE IS NECESSARY IF WATER IS POTABLE AND COMES FROM A PROVEN SOURCE.

TABLE 5 - ACCEPTANCE SAMPLING GUIDE FOR MATERIAL USED WITH PORTLAND CEMENT CONCRETE (Cont'd.)				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1006	Admixtures	Chlorides	Project or plant	For pre-approved material, certification only. For material not pre-approved, certification and 1/2 gal. sample per lot.
1011	Joint Materials	Durometer, Viscosity, Compression, Thickness	Project	For pre-approved material, certification only. For material not pre-approved, certification and one sample (1/2 gal. for liquid materials).

TABLE 6 - ACCEPTANCE SAMPLING GUIDE FOR STABILIZED SOILS AND BASES				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
301	LS Lime Treated Subgrade	Proctor Density	Roadway	At start of production then as material changes
		Compaction	Roadway	One per lift per 1000'
302	CS Cement Treated Subgrade	Proctor Density	Roadway	At start of production then as material changes
		Compaction	Roadway	One per lift per 1000'
304	CB Cement Treated Base	Proctor Density	Roadway	At start of production then one per week
		Compaction	Roadway or Point of Placement	One per lift per 1000'
		Compressive Strength	Roadway or Point of Placement	Five random sets of three per shift
305	LC Lean Concrete Base	Compressive Strength, Slump, Entrained Air	At Discharge	Four random sets per 1000 linear feet of pass
		Thickness*	Roadway	Four random cores per 1000 linear feet of pass
* THICKNESS MEASUREMENTS TAKEN ON CORES SHOULD BE SUBMITTED TO MATERIALS SECTION TO SERVE AS DATA FOR FINAL RECORD SAMPLING AND TESTING REPORT TO FHWA.				

TABLE 7 - ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MIXTURES				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
405	RM Road Mix	Moisture Content	Roadway	One sample per 2000 T.
406	AC Asphaltic Concrete	Extraction*	Roadway	1 per 1/2 shift
		Marshall	Roadway	3 per day
		Ross Count	Plant	At the discretion of the Engineer
		Cores	Roadway	10 per day (1 lot)
406-13	AC Asphaltic Concrete Alternate Acceptance	Extraction*, Marshall, Rice	Roadway	4 per day (1 lot)
		Cores	Roadway	10 per day (1 lot)
407	FC Asphaltic Concrete Friction Course	Extraction*	Trucks at Mixing Plant	Each 1/2 shift
		Moisture Content	Roadway	At the discretion of the Engineer
		Ross Count	Trucks at Mixing Plant	At the discretion of the Engineer

* To include Asphalt Content, Gradation, and Moisture Content.

TABLE 7 - ACCEPTANCE SAMPLING GUIDE FOR BITUMINOUS MIXTURES (Cont'd.)				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
408	RC Recycled Asphaltic Concrete	Extraction*, Marshall, Rice	Roadway	3 required on first day. Thereafter, at the discretion of the Engineer, (Minimum of 2 per day recommended).
		Gradation of salvaged pavement particles	Stockpiles	Each days production
		Cores	Roadway	10 per day (1 lot)
409	AC Asphaltic Concrete - Misc. Structural	Extraction*, Marshall, Rice	Roadway	At the discretion of the Engineer
411	FC Asphaltic Concrete - Friction Course - Misc.	Extraction*	Trucks at Mixing Plant	At the discretion of the Engineer
416	AC Asphaltic Concrete - End Product	Extraction*, Marshall, Rice	Roadway	4 per day (1 Lot)
		Cores	Roadway	10 per day (1 Lot)
417	FC Asphaltic Concrete Friction Course - End Product	Extraction*	Trucks at Mixing Plant	4 per day (1 Lot)

* To include Asphalt Content, Gradation, and Moisture Content

TABLE 8 - ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
301	Lime	Chemical Physical	Project or Commercial Source	Certification and one sample per project (one gallon in metal can). Certification only when used for Mineral Admixture for AC
407	Asphalt Cement Liquid Additive	IR Scan, pH and Base Value	Contractors Storage Tank	Certification and pre-approved material. See PPD.
501	Bituminous Coated Corrugated Metal Pipe	Yearly check by Central Lab	Suppliers Yard	Certification of Analysis
501 1010	Reinforced or Non-reinforced Concrete Pipe	Compression Absorption, Wall Thickness	Suppliers Yard	One sample for each 100 sections per size per type
501 1006	Non-reinforced, Cast-in-Place Concrete Pipe	Compressive Strength, Slump, Entrained Air	At Discharge*	See Std. Spec.
		Wall Thickness	Site	

* WHEN CONCRETE IS PUMPED, SAMPLES SHOULD BE TAKEN AT BOTH THE TRUCK AND HOSE DISCHARGE TO DETERMINE THAT THE SPECIFICATIONS ARE MET IN THE STRUCTURE AND TO CORRELATE SLUMP AND AIR-ENTRAINMENT RESULTS. IF CORRELATION IS SATISFACTORY SAMPLING MAY CONTINUE FROM THE MOST CONVENIENT LOCATION WITH OCCASIONAL RETESTING FOR CORRELATION.

TABLE 8 - ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS (Cont'd.)				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
Refer to Special Provisions	Polyvinyl Chloride Pipe for Water Pipe	Wall Thickness, Burst Pressure, Diameter	Project	Certification of Analysis and one sample per 2000 linear feet
Refer to Special Provisions	Polyvinyl Chloride Pipe for Electrical Conduit	Resistance to Crushing	Project	Certification of Analysis and one sample per 2000 linear feet
Refer to Special Provisions	Vitrified Clay Pipe	Compression	Project	Certification and one sample for each 100 sections per size per type
505	Brick	Compression	Project	5 bricks per project
Refer to Special Provisions	Cinder Block or Slump Block	Compression and Absorption	Project	10 Cinder/Slump blocks per project
604 1004	High Strength Bolts, Nuts and Washers	Rockwell Hardness	Project	Certification and One sample per lot
701	Traffic Paint	Viscosity, Dry Time, Wt./Gal.	Suppliers Yard or Project	Certification of Analysis

TABLE 8 - ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS (Cont'd.)				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
701 704 705	Glass Beads	Roundness, Gradation, Chemical Resistance, Index of Reflection	Suppliers Yard or Project	One sample (full sack) per 10,000 pounds.
701 705	Pavement Marking Tape	Thickness	Project	Certification of Analysis
706	Raised Reflector	Specific Intensity, Abrasion, Compression	Project	Certification of Analysis
902	Chain Link Fabric	Spelter, Diameter	Suppliers Yard or Project	One 1 foot wide sample per 25 rolls
902 903	Post Clips and Hog Rings	Spelter, Diameter	Suppliers Yard or Project	5 each per project
	Tie Wire, Tension Wire	Spelter, Diameter	Suppliers Yard or Project	One 4 foot sample per 25 rolls
902 903	Misc. Fence Hardware	Spelter	Suppliers Yard or Project	One sample per type per project
902 903	Fence Post and Rails	Wt./Ft., Spelter, Diameter, Length, Acrylic Coating	Suppliers Yard or Project	One post of each type

TABLE 8 - ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS (Cont'd.)				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
903	Fence Stays	Spelter, Diameter	Suppliers Yard or Project	One sample per 25 bundles
903	Barbless Wire or Barbed Wire	Tensile Strength, Spelter, Barb Spacing, Diameter	Suppliers Yard or Project	One 4 foot sample per 25 rolls
903	Woven Wire Fabric	Spelter, Diameter, Tensile Strength	Suppliers Yard or Project	One 2' X 2' sample per 25 rolls
913	Filter Fabric	Permeability Tensile Strength, Elongation, Flow Rate, Grab Strength	Suppliers Yard or Project	Certification required and one sample (1 square yard) sent to Materials Section. See PPD.
913	Wire Rope	Spelter, Diameter	Project	One 3' sample per size
1002	Paint	Wt./Gal., Viscosity, Dry Time, Pigment, IR Scan, Chemical Analysis	Supplier or Project	One sample per batch per type (One quart can)
1008	Prismatic Reflectors	Air Tightness	Project	Certification and one sample (5-10) per type per project

TABLE 8 - ACCEPTANCE SAMPLING GUIDE FOR MISCELLANEOUS (Cont'd.)				
STANDARD SPEC. SECTION	MATERIAL CODE, NAME AND TYPES	TYPE OF TEST(S) REQUIRED	SAMPLING POINT	MINIMUM SAMPLING FREQUENCY
1012	Guardrail Posts and Blocks	None	Project	Certification of Analysis For timber guard rail posts and blocks see PPD.
1012	Guardrail Fasteners	Spelter	Project	Certification and one sample per type

TABLE 9 - INDEX OF MATERIALS

MATERIAL	ABBREVIATION	PAGE
Admixtures	-	20
~~Aggregate Base~~	~~AB~~	~~6~~
Aggregate	AG	7-8
~~Aggregate Subbase~~	~~AS~~	~~7~~
Asphalt Cement	-	12-13
Asphalt Cement Liquid Additive	-	24
~~Asphaltic Concrete~~	~~AC~~	~~22-23~~
~~Asphaltic Concrete Friction Course~~	~~FC~~	~~22-23~~
Backfill	BF	6
Barbless or Barbed Wire	-	27
Bearing Pads	-	17
~~Bedding Material~~	~~BM~~	~~10~~
~~Bitter Material~~	~~BL~~	~~7~~
Brick	-	25
~~Cement Treated Base~~	~~CB~~	~~21~~
~~Cement Treated Subgrade~~	~~CS~~	~~21~~
Chain Link Fabric	-	26
Cinder Block or Slump Block	-	25
~~Coarse Aggregate for PCC~~	~~CA~~	~~11~~
~~Cover Material~~	~~CM~~	~~7~~
Curing Compound	-	18
~~Embankment~~	~~EM~~	~~5~~
Emulsified Asphalt	-	12
Emulsified Recycling Agent	ERA	13
Extender Oil for Asphalt Rubber	-	14
Fence Post and Rails	-	26
Fence Stays	-	27
Filter Fabric	-	27
Filter Material for Perforated Pipe	-	10
~~Fine Aggregate for PCC~~	~~FA~~	~~11~~
Fly Ash	FL	19
Glass Beads	-	26
Guardrail Fasteners	-	28
Guardrail Posts and Blocks	-	28
High Strength Bolts, Nuts, and Washers	-	25
Hydraulic Cement	-	18
Joint Materials	-	20
Kerosene for Asphalt Rubber	-	14
~~Lean Concrete Base~~	~~LC~~	~~21~~
Lime	-	24
~~Lime Treated Subgrade~~	~~LS~~	~~21~~

TABLE 9 - INDEX OF MATERIALS (Cont'd.)

MATERIAL	ABBREVIATION	PAGE
Liquid Asphalt	-	12
~~Mineral Aggregate~~	~~MA~~	~~8-10~~
Misc. Fence Hardware	-	26
~~Natural Ground~~	~~NG~~	~~5~~
Paint	-	27
Pavement Marking Tape	-	26
Pipe, Bituminous Coated Corrugated Metal	-	24
Pipe, Non-Reinforced Cast in Place Concrete	-	24
Pipe, Polyvinyl Chloride for Electrical Conduit	-	25
Pipe, Polyvinyl Chloride for Water	-	25
Pipe, Reinforced or Non-Reinforced Concrete	-	24
Pipe, Vitrified Clay	-	24
~~Plating Material~~	-	~~10~~
~~Portland Cement Concrete Pavement~~	~~PCC~~	~~15~~
Portland Cement Structural Concrete	-	15
Post Clips and Hog Rings	-	26
Prestressed and Post-Tensioned	-	15
Prestressing Steel	-	17
Prismatic Reflectors	-	27
Raised Reflectors	-	26
~~Recycled Asphaltic Concrete~~	~~RC~~	~~23~~
Recycling Agent	RA	13
Reinforcement Bars	-	17
Road Mix	RM	22
Rock	RK	11
Rubber for Asphalt Rubber	-	14
~~Shotcrete~~	-	~~16~~
Structural Class S and B	-	15
~~Structure Backfill~~	~~SB~~	~~6~~
~~Subgrade~~	~~SG~~	~~5~~
Tie Wire, Tension Wire	-	26
~~Top Soil~~	~~TS~~	~~[illegible]~~
Traffic Paint	-	25
Utility, Class U	-	16
Water	-	19
Welded Wire Fabric	-	17
Wire Rope	-	27
Woven Wire Fabric	-	27

ARIZONA DEPARTMENT OF TRANSPORTATION

REPORT OF INDEPENDENT ASSURANCE SAMPLING AND TESTING

Date: _____

Project No: _____ Date of Visit _____

Project Name: _____ Resident Engineer _____

Contractor: _____ District _____ Lab No: _____

Material Type: _____ Sampled By _____

Sample Location: _____

Location Of Supply: _____ Tested By _____

SAMPLE TYPE		TEST CHARACTERISTIC														
I.A. SAMPLE																
I.A. SPLIT SAMPLE																
ACCEPTANCE TESTS																
STATISTICS	DEV. / ALLOW															

FAVORABLE COMPARISON: _____ YES _____ NO (EXPLAIN BELOW)

ACTION TAKEN: _____

REMARKS: _____

CC Materials Section
District Engineer
Area Engineer
Resident Engineer
District Lab File
*† 44-3928 (7/87

DISTRICT MATERIALS ENGINEER (SIGNATURE) _____

Appendix D
Location of Data Fields in the ADOT Construction Materials Data Base

On February 26, 1988, John Eisenberg presented a revised list of the material test that ADOT wishes to review as part of the quality assurance program. Review of this list found that some of the tests identified on the list were not on the data sheets. Mr. Eisenberg said we can ignore any tests that are not explicitly identified in the data sheets. This eliminated the need to review several tests:

Abrasion

Resistivity

pH

Absorption

Coating Index

Mortar Strength

Soundness

Moisture content of asphalt concrete materials

Ross Count

Thickness

Marshall Stability

Marshall Flow

Rice Density

Mr. Eisenberg also indicated we do not need to evaluate Top Soil and Slurry Backfill. Don Green indicated that we do not need to evaluate lime and cement treated bases. In addition, no tests were defined for Rock for Wire Tied

Riprap and Rock for Grouted Riprap. The tests for Aggregate for RM are controlled by special provision and therefore can not be extracted from the current data base. Finally, there are very few data elements for aggregates for LC and therefore we could assume the variability of concrete aggregates can represent the variability of the aggregate for LC.

The list of tests for each material identifies using the Flakeness Index and Sand Equivalent for several materials. However, the Flakiness Index is only used in the data base when the material type in columns 7 and 8 is CM. The Sand Equivalent test is only used in the data base when the material type in column 7 and 8 is FA and the type in column 9 or 10 is S.

Based on this review of the required material tests, the attached table was prepared to define the cards and columns for the data in the data base. Review of the specifications for the data base indicates there are several complexities to the way some of the data are recorded. Thus, a review of each of the fields on each of the cards is in order.

CARD P1

This card contains identification information for each test that is performed. The sample identification are in columns 3 through 19. This information should match the information in the same columns on cards P2 and P3. The only other data field that has particular significance is the

METHOD information in column 35. This column should contain an A, C, or D for Proctor Method codes A, C, and D respectively. These codes refer to the type of Proctor test performed. Methods C and D are used for cinder type materials so the majority of cases should be A. In reviewing a sample of the database, it was noted that there are other values in this column. The meaning of values other than blank, A, C, or D are unknown at this time.

CARD P2

This card contains data associated with the Proctor test. The primary data of interest are the Proctor of the material smaller than the #4 in columns 39 to 42, and the field density in columns 57 to 60. None of the other information are of interest at this time.

CARD P3

This card contains comments about the tests reported on card P2. At this time the information on these cards is not of interest. However, some of the comment columns on this card were used to store miscellaneous data, so this card may be important in the future project.

CARD M1

This card contains identification of materials gradation tests. The needed identification tests are also contained on the M2 card. The other information on this card is not needed at this time.

CARD M2

Unfortunately, there are two cards with M2 in columns 1 and 2, the materials and gradation card and the asphalt concrete pay factor tabulation. Columns 1 through 19 of these cards are the same with the exception the pay factor tabulation card has the material, purpose, and lab fields filled in with AC, A, and P respectively. The other fields on these cards have different definitions. These cards can be distinguished by examining columns 16 and 17; a number in these cards indicates a Pay Factor Card, there are no numbers in these columns for the material gradation cards.

The Suffix or Lot# columns, 16 to 17, have significance for the future evaluation. If there is a number in these columns then the test was for statistical acceptance of asphalt concrete only. A letter in these columns indicates a replicate test, usually for compaction or gradation.

For the materials gradation card, there are two sets of columns that have a variable meaning. The standard definition of columns 66 to 67 is the Plasticity Index, PI. However, if the material type in columns 7 to 8 is CM for Cover Material, then the value in columns 66 to 67 is the Flakiness Index. Although the Flakiness Index is now used for other materials, the data base we are working with only has results for Cover Materials. The other exception is in columns 71 to 72, which is normally defined as the Percent Crushed Faces. When the material type in columns 7 to 8 is Fine Aggregate and the type in columns 9 to 10 is S (it may

be either S blank or blank S) then columns 71 to 72 contain the values for the Sand Equivalent test. The data base we are working with only has Sand Equivalent results for type S Fine Aggregates. These exceptions are correctly identified in the attached table of the data layout.

ADOT relies on the ASTM specifications for the gradation of course aggregates for concrete, material type CA. The sieves and the gradation requirements for each sieve in the ASTM specifications varies depending on the class of the material. The class of the material is not specified on the ADOT gradation card. Thus, a data layout specification could not be prepared for the initial investigation into the data base. This is an area that can be further explored in the second phase of the project.

All other columns of the material gradation card should have a single definition as defined in the table of the data lay out. However, in reviewing the sample data base comments were found on card M4 indicating that in one case there was a change order that called for a specification for an 1/4 inch sieve rather than for the standard 3/8 inch sieve so the data for the 1/4 inch sieve were recorded in the columns for the 3/8 inch sieve. Detection of this type of variance in the data base will require manual review of all of the M4 cards. Without reviewing a larger sample of the data base, we do not know how prevalent these exceptions are nor do we know the effect of ignoring these exceptions.

CARD M3

This card contains voids analysis for asphalt concrete. We have not been requested to evaluate these data, thus the M3 card can be ignored.

CARD M4

This card contains comments about the test, As noted above, it may be necessary to review the data on this card to find exceptions to the definition of the data cards. Also the M4 card was used to record data for tests that are not defined in the definition of the M2 fields. Review of the sample data set shows there are data for sand equivalent, resistivity, pH, etc. tests on the M4 card. If we need to access these data in the future, then rules for searching through the fields of the M4 card will be required. These rules will probably be complicated as there was not a standard method for recording the data.

CARD M5

This card is only used with the pay factor tabulation M2 card. The only data on the M5 card is the number of tons in the lot which the data on the M2 represents. Thus we will probably not need to use this card.

CARD K1

This card is used for identification of concrete tests. The data on this card are not required for this project.

CARD K2

This card is used for tests at the concrete batch plant and no data from this card are required for this project.

CARD K3

This card is used for tests at the concrete site tests and no data from this card are required for this project.

CARD K4

This card is used for tests at the concrete site tests. The data for the entrained air content and measured slump in columns 21 to 23 and 39 to 41 respectively are required for this project.

CARD K5

This card should contain lab tests of concrete at times other than 28 days. The instructions for test results from Don Green did not specify the time of testing, in which case the normal assumption is to use the test results at 28 days. Discussions with ADOT personnel indicated there was some confusion in filling out this card and that sometimes this card was used for 28 day strength tests. Thus, the AGE columns 21 to 23 should be examined to determine if the card has data for the strength at 28 days.

CARD K6

The AGE field, columns 21 to 23 should be examined to verify that the data are for 28 days. The average compressive strength at 28 days is recorded in columns 69 to 73. These columns are also used for the results of beam and Schmidt hammer tests. The results of the compressive strength at 28 days should always be greater than 1000 where as the results of the other tests should always be less than

1000. This criteria should be sufficiently robust to distinguish the data in this field.

CARD K7

This card contains comments about the concrete tests and therefore should not be required for this project.

CARD C1

Some concrete strength data may be recorded on the "C" series of cards. The number of C1 cards should be counted to determine if there is a significant number of these cards.

SUMMARY

The recommendations presented in this memo are based on the current understanding of the methods used to record the data in the materials data base. The number of exceptions noted in this memo compromises the level of confidence in these recommendations. The analysis of the data base was performed with the understanding that some parts of the analysis may need to be repeated if exceptions are found in the way the data are recorded or if more accurate information becomes available.

TABLE D.1 LAYOUT OF DATA CARDS

material	mtl. code	tests	values in data col 1,2	columns
subgrade	SG	proctor density	P2	39-42
		field density	P2	57-60
		moisture content	M2	76-78
		gradation #200	M2	66-67
		PI	M2	63-65
embankment	EM	proctor density	P2	39-42
		field denstiy	P2	57-60
		moisture content	M2	76-78
natural ground	NG	proctor density	P2	39-42
		field density	P2	57-60
		moisture content	M2	76-78
Strc. backfill	SB	proctor density	P2	39-42
		field density	P2	57-60
		moisture content	M2	76-78
		PI	M2	66-67
		gradation 3"	M2	21-23
		gradation 3/4"	M2	30-31
		gradation #8	M2	45-47
		gradation #200	M2	63-65
backfill	BF	proctor density	P2	39-42
		field density	P2	57-60
		PI	M2	66-67
		gradation 3"	M2	21-23
		gradation 3/4"	M2	30-31
		gradation #8	M2	45-47
		gradation #200	M2	63-65
agg. base	AB	proctor density	P2	39-42
		field density	P2	57-60
		crushed faces	M2	71-72
		PI	M2	66-67
		gradation 1.5"	M2	24-26
		gradation 1"	M2	27-29
		gradation #8	M2	45-47
		gradation #200	M2	63-65
agg subbase	AS	proctor density	P2	39-42
	or	field density	P2	57-60
	SM	crushed faces	M2	71-72
		gradation 3"	M2	21-23
		gradation .25"	M2	39-41
		gradation #200	M2	63-65
		PI	M2	66-67

material	mtl. code	tests	values in data col 1,2	columns
agg. for CB	AG	gradation 1.5"	M2	24-26
		gradation 1"	M2	27-29
		gradation #8	M2	45-47
		gradation #200	M2	63-65
		crushed faces	M2	71-72
		PI	M2	66-67
agg. for lc will not have, use variability for AB	AG	gradation 1.5"	M2	24-26
		gradation 1"	M2	27-29
		gradation #8	M2	45-47
		gradation #200	M2	63-65
		crushed faces	M2	71-72
		gradation 3/8"	M2	36-38
		gradation #4	M2	42-44
		gradation #16	M2	48-50
		gradation #50	M2	57-59
		gradation #100	M2	60-62
		gradation #200	M2	63-65
		gradation ca		
blotter mtl	BL	gradation 3/8"	M2	36-38
		gradation #4	M2	42-44
		gradation #16	M2	48-50
		gradation #200	M2	63-65
cover mtl.	CM	gradation 3/8"	M2	36-38
		gradation #4	M2	42-44
		gradation #8	M2	45-47
		gradation #200	M2	63-65
		crushed faces	M2	71-72
		flakiness	M2	66-67
mineral agg. for AC	MA	gradation 1"	M2	27-29
		gradation 3/4"	M2	30-32
		gradation 1/2"	M2	33-35
		gradation #8	M2	45-47
		gradation #40	M2	54-56
		gradation #200	M2	63-65
mineral agg. for fc	MA	flakiness	M2	66-67
		crushed faces	M2	71-72
		gradation 3/8"	M2	36-38
		gradation #4	M2	42-44
		gradation #8	M2	45-47
		gradation #200	M2	63-65
mineral agg for rc	MA	crushed faces	M2	71-72

material	mtl. code	tests	values in data col 1,2	columns
mineral agg. for ac, misc	MA	gradation 3/4"	M2	30-32
		gradation 3/8"	M2	36-38
		gradation #8	M2	45-47
		gradation #200	M2	63-65
mineral agg for FC	MA	flakiness	M2	66-67
		crushed faces	M2	71-72
		gradation 3/8"	M2	36-38
		gradation #4	M2	42-44
		gradation #8	M2	45-47
		gradation #200	M2	63-65
mineral agg. for AC end product	MA	crushed faces	M2	71-72
		coating index		
mineral agg for FC end product	MA	sand equivalent	M2	71-72
filter mtl.		gradation 3/8"	M2	36-38
		gradation #4	M2	42-44
		gradation #16	M2	48-50
		gradation #50	M2	57-59
		gradation #100	M2	60-62
		gradation #200	M2	63-65
plating mtl.		PI	M2	66-67
bedding mtl.	BM	gradation 1.5"	M2	24-26
		gradation 1"	M2	27-29
		gradation #8	M2	45-47
		gradation #200	M2	63-65
		PI	M2	66-67
		field density	P2	57-60
		moisture content	M2	76-78
bank protection		gradation 2"		
fine agg pcc p,s,b,u	FA	gradation 3/8"	M2	36-38
		gradation #4	M2	42-44
		gradation #16	M2	48-50
		gradation #50	M2	57-59
		gradation #100	M2	60-62
		gradation #200	M2	63-65
for type S only		sand equivalent	M2	71-72
coarse agg. pcc p,s,b,u	CA	gradation m43		

material	mtl. code	tests	values in data col 1,2	columns
PCC pavement		comp. str. 28	K6	69-73
		slump	K4	39-41
		entrained air	K4	21-23
PCC Struc.		comp. str.	K6	69-73
		slump	K4	39-41
		entrained air	K4	21-23
PCC prestress		comp. str.	K6	69-73
post tension		slump	K4	39-41
		entrained air	K4	21-23
shotcrete		comp. str.	K6	69-73
cem. treat base	CB	proctor density	P2	39-42
		field density	P2	57-60
		comp. str.	K6	69-73
lean conc. base	LC	comp. str.	K6	69-73
		slump	K4	39-41
		entrained air	K4	21-23
asphalt concrete	AC	asph content	M2	68-70
materials		gradation 3/8"	M2	36-38
gradation		gradation #8	M2	45-47
tabulation		gradation #40	M2	54-56
		gradation #200	M2	63-65
asphalt concrete	AC	asph content	M2*	45-47
pay factor		gradation 3/8"	M2*	30-32
tabulation		gradation #8	M2*	36-38
		gradation #40	M2*	39-41
		gradation #200	M2*	42-44
asphalt concrete	AC	asph content	M2	68-70
alt acceptance		gradation 3/8"	M2	36-38
materials		gradation #8	M2	45-47
gradation		gradation #40	M2	54-56
tabulation		gradation #200	M2	63-65
asphalt concrete	AC	asph content	M2*	45-47
alt acceptance		gradation 3/8"	M2*	30-32
pay factor		gradation #8	M2*	36-38
tabulation		gradation #40	M2*	39-41
		gradation #200	M2*	42-44
asphalt concrete	FC	asphalt content	M2	68-70
friction course		gradation #4	M2	42-44
		gradation #8	M2	45-47
		gradation #200	M2	63-65
		moisture cont.	M2	76-78

material	mtl. code	tests	values in data col 1,2	columns
recycled asphalt concrete	RC	asph content	M2	68-70
		gradation 3/8"	M2	36-38
		gradation #8	M2	45-47
		gradation #40	M2	54-56
		gradation #200	M2	63-65
		moisture cont.	M2	76-78
asphalt concrete misc. str	AC	asph content	M2	68-70
		gradation 3/8"	M2	36-38
		gradation #8	M2	45-47
		gradation #40	M2	54-56
		gradation #200	M2	63-65
		moisture cont.	M2	76-78
asphalt concrete misc. str FC	FC	asph content	M2	68-70
		gradation 3/8"	M2	36-38
		gradation #8	M2	45-47
		gradation #40	M2	54-56
		gradation #200	M2	63-65
		moisture cont.	M2	76-78
asphalt concrete end product	AC	asph content	M2	68-70
		gradation 3/8"	M2	36-38
		gradation #8	M2	45-47
		gradation #40	M2	54-56
		gradation #200	M2	63-65
		moisture cont.	M2	76-78
asphalt concrete end product FC	FC	asph content	M2	68-70
		gradation 3/8"	M2	36-38
		gradation #8	M2	45-47
		gradation #40	M2	54-56
		gradation #200	M2	63-65
		moisture cont.	M2	76-78

Appendix E

Statistical Tables and Figures

Note: An explanation of the column headings is given on pages 3-6 in the body of the report. The character ' ' indicates a 'blank' appeared in the field. The "Abbreviated Version" of the Final Report contains only a subset of all the tables and figures generated in this research. The entire set may be obtained by contacting Mr. Steven L. Tritsch of Arizona Transportation Research Center.

Material	mtl. code	tests col 1,2	value	column.	no. of obs.	lab p	lab d	lab c	lab Δ	pur P	pur D
A.											
subgrade	SG	proctor density	P2	39-42	6846	6221	58	0	567	391	6455
		field density	P2	57-60	6251	5716	9	0	526	0	6251
		moisture content	M2	76-78	72	72	0	0	0		
		gradation #200	M2	66-67	3411	2521	579	311	0		
		PI	M2	63-65	5008	3785	843	380	0		

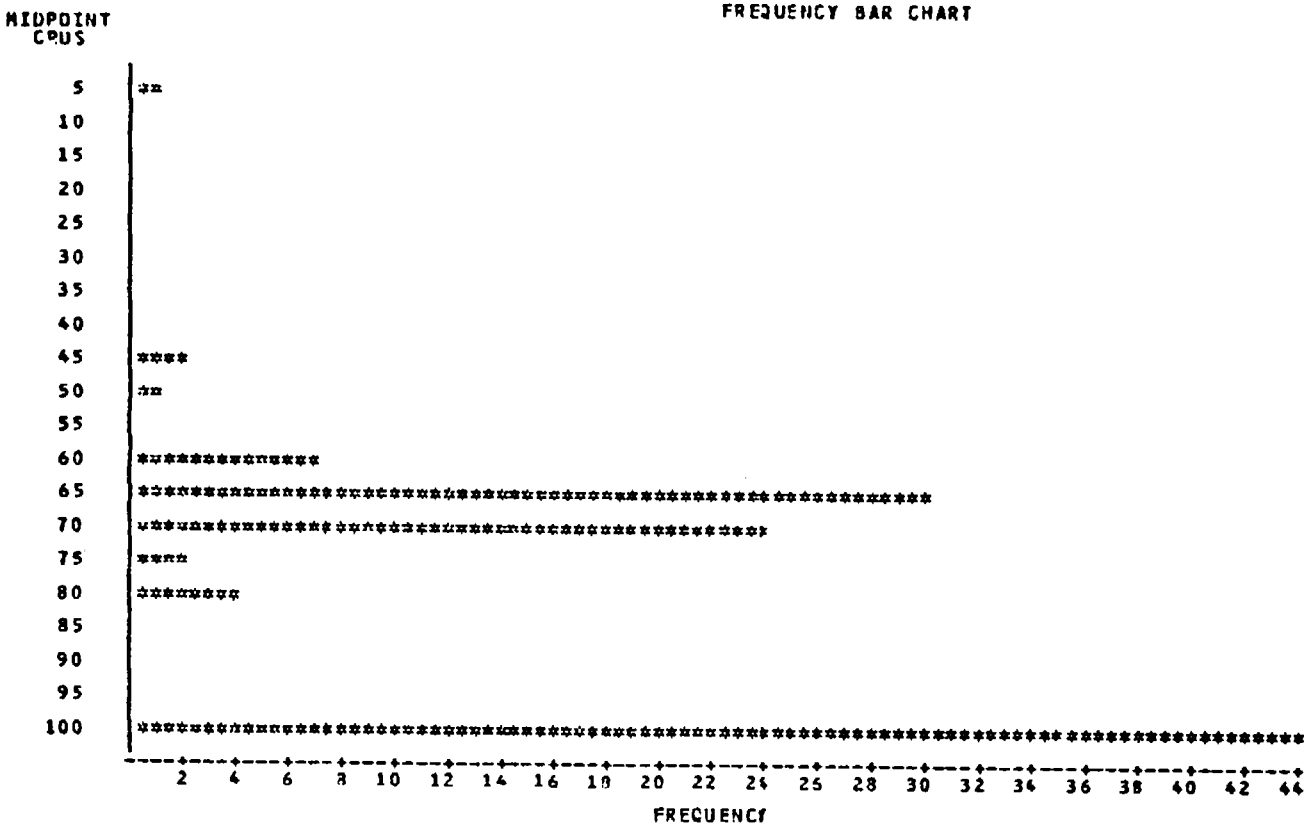
Mat.	test	total	lab/pur	#	mean	std	min	max	25%	75%
A.										
SG	proctor density	6846	p/P	343	116.3 66	19.2 75	83.4	412.3	110.3	123.6
			p/D	5878	111.7 79	24.7 50	9.0	911.1	106.6	121.2
			d/P	48						
			d/D	10						
			Δ/P	0						
			Δ/D	567	106.7 58	25.2 07	11.4	133.7	105.6	119.6
	field density	6251	p/P	0						
			p/D	5716	111.7 77	27.8 70	10.4	711.5	105.7	126.3
			d/P	0						
			d/D	9						
			Δ/P	0						
			Δ/D	526	980 41	404 18	105	1460	984	1234
	moisture content	72	p/							
	gradation #200	3411	p/	2521	11.93	8.09	1	96	6	16
			d/	579	11.51	7.96	1	71	5	16
			c/	311	12.61	9.86	1	57	5	17
	PI	5008	p/	3785	237.25	204.61	2	972	87	341
			d/	843	251.46	198.98	6	946	103	363
			c/	380	278.15	207.68	7	953	119	406

Material	mtl. code	tests col 1,2	value	column.	no. of obs.	lab p	lab d	lab c	lab Δ	pur P	pur D
E.											
agg. base	AB	proctor density	P2	39-42	2631	2093	34	0	503	160	2471
		field density	P2	57-60	2265	1764	0	0	501	0	2265
		crushed faces	M2	71-72	124	115	6	3	0		
		PI	M2	66-67	392	258	97	36	0		
		gradation 1.5"	M2	24-26	1958	1385	295	276	2		
		gradation 1"	M2	27-29	5828	4446	873	507	2		
		gradation #8	M2	45-47	5244	3902	847	493	2		
		gradation #200	M2	63-65	5964	4500	922	540	2		

Mat.	test	total	lab/pur	#	mean	std	min	max	25%	75%
E.										
AB	proctor density	2631	p/P	126	119.8 73	15.5 51	11.7	141.0	116.6	125.0
			p/D	1967	122.3.21	16.7 69	11.7	141.0	120.1	128.8
			d/P	34						
			Δ/D	503	119.2 87	25.1 78	11.5	126.5	124.7	125.8
			v/D	1						
	field density	2265	p/P	0						
			p/D	1764	130.9 83	29.0 50	11.9	745.0	130.1	139.7
			Δ/D	501	124.5 44	36.7 15	12.4	148.4	132.8	138.6
	crushed faces	124	p /	115	77.85	17.57	5	98	65	98
			d /	6						
			c /	3						
	PI	392	p /	258	4.10	4.21	1	48	1	5
			d /	97						
			c /	36						
	gradation 1.5"	1958	p /	1385	93.91	23.77	1	100	100	100
			d /	295	99.99	0.17	97	100	100	100
			c /	276	99.79	1.49	86	100	100	100
			Δ/	2						
	gradation 1"	5828	p /	4446	97.41	5.88	70	100	100	100
			d /	873	97.38	5.92	72	100	100	100
			c /	507	98.71	4.32	74	100	100	100
			Δ	2						
	gradation #8	5244	p /	3902	37.26	15.83	1	89	24	49
			d /	847	40.12	15.11	1	86	33	51
			c	493	43.90	11.73	3	68	21	41
			Δ	2						
	gradation #200	5964	p /	4500	4.8 71	3.0 90	1	32.5	2.3	6.8
			d /	922	5.5.67	3.0 64	1	19.4	3.7	7.5
			c /	540	5.7.56	2.7.43	3	19.6	4.2	7.6
			Δ/	2						

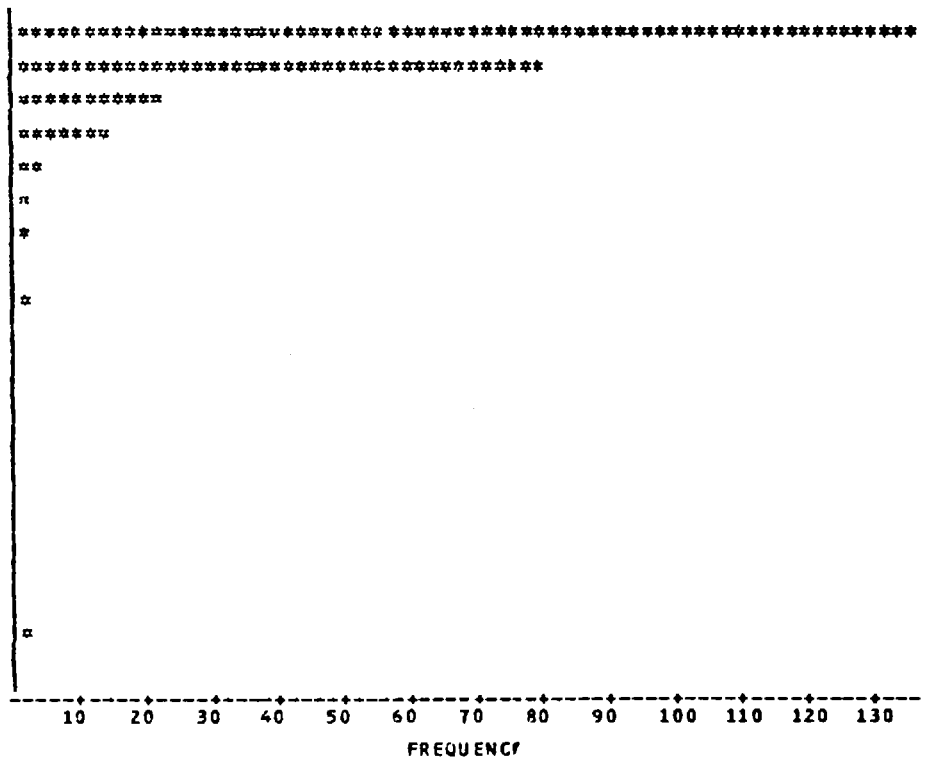
FREQ & CUMFREQ CHART MAT=AB LAB=P COL71-72 CRUS 17:08 SATURDAY, MARCH 19, 1988 17

FREQUENCY BAR CHART



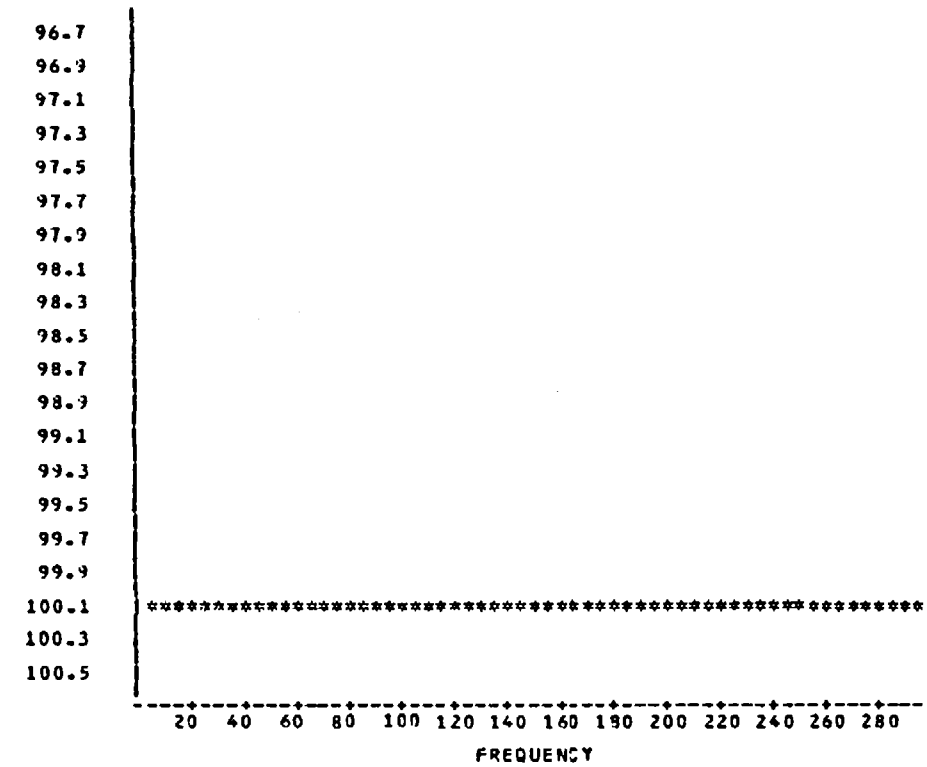
FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
1	1	0.87	0.87
0	1	0.00	0.87
0	1	0.00	0.87
0	1	0.00	0.87
0	1	0.00	0.87
0	1	0.00	0.87
0	1	0.00	0.87
0	1	0.00	0.87
2	3	1.74	2.61
1	4	0.87	3.48
0	4	0.00	3.48
7	11	6.09	9.57
30	41	26.09	35.65
24	65	20.87	56.52
2	67	1.74	58.26
4	71	3.48	61.74
0	71	0.00	61.74
0	71	0.00	61.74
0	71	0.00	61.74
44	115	38.26	100.00

FREQUENCY BAR CHART



MIDPOINT PI	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
2.5	136	136	52.71	52.71
5.0	79	215	30.62	83.33
7.5	21	236	8.14	91.47
10.0	14	250	5.43	96.90
12.5	3	253	1.16	98.06
15.0	2	255	0.78	98.84
17.5	1	256	0.39	99.22
20.0	0	256	0.00	99.22
22.5	1	257	0.39	99.61
25.0	0	257	0.00	99.61
27.5	0	257	0.00	99.61
30.0	0	257	0.00	99.61
32.5	0	257	0.00	99.61
35.0	0	257	0.00	99.61
37.5	0	257	0.00	99.61
40.0	0	257	0.00	99.61
42.5	0	257	0.00	99.61
45.0	0	257	0.00	99.61
47.5	1	258	0.39	100.00
50.0	0	258	0.00	100.00

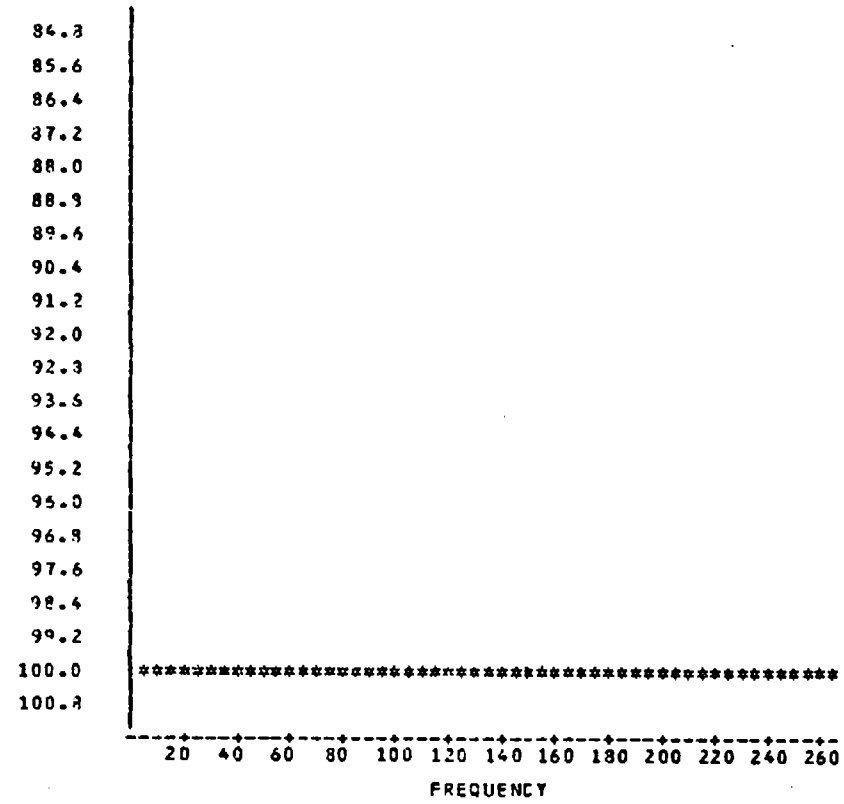
FREQUENCY BAR CHART



MIDPOINT GRAS	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
96.7	0	0	0.00	0.00
96.9	0	0	0.00	0.00
97.1	1	1	0.34	0.34
97.3	0	1	0.00	0.34
97.5	0	1	0.00	0.34
97.7	0	1	0.00	0.34
97.9	0	1	0.00	0.34
98.1	0	1	0.00	0.34
98.3	0	1	0.00	0.34
98.5	0	1	0.00	0.34
98.7	0	1	0.00	0.34
98.9	0	1	0.00	0.34
99.1	0	1	0.00	0.34
99.3	0	1	0.00	0.34
99.5	0	1	0.00	0.34
99.7	0	1	0.00	0.34
99.9	0	1	0.00	0.34
100.1	294	295	99.66	100.00
100.3	0	295	0.00	100.00
100.5	0	295	0.00	100.00

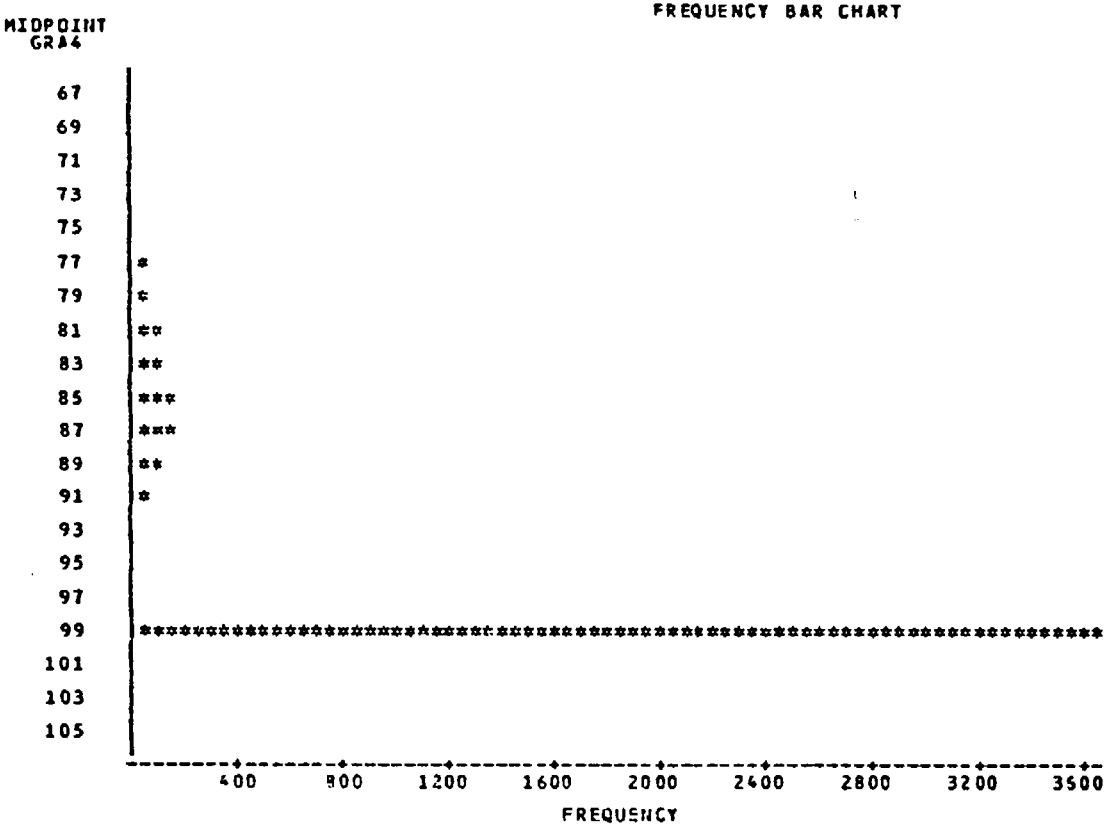
FREQ & CUMFREQ CHART MAT=AB LAB=C COL24-26 1.5IN 17:08 SATURDAY, MARCH 19, 1988 35

FREQUENCY BAR CHART



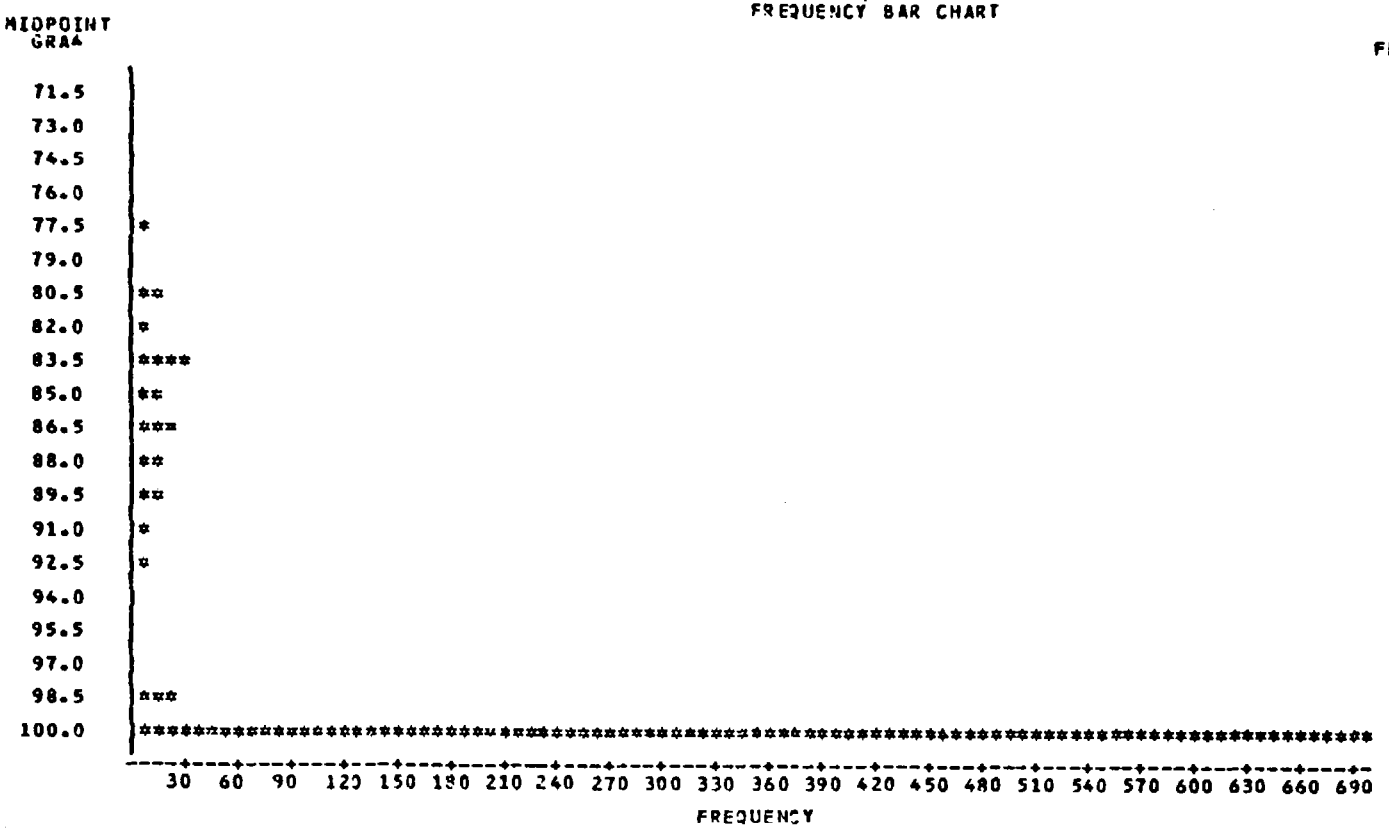
FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
0	0	0.00	0.00
0	0	0.00	0.00
1	1	0.36	0.36
1	2	0.36	0.72
0	2	0.00	0.72
2	4	0.72	1.45
0	4	0.00	1.45
0	4	0.00	1.45
0	4	0.00	1.45
0	4	0.00	1.45
0	4	0.00	1.45
0	4	0.00	1.45
0	4	0.00	1.45
0	4	0.00	1.45
0	4	0.00	1.45
1	5	0.36	1.81
0	5	0.00	1.81
2	7	0.72	2.54
2	9	0.72	3.26
267	276	96.74	100.00
0	276	0.00	100.00

FREQUENCY BAR CHART



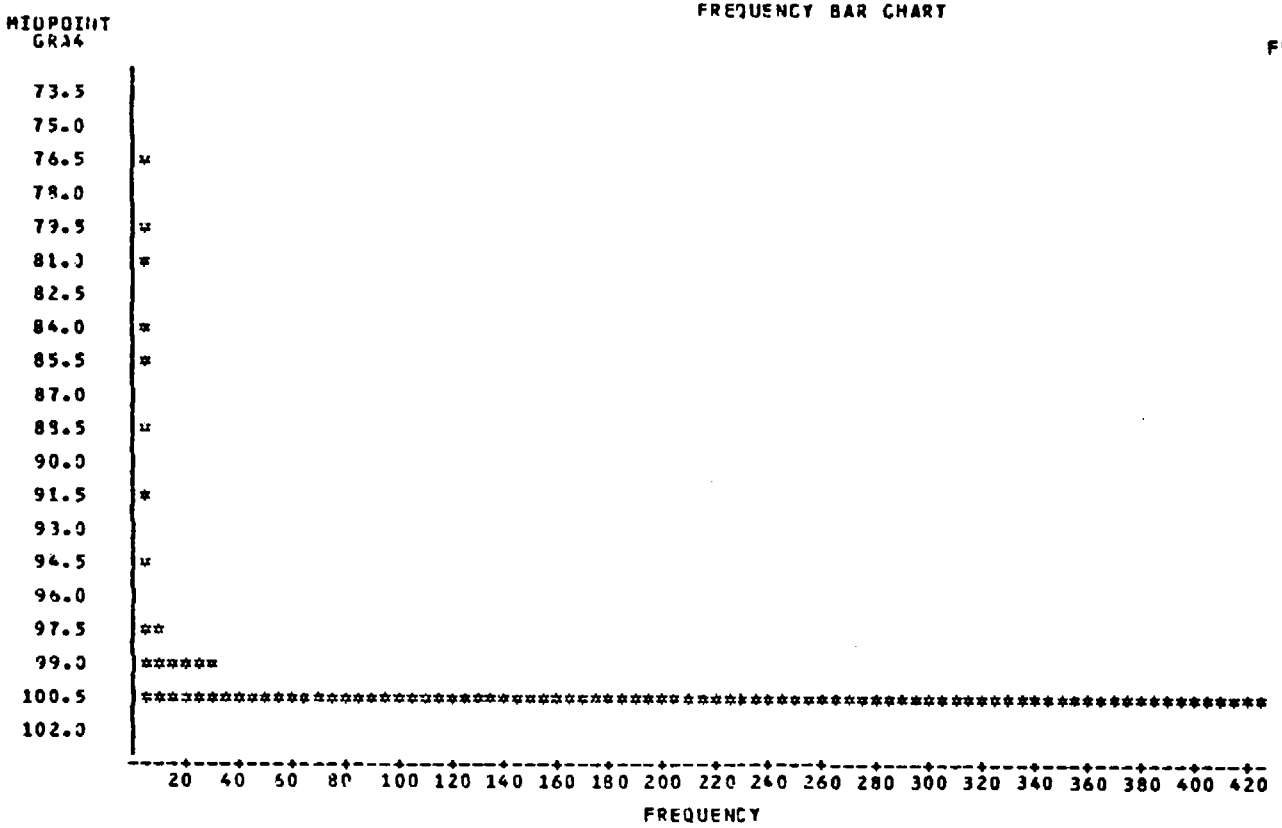
MIDPOINT GRA4	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
67	0	0	0.00	0.00
69	1	1	0.02	0.02
71	6	7	0.13	0.16
73	7	14	0.16	0.31
75	11	25	0.25	0.56
77	30	55	0.67	1.24
79	42	97	0.94	2.18
81	90	187	2.02	4.21
83	121	308	2.72	6.93
85	154	462	3.46	10.39
87	133	595	2.99	13.38
89	104	699	2.34	15.72
91	45	744	1.01	16.73
93	22	766	0.49	17.23
95	14	780	0.31	17.54
97	12	792	0.27	17.81
99	3654	4446	82.19	100.00
101	0	4446	0.00	100.00
103	0	4446	0.00	100.00
105	0	4446	0.00	100.00

FREQUENCY BAR CHART



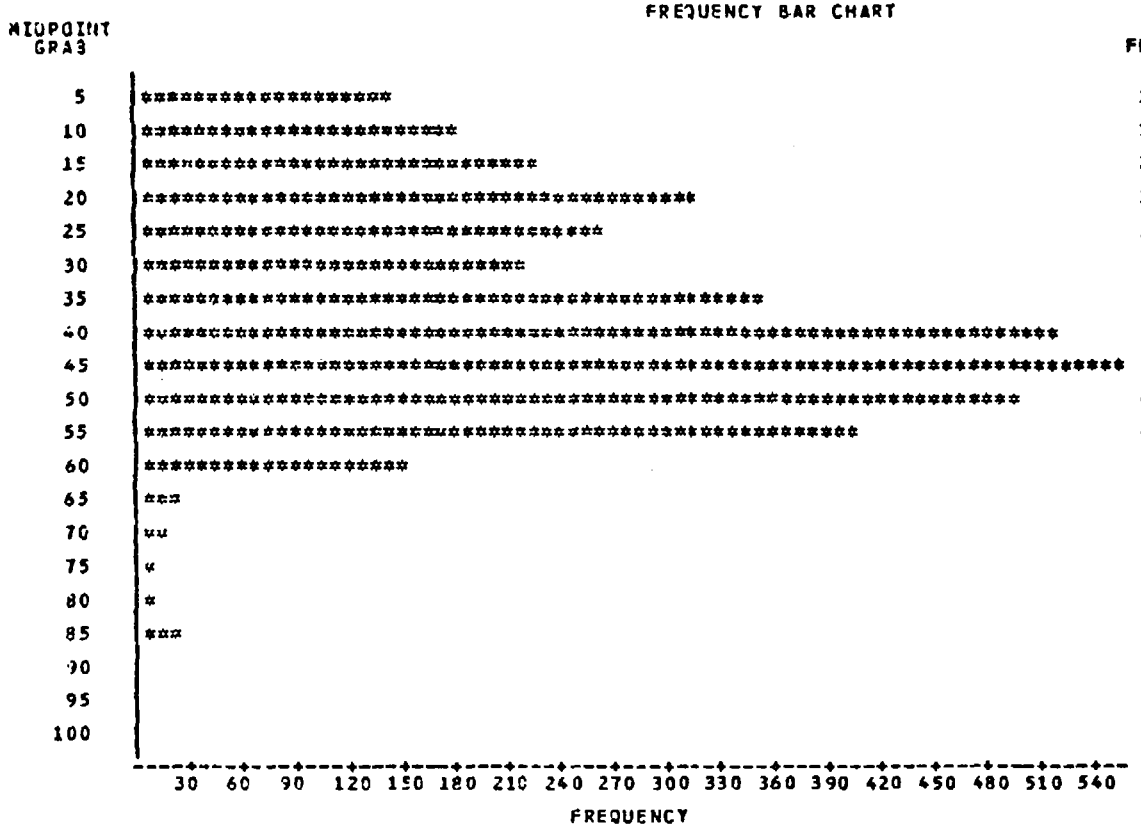
FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
1	1	0.11	0.11
2	3	0.23	0.34
0	3	0.00	0.34
2	5	0.23	0.57
9	14	1.03	1.60
0	14	0.00	1.60
14	28	1.60	3.21
10	38	1.15	4.35
27	65	3.09	7.45
14	79	1.60	9.05
26	105	2.98	12.03
14	119	1.60	13.63
14	133	1.60	15.23
8	141	0.92	16.15
6	147	0.69	16.84
3	150	0.34	17.18
2	152	0.23	17.41
2	154	0.23	17.64
21	175	2.41	20.05
698	873	79.95	100.00

FREQUENCY BAR CHART



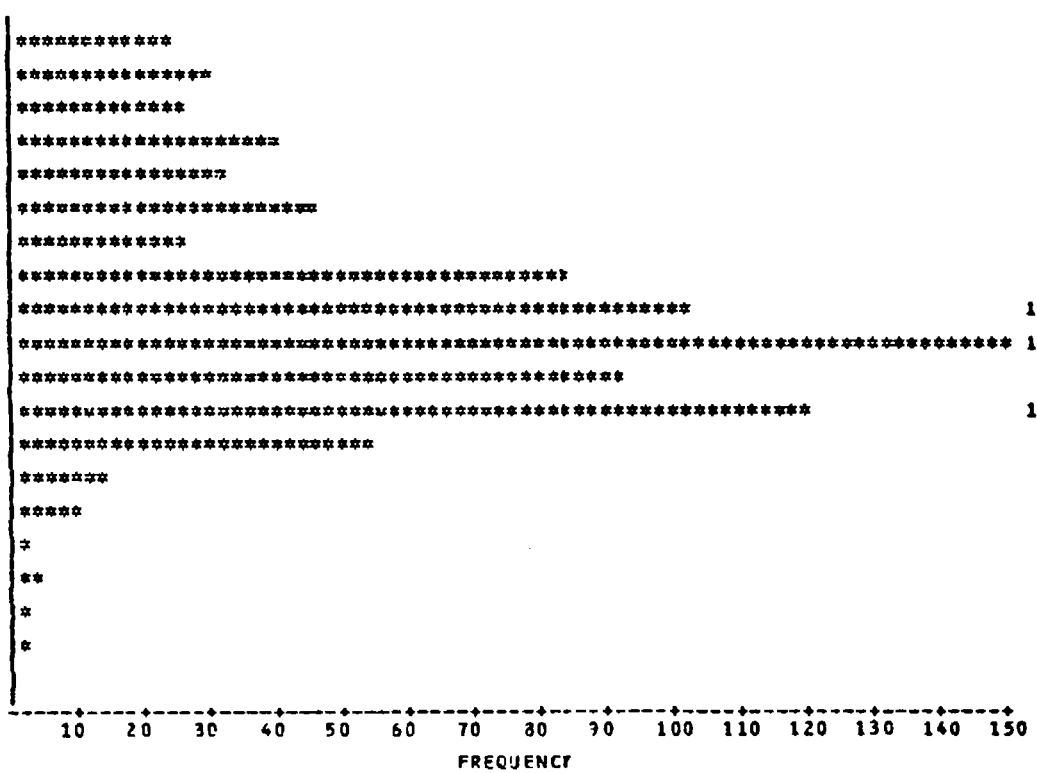
FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
1	1	0.20	0.20
1	2	0.20	0.39
3	5	0.59	0.99
1	6	0.20	1.18
3	9	0.59	1.78
3	12	0.59	2.37
2	14	0.39	2.76
4	18	0.79	3.55
6	24	1.18	4.73
1	25	0.20	4.93
5	30	0.99	5.92
2	32	0.39	6.31
3	35	0.59	6.90
1	36	0.20	7.10
4	40	0.79	7.89
1	41	0.20	8.09
12	53	2.37	10.45
29	82	5.72	16.17
425	507	83.83	100.00
0	507	0.00	100.00

FREQUENCY BAR CHART



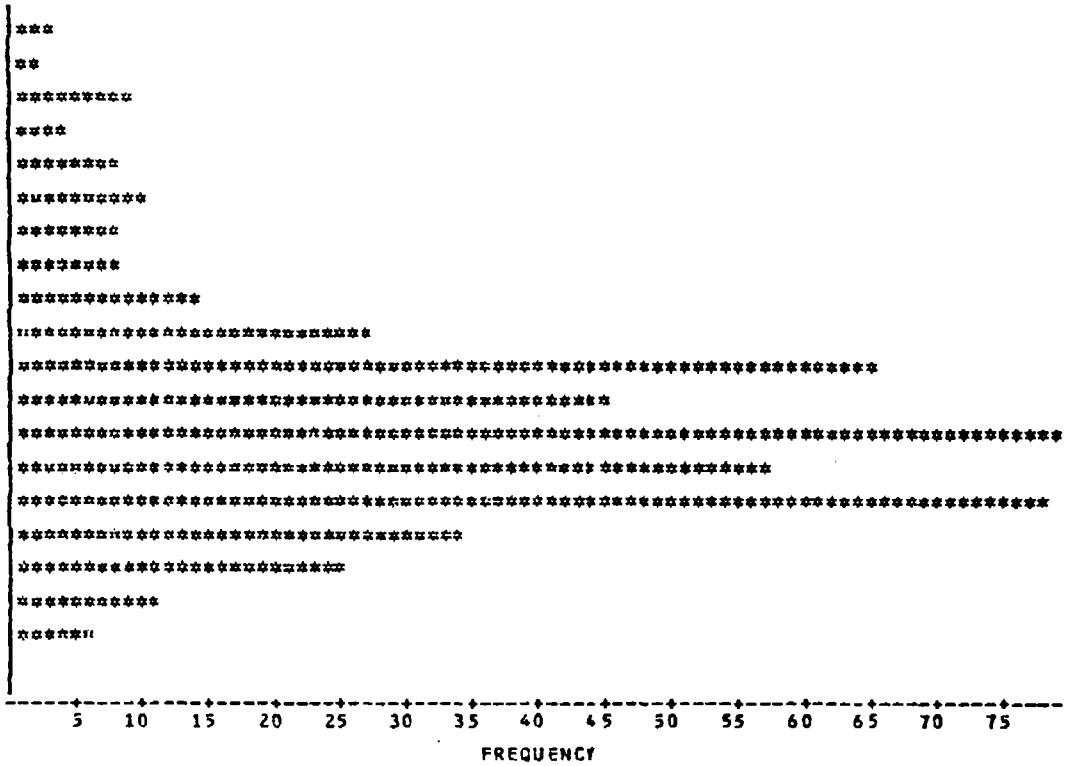
MIDPOINT GRA3	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
5	139	139	3.56	3.56
10	183	322	4.69	8.25
15	224	546	5.74	13.99
20	317	863	8.12	22.12
25	266	1129	6.82	28.93
30	216	1345	5.54	34.47
35	351	1696	9.00	43.46
40	518	2214	13.28	56.74
45	556	2770	14.25	70.99
50	435	3265	12.69	83.68
55	404	3669	10.35	94.03
60	150	3819	3.84	97.87
65	25	3844	0.64	98.51
70	17	3861	0.44	98.95
75	9	3870	0.23	99.18
80	10	3880	0.26	99.44
85	21	3901	0.54	99.97
90	1	3902	0.03	100.00
95	0	3902	0.00	100.00
100	0	3902	0.00	100.00

FREQUENCY BAR CHART



MIDPOINT GRAB	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
4.5	23	23	2.72	2.72
9.0	30	53	3.54	6.26
13.5	25	78	2.95	9.21
18.0	40	118	4.72	13.93
22.5	31	149	3.66	17.59
27.0	45	194	5.31	22.90
31.5	26	220	3.07	25.97
36.0	83	303	9.80	35.77
40.5	102	405	12.04	47.82
45.0	149	554	17.59	65.41
49.5	91	645	10.74	76.15
54.0	119	764	14.05	90.20
58.5	54	818	6.38	96.58
63.0	14	832	1.65	98.23
67.5	9	841	1.06	99.29
72.0	1	842	0.12	99.41
76.5	3	845	0.35	99.76
81.0	1	846	0.12	99.88
85.5	1	847	0.12	100.00
90.0	0	847	0.00	100.00

FREQUENCY BAR CHART



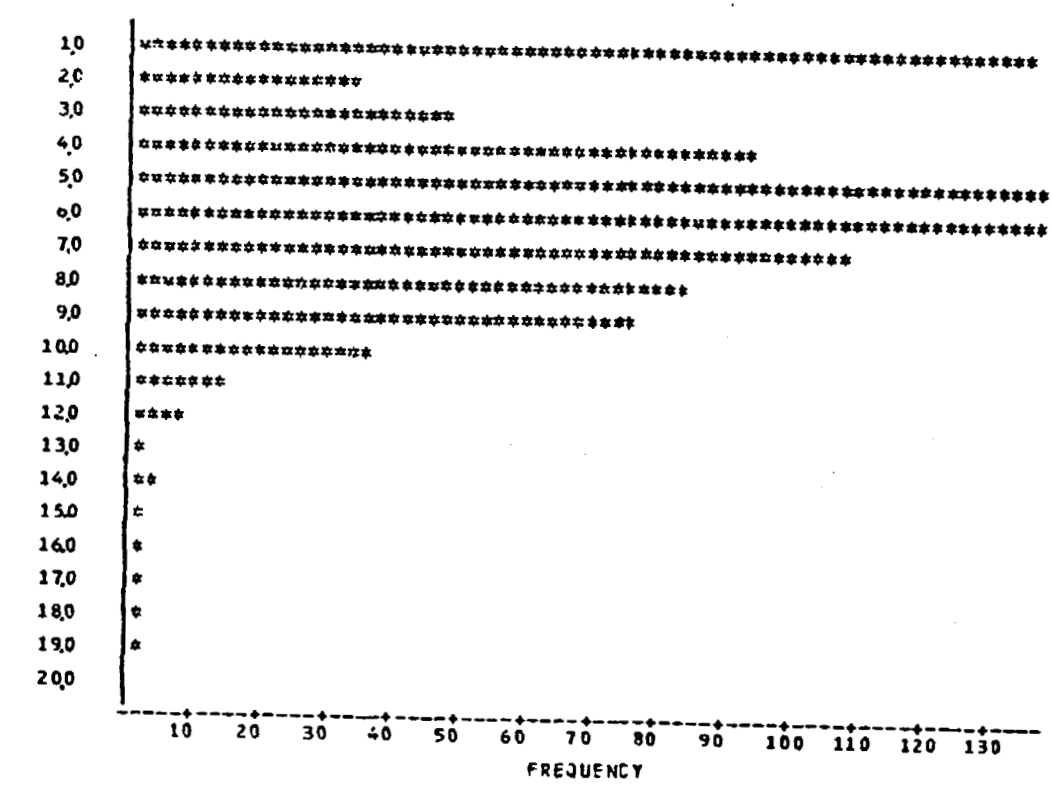
MIDPOINT GRAB	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
3.5	3	3	0.61	0.61
7.0	2	5	0.41	1.01
10.5	9	14	1.83	2.84
14.0	4	18	0.81	3.65
17.5	8	26	1.62	5.27
21.0	10	36	2.03	7.30
24.5	8	44	1.62	8.92
28.0	8	52	1.62	10.55
31.5	14	66	2.84	13.39
35.0	27	93	5.48	18.86
38.5	65	158	13.18	32.05
42.0	45	203	9.13	41.18
45.5	79	282	16.02	57.20
49.0	57	339	11.56	68.76
52.5	78	417	15.82	84.58
56.0	34	451	6.90	91.48
59.5	25	476	5.07	96.55
63.0	11	487	2.23	98.78
66.5	6	493	1.22	100.00
70.0	0	493	0.00	100.00

FREQUENCY BAR CHART

```
MIDPOINT
 GRA13
  1.7  |*************************************************************
  3.4  |****************************
  5.1  |*****************************************************
  6.8  |*********************************************
  8.5  |*********************
 10.2  |*********
 11.9  |**
 13.6  |*
 15.3  |*
 17.0  |
 18.7  |
 20.4  |
 22.1  |
 23.8  |
 25.5  |
 27.2  |
 28.9  |
 30.6  |
 32.3  |
 34.0  |
       +----+----+----+----+----+----+----+----+----+----+----+
        100  200  300  400  500  600  700  800  900 1000 1100 1200
                          FREQUENCY
```

	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
1.7	1194	1194	26.53	26.53
3.4	566	1760	12.58	39.11
5.1	1099	2859	24.42	63.53
6.8	917	3776	20.38	83.91
8.5	447	4223	9.93	93.84
10.2	186	4409	4.13	97.98
11.9	49	4458	1.09	99.07
13.6	11	4469	0.24	99.31
15.3	14	4483	0.31	99.62
17.0	8	4491	0.18	99.80
18.7	3	4494	0.07	99.87
20.4	0	4494	0.00	99.87
22.1	0	4494	0.00	99.87
23.8	1	4495	0.02	99.89
25.5	2	4497	0.04	99.93
27.2	0	4497	0.00	99.93
28.9	1	4498	0.02	99.96
30.6	0	4498	0.00	99.96
32.3	2	4500	0.04	100.00
34.0	0	4500	0.00	100.00

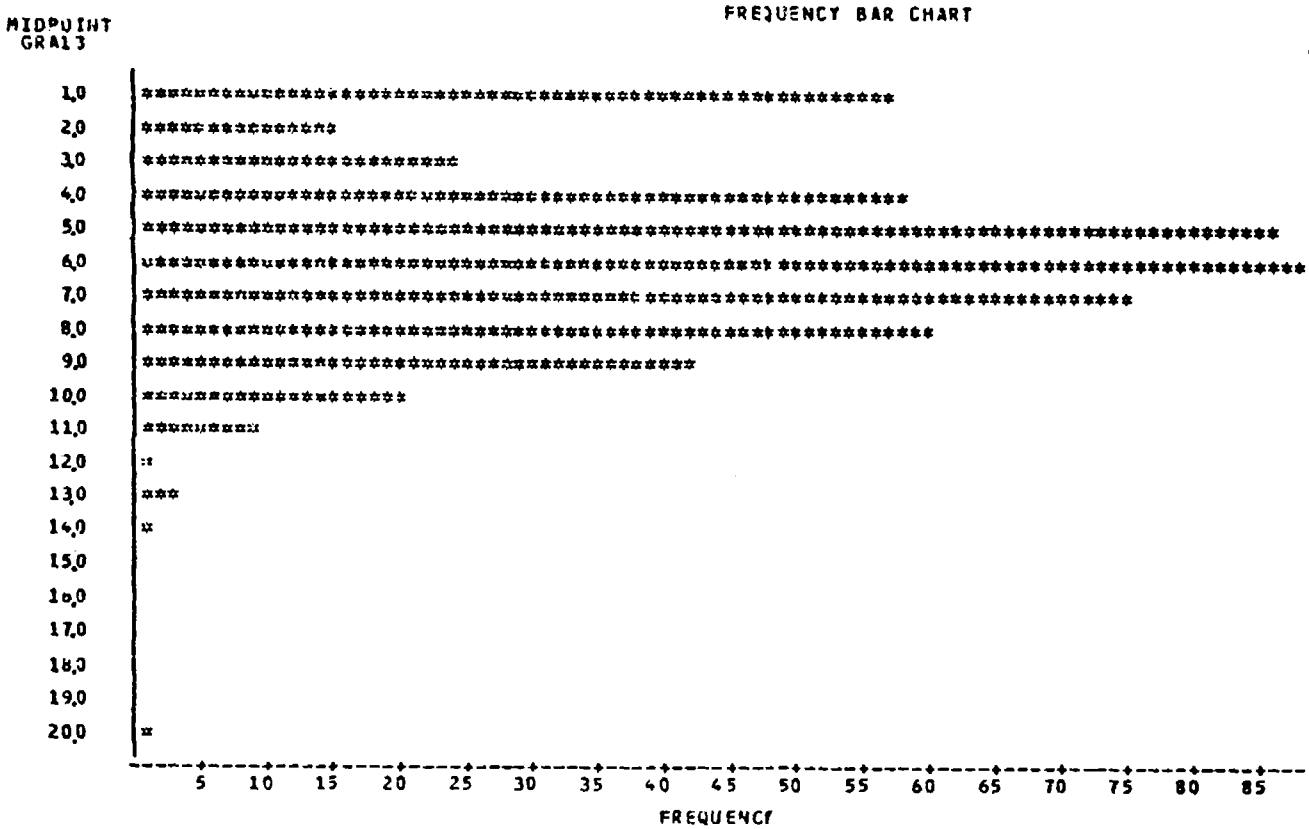
FREQUENCY BAR CHART



FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
135	135	14.64	14.64
33	168	3.58	18.22
48	216	5.21	23.43
94	310	10.20	33.62
138	448	14.97	48.59
137	585	14.86	63.45
108	693	11.71	75.16
84	777	9.11	84.27
75	852	8.13	92.41
36	888	3.90	96.31
14	902	1.52	97.83
8	910	0.87	98.70
1	911	0.11	98.81
4	915	0.43	99.24
2	917	0.22	99.46
1	918	0.11	99.57
2	920	0.22	99.78
1	921	0.11	99.89
1	922	0.11	100.00
0	922	0.00	100.00

FREQ & CUMFREQ CHART MAT=A8 LAB=C COL45-47 #200 17:08 SATURDAY, MARCH 19, 1988 41

FREQUENCY BAR CHART

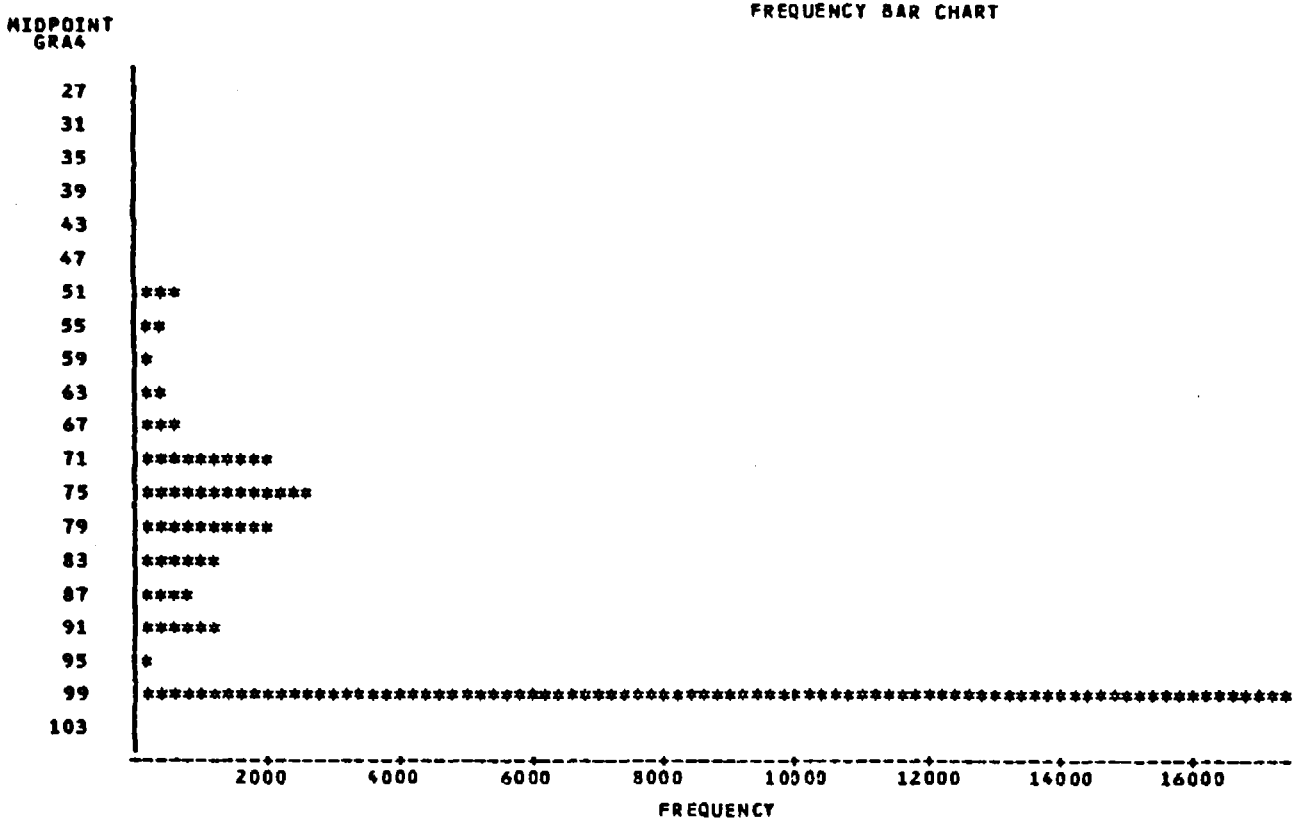


MIDPOINT GRA13	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
1.0	57	57	10.56	10.56
2.0	15	72	2.78	13.33
3.0	24	96	4.44	17.78
4.0	58	154	10.74	28.52
5.0	86	240	15.93	44.44
6.0	88	328	16.30	60.74
7.0	75	403	13.89	74.63
8.0	60	463	11.11	85.74
9.0	42	505	7.78	93.52
10.0	20	525	3.70	97.22
11.0	9	534	1.67	98.89
12.0	1	535	0.19	99.07
13.0	3	538	0.56	99.63
14.0	1	539	0.19	99.81
15.0	0	539	0.00	99.81
16.0	0	539	0.00	99.81
17.0	0	539	0.00	99.81
18.0	0	539	0.00	99.81
19.0	0	539	0.00	99.81
20.0	1	540	0.19	100.00

Material	mtl. code	tests col 1,2		value	column.	no. of obs.	p	lab d	lab c	1	Δ
L.											
mineral agg. for AC	MA	gradation	1"	M2	27-29	36416	29744	4833	1836	2	1
		gradation	3/4"	M2	30-32	41973	34012	5756	2200	3	2
		gradation	1/2"	M2	33-35	48831	39765	6535	2526	3	2
		gradation	#8	M2	45-47	42510	32907	6906	2693	1	3
		gradation	#40	M2	54-56	28163	20471	5425	2264	1	2
		gradation	#200	M2	63-65	30812	22324	5908	2577	1	2

Mat.	test		total	lab/pur	#	mean	std	min	max	25%	75%
L.											
MA	gradation	1"	36416	p /	29744	89.91	13.73	26	100	78	100
				d /	4833	97.40	8.07	10	100	100	100
				c /	1836	98.60	6.18	43	100	100	100
	gradation	3/4"	41973	p /	34012	82.19	16.78	3	100	68	97
				d /	5756	90.90	12.66	1	100	89	99
				c /	2200	92.37	10.80	11	100	90	100
	gradation	1/2"	48831	p /	39765	64.04	27.45	1	100	44	95
				d /	6535	71.42	25.16	1	182	54	92
				c /	2526	72.64	26.43	1	100	55	99
	gradation	#8	42510	p /	32907	43.49	34.54	1	100	4	79
				d /	6906	42.33	28.84	1	100	21	63
				c /	2693	43.64	31.29	1	100	10	74
	gradation	#40	28163	p /	20471	23.69	12.96	1	327	15	32
				d /	5425	21.11	12.08	1	85	14	28
				c /	2264	20.23	14.13	1	100	11	29
	gradation	#200	30812	p /	22324	5.8 44	4.8 .25	.1	71.2	1.9	8.5
				d /	5908	5.5 .07	3.9 .87	.1	97.7	3.2	6.7
				c /	2577	4.7 14	3.9 19	.1	28.3	1.5	6.4

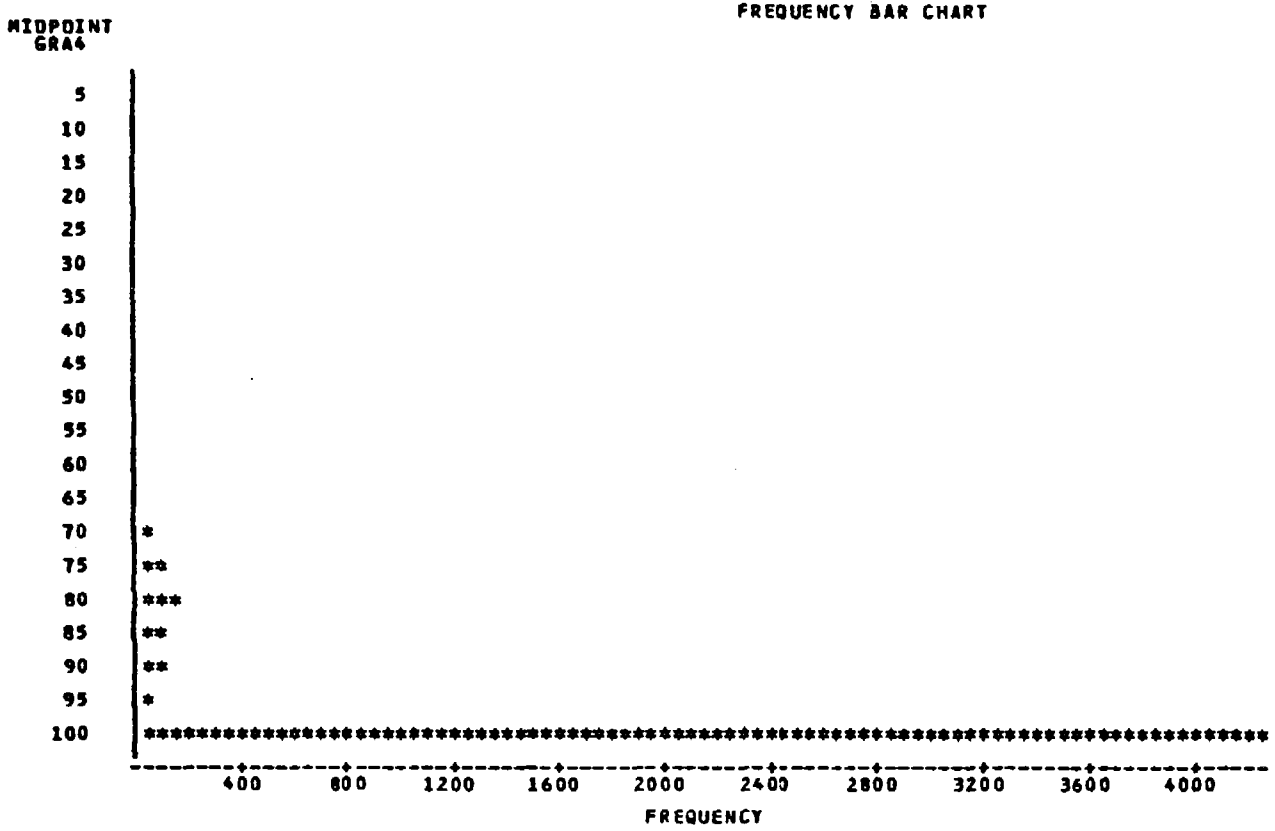
FREQUENCY BAR CHART



MIDPOINT GRA4	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
27	3	3	0.01	0.01
31	4	7	0.01	0.02
35	4	11	0.01	0.04
39	3	14	0.01	0.05
43	15	29	0.05	0.10
47	47	76	0.16	0.26
51	518	594	1.74	2.00
55	486	1080	1.63	3.63
59	296	1376	1.00	4.63
63	308	1684	1.04	5.66
67	667	2351	2.24	7.90
71	2071	4422	6.96	14.87
75	2620	7042	8.81	23.68
79	2061	9103	6.93	30.60
83	1159	10262	3.90	34.50
87	740	11002	2.49	36.99
91	1182	12184	3.97	40.96
95	125	12309	0.42	41.38
99	17435	29744	58.62	100.00
103	0	29744	0.00	100.00

FREQ & CUMFREQ CHART MAT=MA LAB=0 COL27-29 1 IN 17:46 SUNDAY, MARCH 20, 1988 29

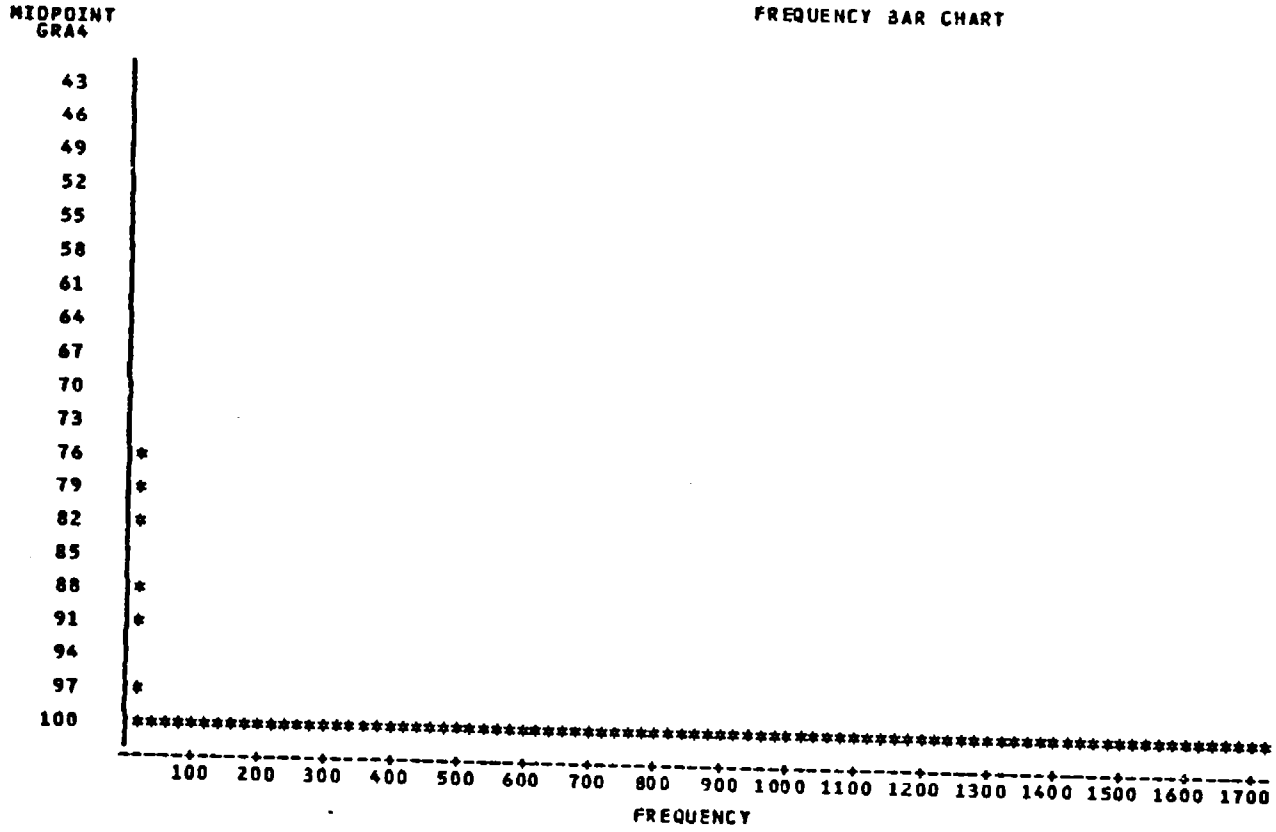
FREQUENCY BAR CHART



	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
5	0	0	0.00	0.00
10	4	4	0.08	0.08
15	0	4	0.00	0.08
20	0	4	0.00	0.08
25	0	4	0.00	0.08
30	0	4	0.00	0.08
35	0	4	0.00	0.08
40	1	5	0.02	0.10
45	7	12	0.14	0.25
50	15	27	0.31	0.56
55	20	47	0.41	0.97
60	1	48	0.02	0.99
65	11	59	0.23	1.22
70	50	109	1.03	2.26
75	100	209	2.07	4.32
80	145	354	3.00	7.32
85	103	457	2.13	9.46
90	92	549	1.90	11.36
95	57	606	1.18	12.54
100	4227	4833	87.46	100.00

FREQ & CUMFREQ CHART MAT=MA LAB=C COL27-29 1 IN 17:46 SUNDAY, MARCH 20, 1988 49

FREQUENCY BAR CHART

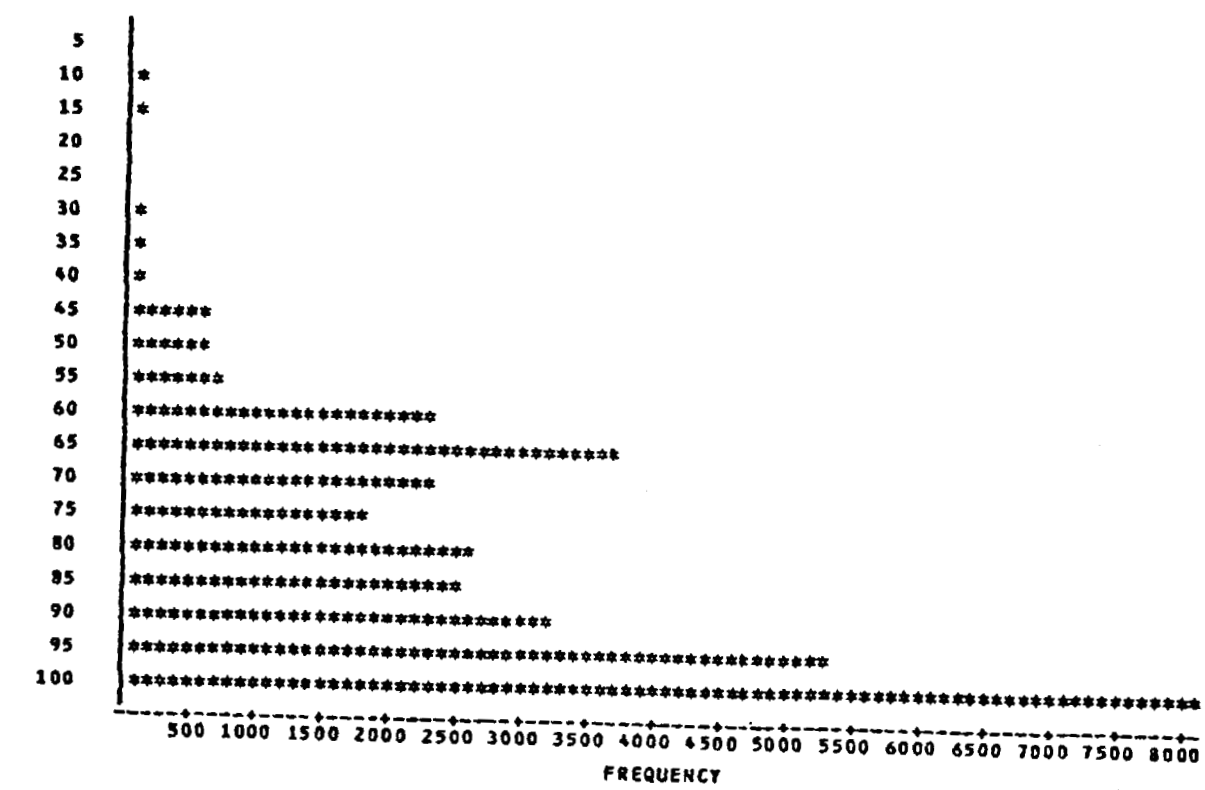


FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
1	1	0.05	0.05
0	1	0.00	0.05
3	4	0.16	0.22
5	9	0.27	0.49
3	12	0.16	0.65
3	15	0.16	0.82
1	16	0.05	0.87
1	17	0.05	0.93
5	22	0.27	1.20
3	25	0.16	1.36
8	33	0.44	1.80
16	49	0.87	2.67
13	62	0.71	3.38
10	72	0.54	3.92
7	79	0.38	4.30
14	93	0.76	5.07
11	104	0.60	5.66
6	110	0.33	5.99
13	123	0.71	6.70
1713	1836	93.30	100.00

FREQ & CUMFREQ CHART MAT=MA LAB=P COL30-32 3/4IN

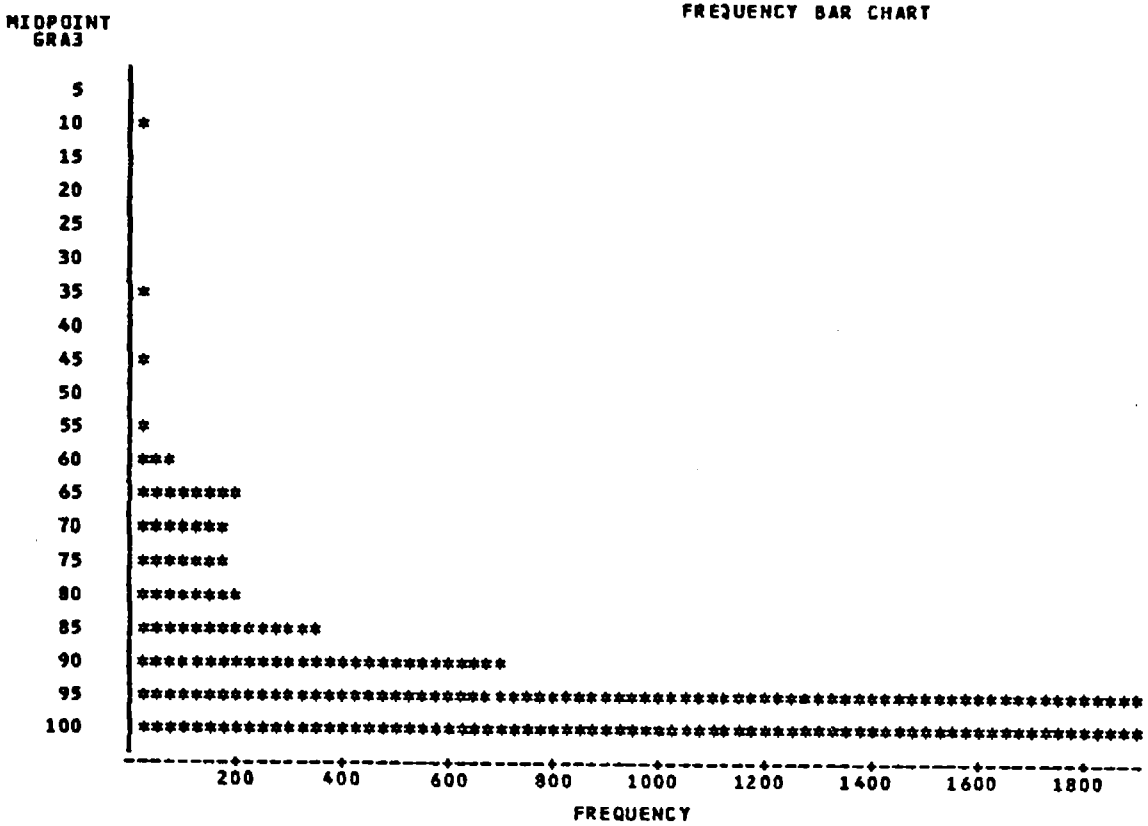
17:46 SUNDAY, MARCH 20, 1988 10

FREQUENCY BAR CHART



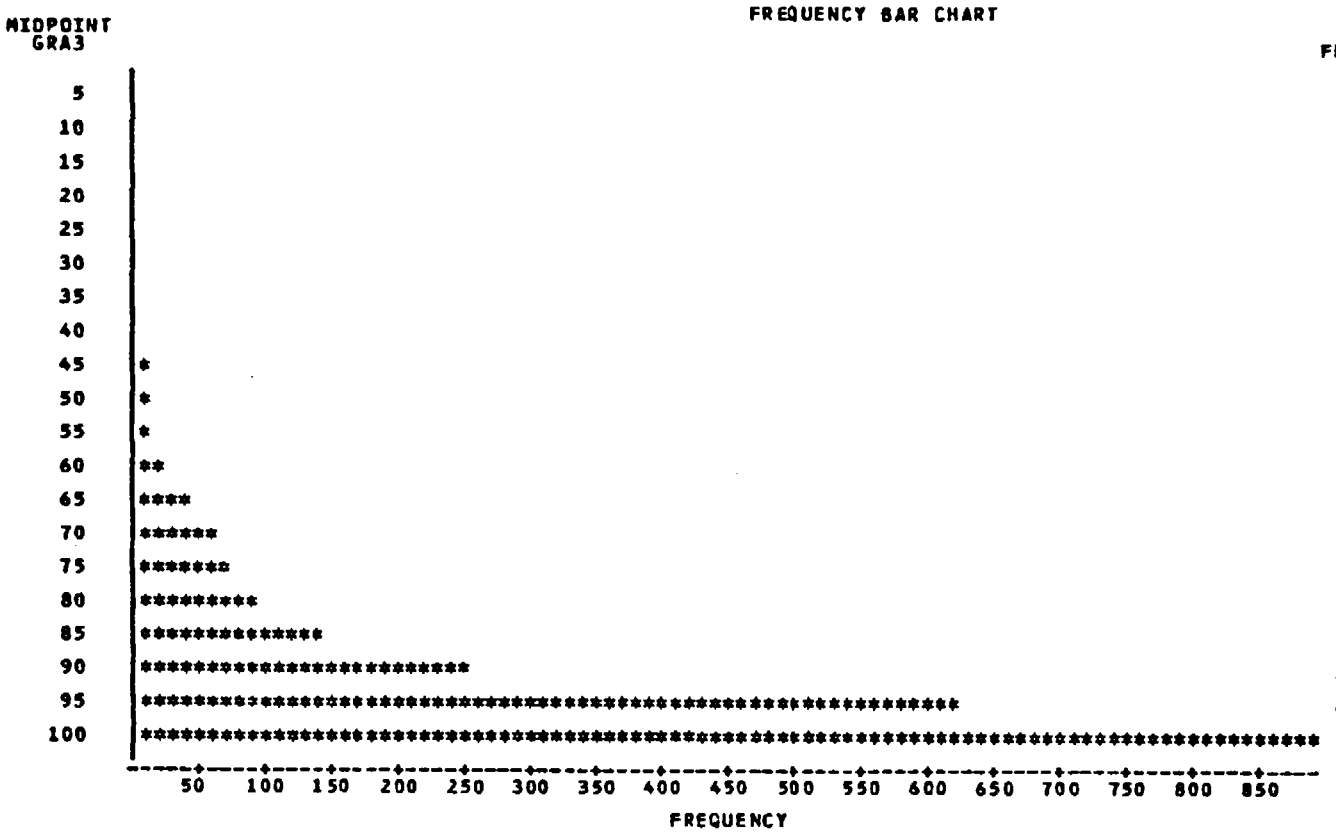
FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
16	16	0.05	0.05
81	97	0.24	0.29
59	156	0.17	0.46
25	181	0.07	0.53
38	219	0.11	0.64
56	275	0.16	0.81
72	347	0.21	1.02
69	416	0.20	1.22
558	974	1.64	2.86
616	1590	1.81	4.67
685	2275	2.01	6.69
2256	4531	6.63	13.32
3744	8275	11.01	24.33
2259	10534	6.64	30.97
1769	12303	5.20	36.17
2596	14899	7.63	43.81
2531	17430	7.44	51.25
3222	20652	9.47	60.72
5273	25925	15.50	76.22
8087	34012	23.78	100.00

FREQUENCY BAR CHART



FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
8	8	0.14	0.14
14	22	0.24	0.38
5	27	0.09	0.47
2	29	0.03	0.50
5	34	0.09	0.59
10	44	0.17	0.76
17	61	0.30	1.06
8	69	0.14	1.20
15	84	0.26	1.46
10	94	0.17	1.63
18	112	0.31	1.95
72	184	1.25	3.20
196	380	3.41	6.60
169	549	2.94	9.54
163	712	2.83	12.37
203	915	3.53	15.90
344	1259	5.98	21.87
710	1969	12.33	34.21
1898	3867	32.97	67.18
1889	5756	32.82	100.00

FREQUENCY BAR CHART



FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
0	0	0.00	0.00
4	4	0.18	0.18
2	6	0.09	0.27
0	6	0.00	0.27
0	6	0.00	0.27
2	8	0.09	0.36
3	11	0.14	0.50
0	11	0.00	0.50
5	16	0.23	0.73
5	21	0.23	0.95
6	27	0.27	1.23
15	42	0.68	1.91
38	80	1.73	3.64
61	141	2.77	6.41
69	210	3.14	9.55
85	295	3.86	13.41
138	433	6.27	19.68
249	682	11.32	31.00
624	1306	28.36	59.36
894	2200	40.64	100.00

FREQ & CUMFREQ CHART MAT=MA LAB=P COL33-35 1/2IN 17:46 SUNDAY, MARCH 20, 1988 12

FREQUENCY BAR CHART

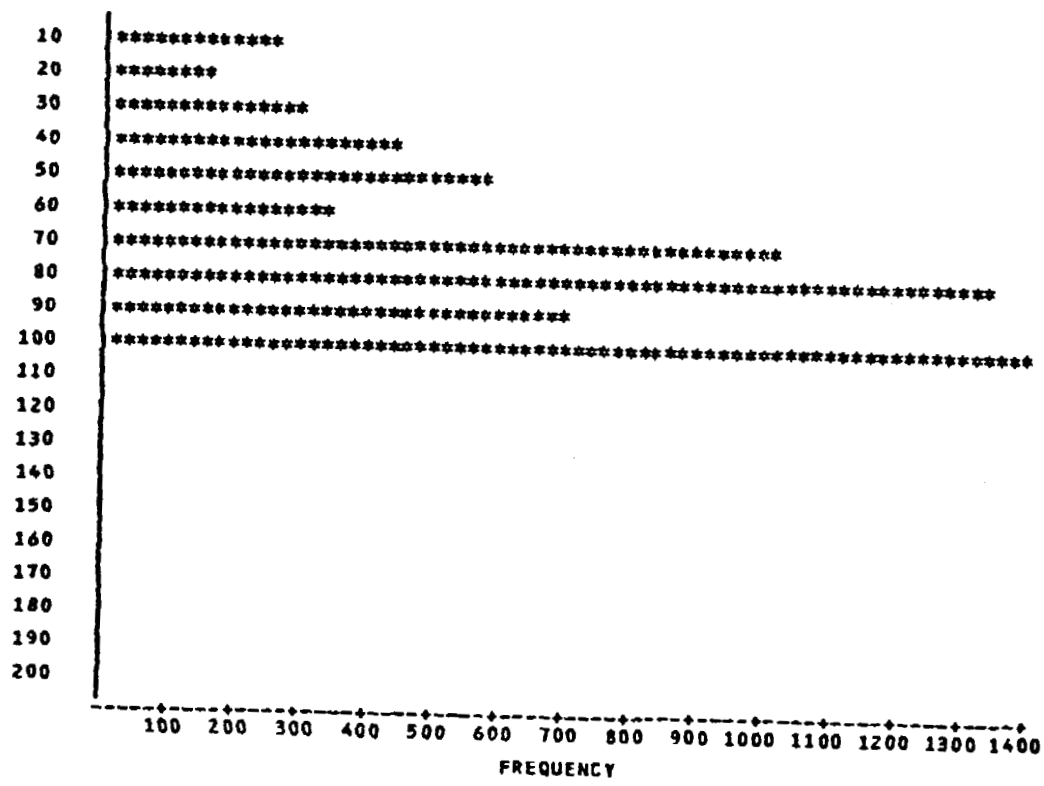
MIDPOINT GRAD		FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
5	****	795	795	2.00	2.00
10	**	364	1159	0.92	2.91
15	***	583	1742	1.47	4.38
20	****	885	2627	2.23	6.61
25	*****	981	3608	2.47	9.07
30	*****	957	4565	2.41	11.48
35	*******	1408	5973	3.54	15.02
40	**********	2556	8529	6.43	21.45
45	**********	4025	12554	10.12	31.57
50	**********	4616	17170	11.61	43.18
55	**********	2311	19481	5.81	48.99
60	********	1641	21122	4.13	53.12
65	*******	1332	22454	3.35	56.47
70	******	1122	23576	2.82	59.29
75	********	1525	25101	3.84	63.12
80	*********	1871	26972	4.71	67.83
85	*******	1367	28339	3.44	71.27
90	*****	909	29248	2.29	73.55
95	*******	1339	30587	3.37	76.92
100	**********	9178	39765	23.08	100.00

1000 2000 3000 4000 5000 6000 7000 8000 9000

FREQUENCY

FREQ & CUMFREQ CHART MAT=MA LAB=D COL33-35 1/2IN 17:46 SUNDAY, MARCH 20, 1988 33

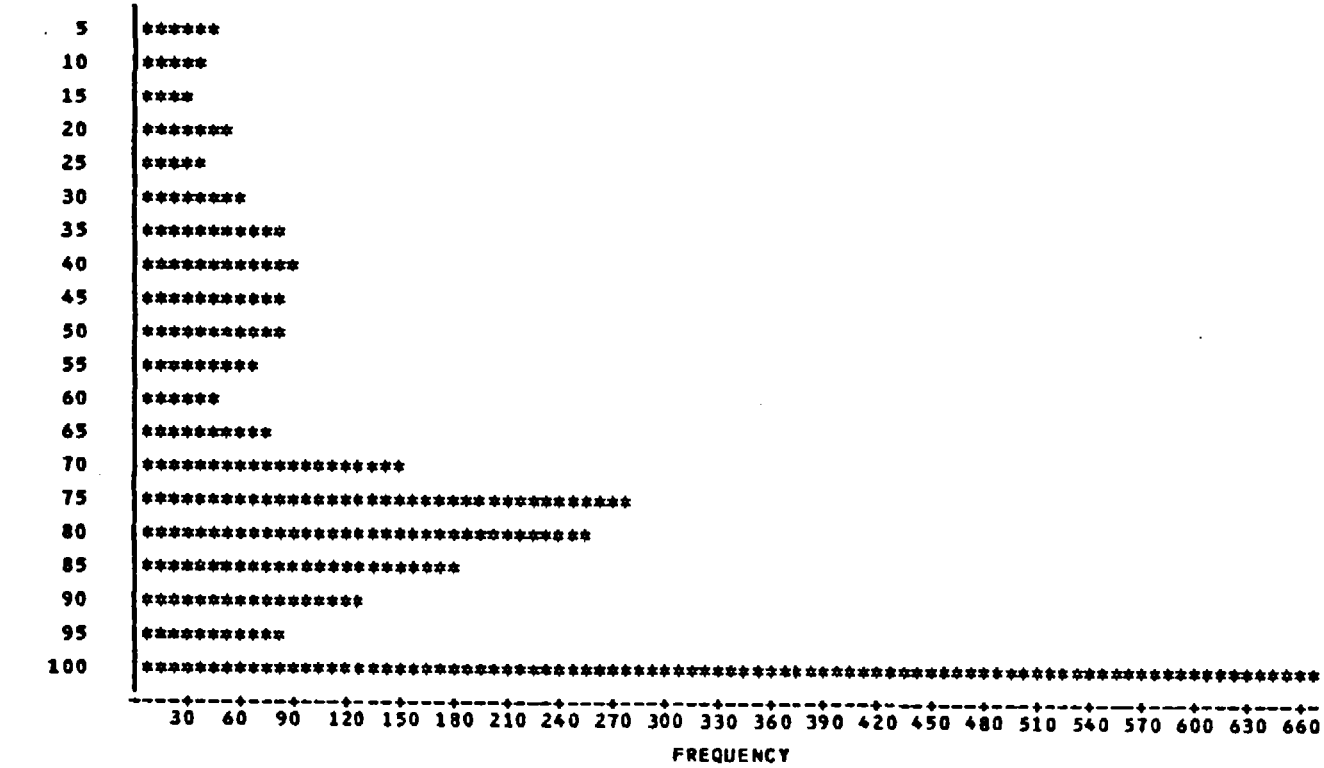
FREQUENCY BAR CHART



FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
252	252	3.86	3.86
157	409	2.40	6.26
299	708	4.58	10.83
439	1147	6.72	17.55
574	1721	8.78	26.34
337	2058	5.16	31.49
1018	3076	15.58	47.07
1345	4421	20.58	67.65
707	5128	10.82	78.47
1406	6534	21.51	99.98
0	6534	0.00	99.98
0	6534	0.00	99.98
0	6534	0.00	99.98
0	6534	0.00	99.98
0	6534	0.00	99.98
0	6534	0.00	99.98
0	6534	0.00	99.98
1	6535	0.02	100.00
0	6535	0.00	100.00
0	6535	0.00	100.00

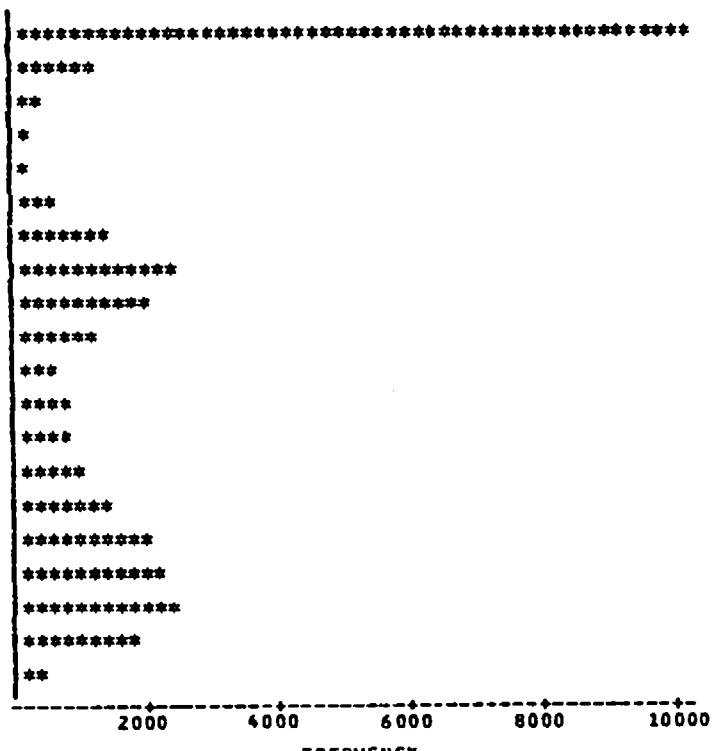
FREQ & CUMFREQ CHART MAT=MA LAB=C COL33-35 1/ZIN 17:46 SUNDAY, MARCH 20, 1988 53

FREQUENCY BAR CHART



FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
47	47	1.86	1.86
37	84	1.46	3.33
27	111	1.07	4.39
49	160	1.94	6.33
39	199	1.54	7.88
58	257	2.30	10.17
82	339	3.25	13.42
89	428	3.52	16.94
86	514	3.40	20.35
81	595	3.21	23.56
67	662	2.65	26.21
48	710	1.90	28.11
73	783	2.89	31.00
148	931	5.86	36.86
280	1211	11.08	47.94
252	1463	9.98	57.92
181	1644	7.17	65.08
131	1775	5.19	70.27
84	1859	3.33	73.59
667	2526	26.41	100.00

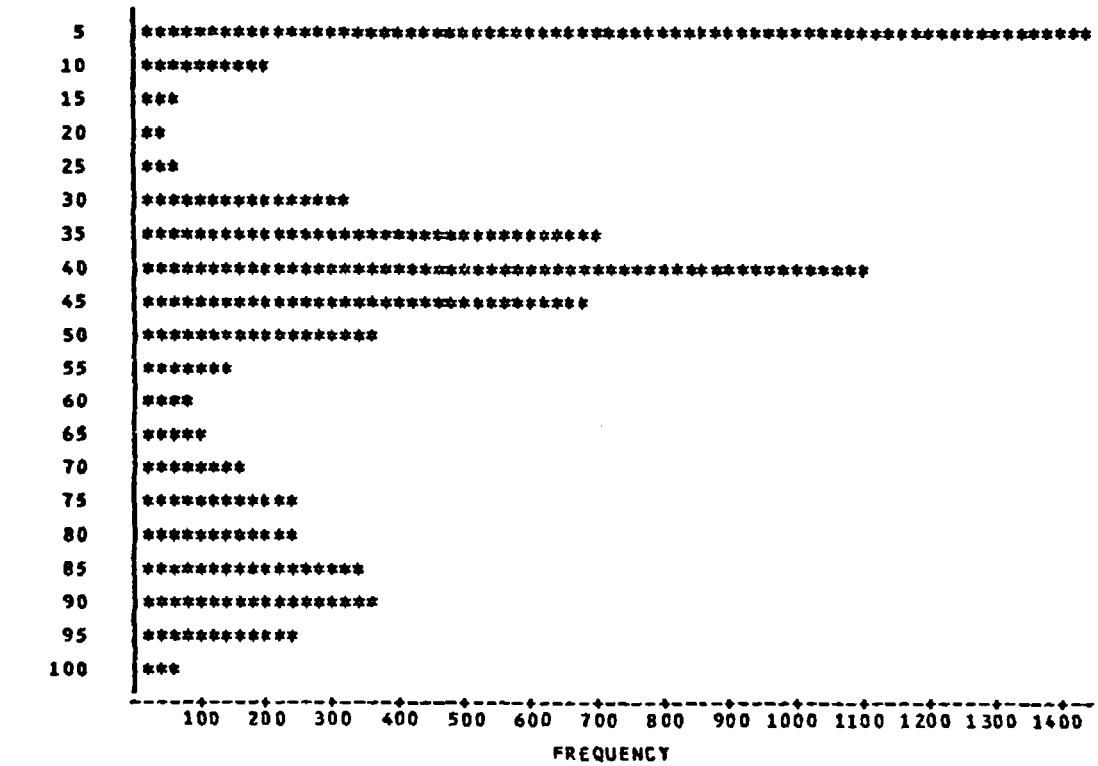
FREQUENCY BAR CHART



MIDPOINT GRAB	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
5	10100	10100	30.69	30.69
10	1117	11217	3.39	34.09
15	432	11649	1.31	35.40
20	232	11881	0.71	36.10
25	266	12147	0.81	36.91
30	594	12741	1.81	38.72
35	1436	14177	4.36	43.08
40	2478	16655	7.53	50.61
45	1932	18587	5.87	56.48
50	1101	19688	3.35	59.83
55	595	20283	1.81	61.64
60	733	21016	2.23	63.86
65	819	21835	2.49	66.35
70	984	22819	2.99	69.34
75	1411	24230	4.29	73.63
80	1930	26160	5.87	79.50
85	2250	28410	6.84	86.33
90	2352	30762	7.15	93.48
95	1750	32512	5.32	98.80
100	395	32907	1.20	100.00

FREQ & CUMFREQ CHART MAT=MA LAB=D COL45-47 #8 17:46 SUNDAY, MARCH 20, 1988 35

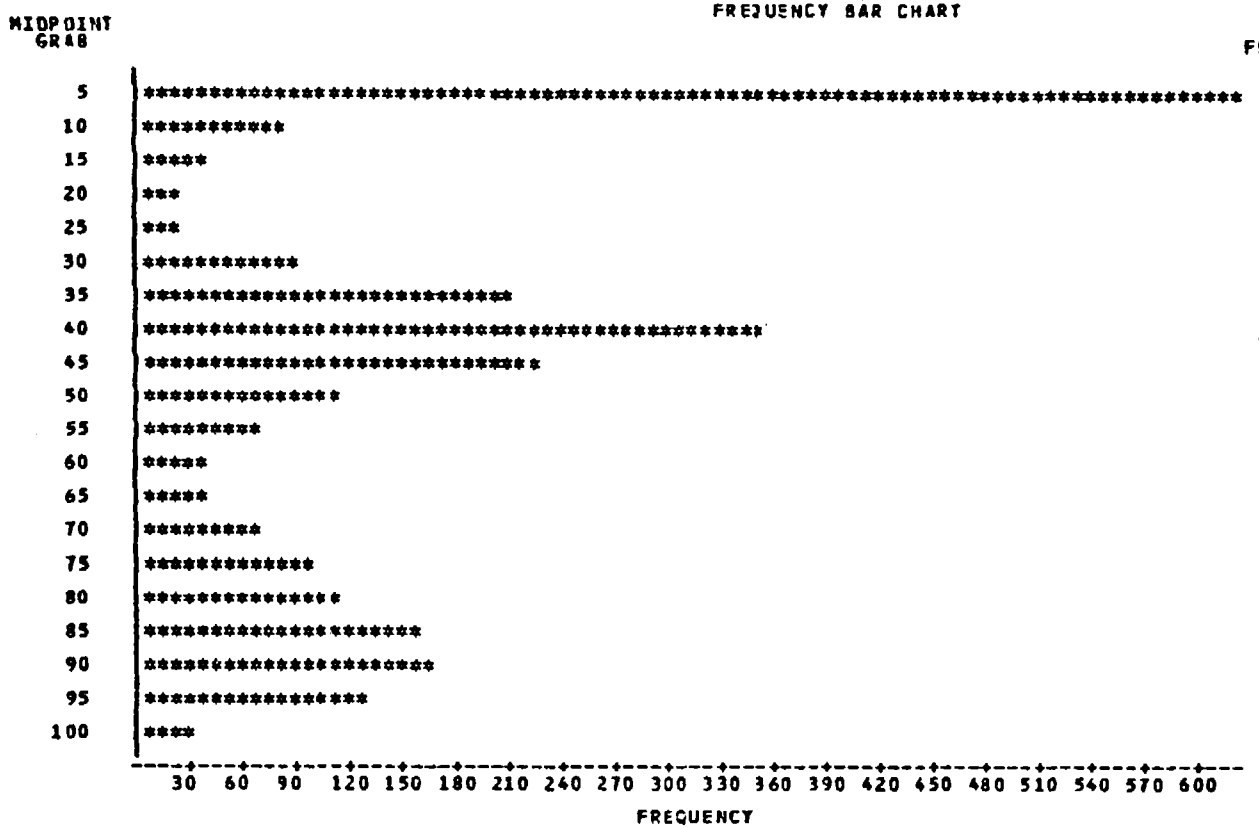
FREQUENCY BAR CHART



MIDPOINT GRAB	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
5	1432	1432	20.74	20.74
10	197	1629	2.85	23.59
15	68	1697	0.98	24.57
20	34	1731	0.49	25.07
25	64	1795	0.93	25.99
30	321	2116	4.65	30.64
35	698	2814	10.11	40.75
40	1104	3918	15.99	56.73
45	685	4603	9.92	66.65
50	355	4958	5.14	71.79
55	131	5089	1.90	73.69
60	83	5172	1.20	74.89
65	106	5278	1.53	76.43
70	158	5436	2.29	78.71
75	237	5673	3.43	82.15
80	246	5919	3.56	85.71
85	337	6256	4.88	90.59
90	363	6619	5.26	95.84
95	230	6849	3.33	99.17
100	57	6906	0.83	100.00

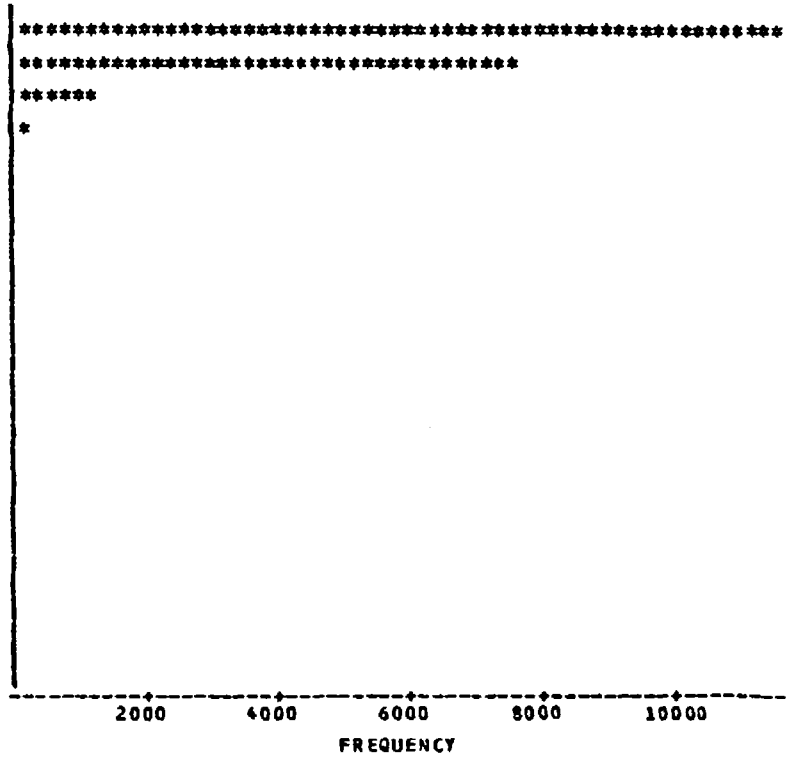
FREQ & CUMFREQ CHART MAT=MA LAB=C COL45-47 #8 17:46 SUNDAY, MARCH 20, 1988 55

FREQUENCY BAR CHART



MIDPOINT GRAB	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
5	621	621	23.06	23.06
10	84	705	3.12	26.18
15	41	746	1.52	27.70
20	23	769	0.85	28.56
25	21	790	0.78	29.34
30	92	882	3.42	32.75
35	211	1093	7.84	40.59
40	355	1448	13.18	53.77
45	227	1675	8.43	62.20
50	115	1790	4.27	66.47
55	64	1854	2.38	68.85
60	39	1893	1.45	70.29
65	37	1930	1.37	71.67
70	64	1994	2.38	74.04
75	100	2094	3.71	77.76
80	115	2209	4.27	82.03
85	161	2370	5.98	88.01
90	166	2536	6.16	94.17
95	130	2666	4.83	99.00
100	27	2693	1.00	100.00

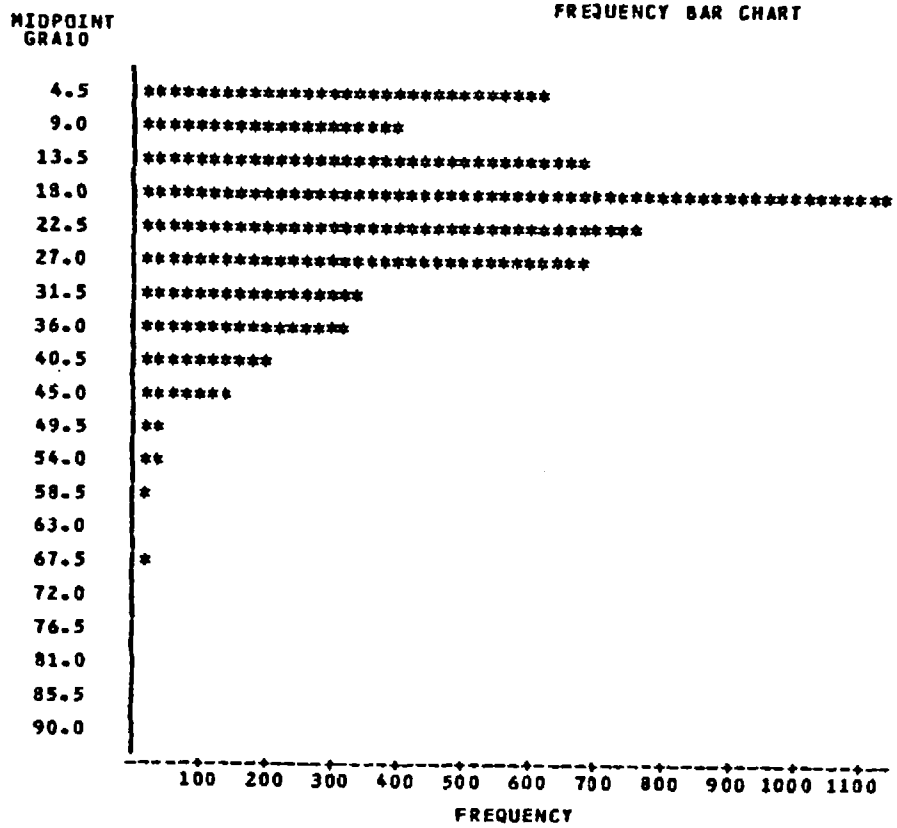
FREQUENCY BAR CHART



MIDPOINT GRA10	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
17	11555	11555	56.45	56.45
34	7546	19101	36.86	93.31
51	1199	20300	5.86	99.16
68	151	20451	0.74	99.90
85	14	20465	0.07	99.97
102	5	20470	0.02	100.00
119	0	20470	0.00	100.00
136	0	20470	0.00	100.00
153	0	20470	0.00	100.00
170	0	20470	0.00	100.00
187	0	20470	0.00	100.00
204	0	20470	0.00	100.00
221	0	20470	0.00	100.00
238	0	20470	0.00	100.00
255	0	20470	0.00	100.00
272	0	20470	0.00	100.00
289	0	20470	0.00	100.00
306	0	20470	0.00	100.00
323	1	20471	0.00	100.00
340	0	20471	0.00	100.00

FREQ & CUMFREQ CHART MAT=MA LAB=0 COL54-56 #40 17:46 SUNDAY, MARCH 20, 1988 37

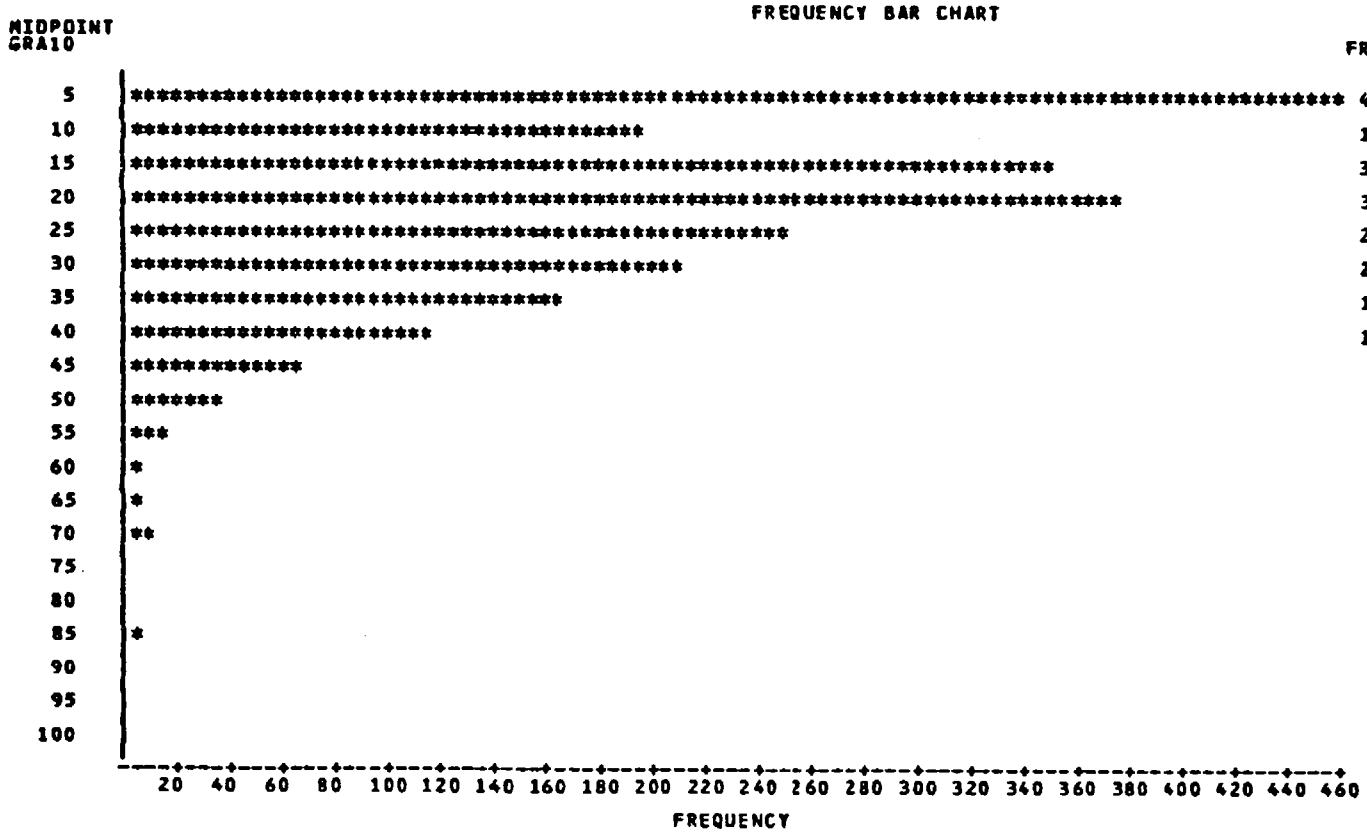
FREQUENCY BAR CHART



FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
625	625	11.52	11.52
405	1030	7.47	18.99
684	1714	12.61	31.59
1134	2848	20.90	52.50
758	3606	13.97	66.47
686	4292	12.65	79.12
330	4622	6.08	85.20
322	4944	5.94	91.13
201	5145	3.71	94.84
142	5287	2.62	97.46
48	5335	0.88	98.34
48	5383	0.88	99.23
13	5396	0.24	99.47
6	5402	0.11	99.58
13	5415	0.24	99.82
3	5418	0.06	99.87
5	5423	0.09	99.96
1	5424	0.02	99.98
1	5425	0.02	100.00
0	5425	0.00	100.00

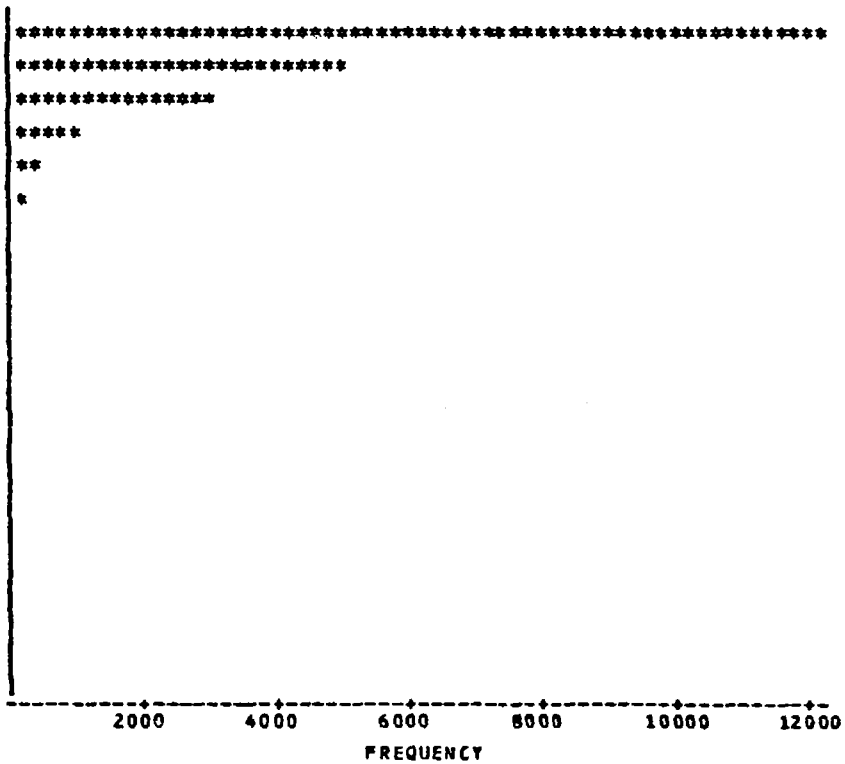
FREQ & CUMFREQ CHART MAT=MA LAB=C COL54-56 #40 17:46 SUNDAY, MARCH 20, 1988 57

FREQUENCY BAR CHART



MIDPOINT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
5	461	461	20.36	20.36
10	196	657	8.66	29.02
15	350	1007	15.46	44.48
20	377	1384	16.65	61.13
25	252	1636	11.13	72.26
30	211	1847	9.32	81.58
35	163	2010	7.20	88.78
40	117	2127	5.17	93.95
45	64	2191	2.83	96.78
50	33	2224	1.46	98.23
55	13	2237	0.57	98.81
60	3	2240	0.13	98.94
65	4	2244	0.18	99.12
70	11	2255	0.49	99.60
75	2	2257	0.09	99.69
80	2	2259	0.09	99.78
85	3	2262	0.13	99.91
90	0	2262	0.00	99.91
95	1	2263	0.04	99.96
100	1	2264	0.04	100.00

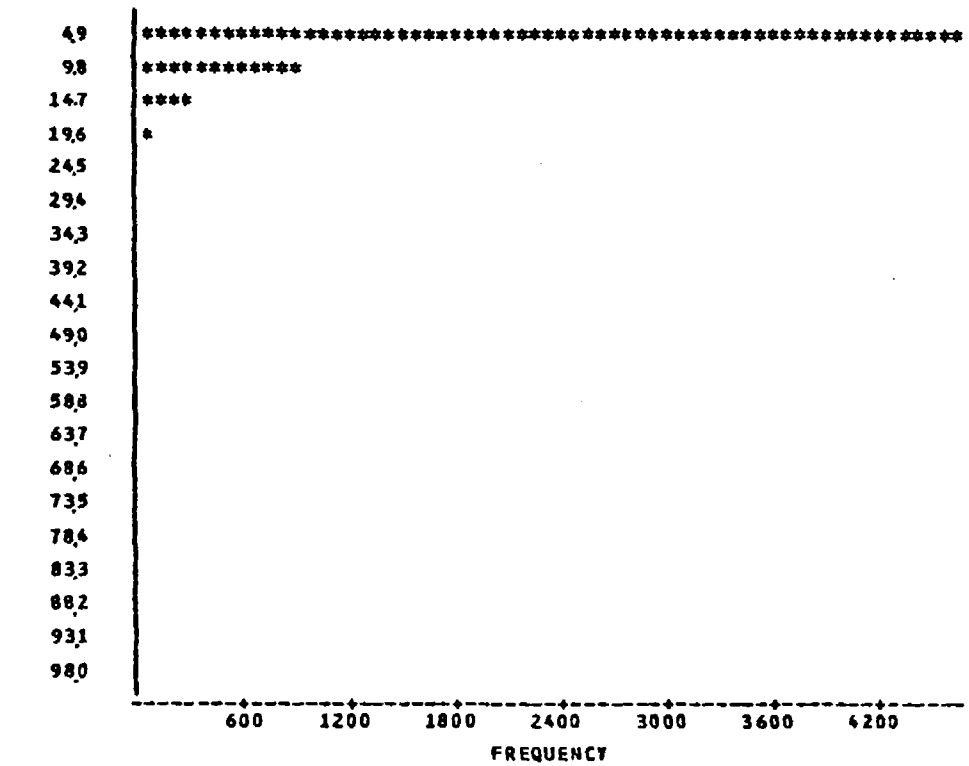
FREQUENCY BAR CHART



MIDPOINT GRA13	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
3.6	12262	12262	54.93	54.93
7.2	5091	17353	22.81	77.73
10.8	3069	20422	13.75	91.48
14.4	1088	21510	4.87	96.35
18.0	485	21995	2.17	98.53
21.6	233	22228	1.04	99.57
25.2	71	22299	0.32	99.89
28.8	15	22314	0.07	99.96
32.4	1	22315	0.00	99.96
36.0	1	22316	0.00	99.96
39.6	1	22317	0.00	99.97
43.2	1	22318	0.00	99.97
46.8	0	22318	0.00	99.97
50.4	2	22320	0.01	99.98
54.0	2	22322	0.01	99.99
57.6	0	22322	0.00	99.99
61.2	1	22323	0.00	100.00
64.8	0	22323	0.00	100.00
68.4	0	22323	0.00	100.00
72.0	1	22324	0.00	100.00

FREQ & CUMFREQ CHART MAT=MA LAB=D COL63-65 #200 17:46 SUNDAY, MARCH 20, 1988 39

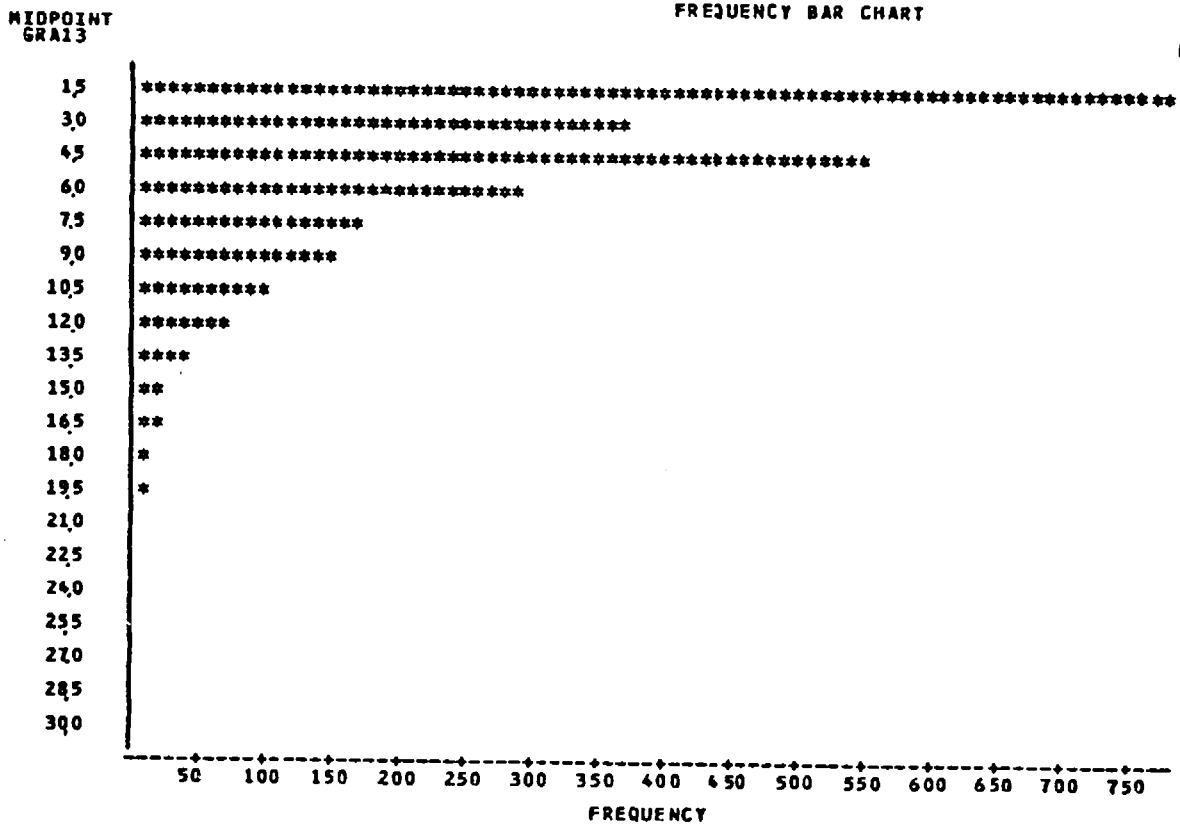
FREQUENCY BAR CHART



FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
4642	4642	78.57	78.57
883	5525	14.95	93.52
308	5833	5.21	98.73
56	5889	0.95	99.68
13	5902	0.22	99.90
4	5906	0.07	99.97
0	5906	0.00	99.97
0	5906	0.00	99.97
1	5907	0.02	99.98
0	5907	0.00	99.98
0	5907	0.00	99.98
0	5907	0.00	99.98
0	5907	0.00	99.98
0	5907	0.00	99.98
0	5907	0.00	99.98
0	5907	0.00	99.98
0	5907	0.00	99.98
0	5907	0.00	99.98
0	5907	0.00	99.98
1	5908	0.02	100.00

FREQ & CUMFREQ CHART MAT=MA LAB=C COL63-65 #200 17:46 SUNDAY, MARCH 20, 1988 59

FREQUENCY BAR CHART

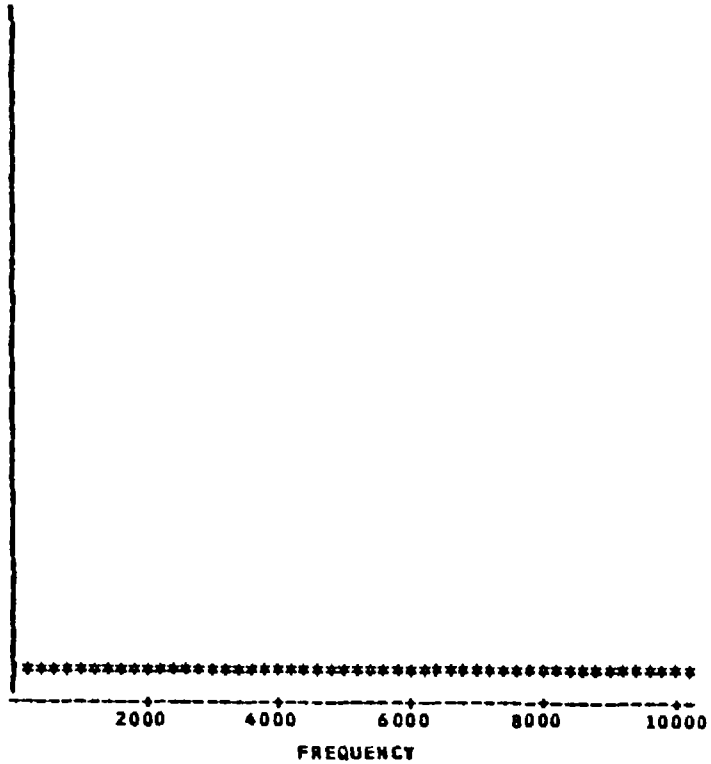


FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
784	784	30.42	30.42
366	1150	14.20	44.63
546	1696	21.19	65.81
293	1989	11.37	77.18
171	2160	6.64	83.82
148	2308	5.74	89.56
96	2404	3.73	93.29
71	2475	2.76	96.04
35	2510	1.36	97.40
21	2531	0.81	98.21
16	2547	0.62	98.84
8	2555	0.31	99.15
10	2565	0.39	99.53
3	2568	0.12	99.65
2	2570	0.08	99.73
3	2573	0.12	99.84
2	2575	0.08	99.92
1	2576	0.04	99.96
1	2577	0.04	100.00
0	2577	0.00	100.00

Material	mtl. code	tests col 1,2	value	column.	no. of obs.	p	lab d	lab c	Δ
W.									
fine agg pcc	FA	gradation 3/8"	M2	36-38	12687	10184	1898	595	10
p,s,b,u		gradation #4	M2	42-44	16014	12216	2706	1082	10
		gradation #16	M2	48-50	16015	12219	2707	1079	10
		gradation #50	M2	57-59	16013	12218	2708	1077	10
		gradation #100	M2	60-62	16014	12214	2710	1080	10
		gradation #200	M2	63-65	15980	12204	2690	1077	9
for type S only		sand equivalent	M2	71-72	140	41	9	90	0

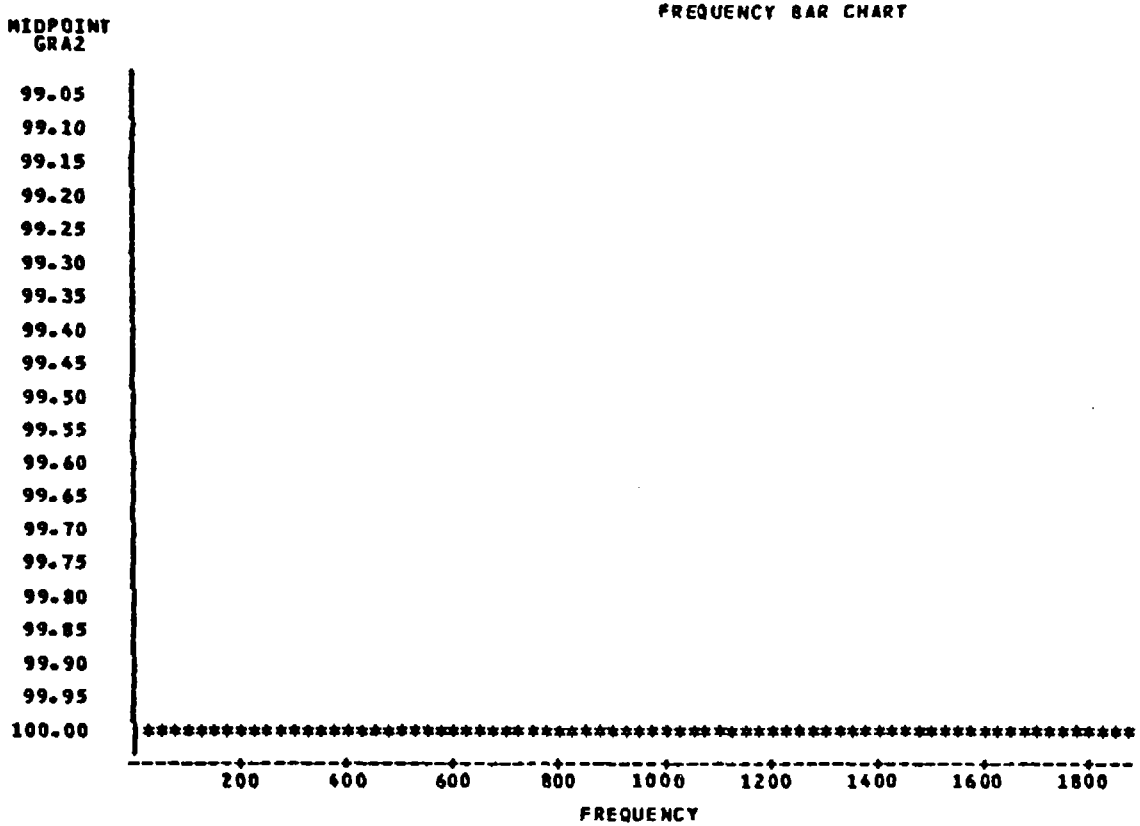
Mat.	test		total	lab/pur	#	mean	std	min	max	25%	75%
W.											
FA	gradation	3/8"	12687	p /	10184	99.99	0.66	33	100	100	100
				d /	1898	99.99	0.08	99	100	100	100
				c	595	99.83	4.06	1	100	100	100
	gradation	#4	16014	p /	12216	99.26	1.57	14	100	99	100
				d /	2706	99.24	2.31	1	110	99	100
				c /	1082	99.33	1.23	92	100	99	100
	gradation	#16	16015	p /	12219	66.65	7.82	25	100	63	72
				d /	2707	66.45	8.47	16	98	61	72
				c /	1079	66.05	8.65	39	95	60	72
	gradation	#50	16013	p /	12218	18.10	4.19	4	70	15	20
				d /	2708	18.71	4.59	1	78	16	21
				c /	1077	18.80	5.09	4	45	16	22
	gradation	#100	16014	p /	12214	6.08	1.92	1	31	5	7
				d /	2710	6.32	2.58	1	92	5	7
				c /	1080	6.10	2.22	1	26	5	7
	gradation	#200	15980	p /	12204	22.43	12.09	.1	183	1.6	2.9
				d /	2690	23.75	11.81	.1	139	1.6	3.0
				c /	1077	24.53	12.11	.1	147	1.7	3.1
	sand equivalent		140	p /	41						
				d /	9						
				c /	90						

FREQUENCY BAR CHART



MIDPOINT GRA2	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
33.5	1	1	0.01	0.01
37.0	0	1	0.00	0.01
40.5	0	1	0.00	0.01
44.0	0	1	0.00	0.01
47.5	0	1	0.00	0.01
51.0	0	1	0.00	0.01
54.5	0	1	0.00	0.01
58.0	0	1	0.00	0.01
61.5	0	1	0.00	0.01
65.0	0	1	0.00	0.01
68.5	0	1	0.00	0.01
72.0	0	1	0.00	0.01
75.5	0	1	0.00	0.01
79.0	0	1	0.00	0.01
82.5	0	1	0.00	0.01
86.0	0	1	0.00	0.01
89.5	0	1	0.00	0.01
93.0	0	1	0.00	0.01
96.5	1	2	0.01	0.02
100.0	10182	10184	99.98	100.00

FREQUENCY BAR CHART

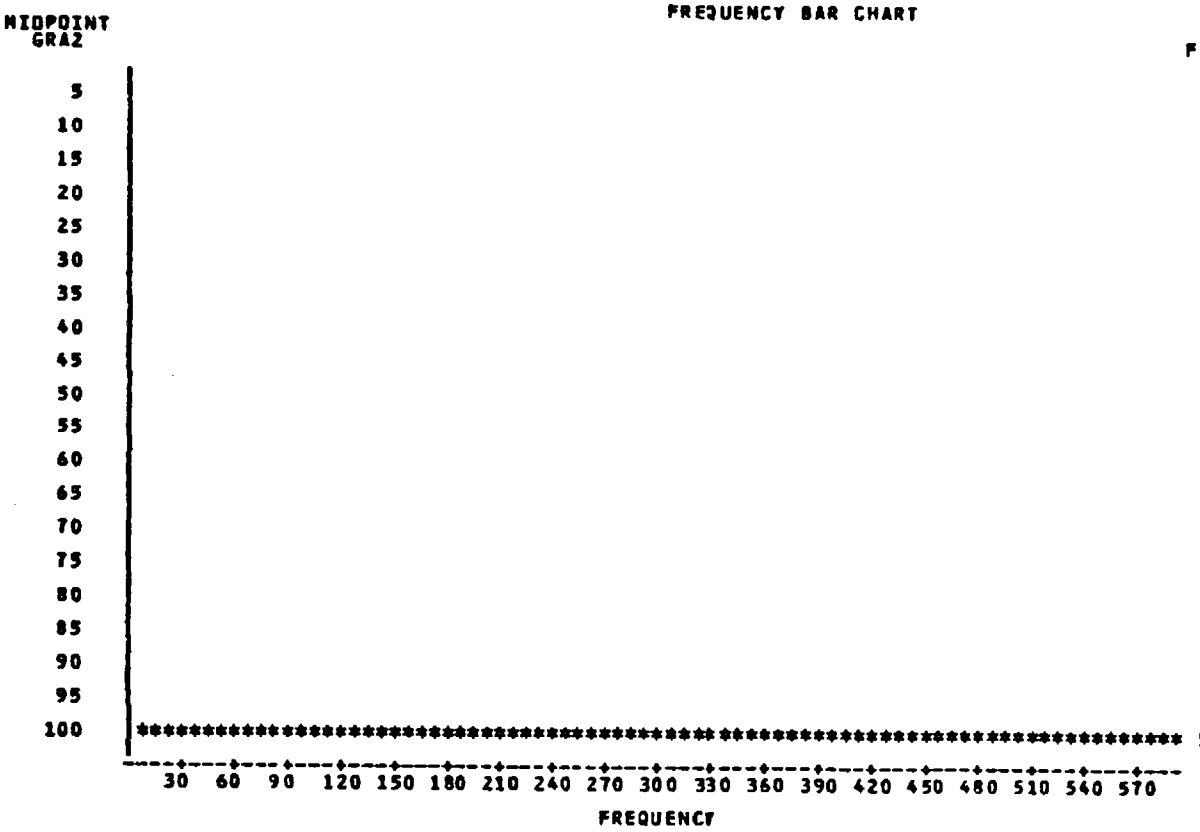


FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
11	11	0.58	0.58
0	11	0.00	0.58
0	11	0.00	0.58
0	11	0.00	0.58
0	11	0.00	0.58
0	11	0.00	0.58
0	11	0.00	0.58
0	11	0.00	0.58
0	11	0.00	0.58
0	11	0.00	0.58
0	11	0.00	0.58
0	11	0.00	0.58
0	11	0.00	0.58
0	11	0.00	0.58
0	11	0.00	0.58
0	11	0.00	0.58
0	11	0.00	0.58
0	11	0.00	0.58
0	11	0.00	0.58
1887	1898	99.42	100.00

FA

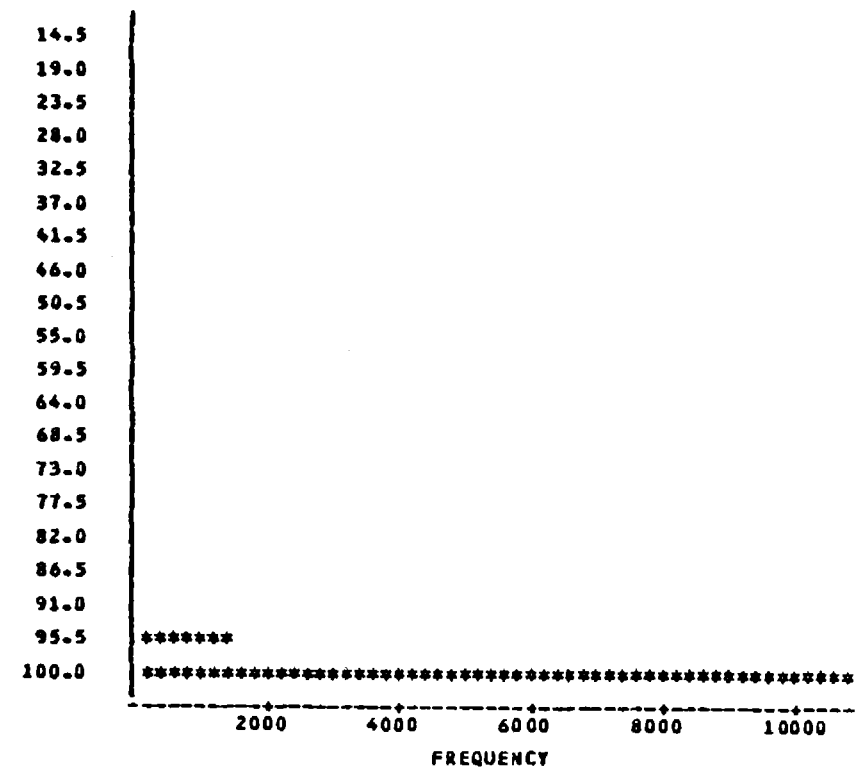
FREQ & CUMFREQ CHART MAT=FA LAB=C COL36-38 3/8IN 17:17 SUNDAY, MARCH 20, 1988 43

FREQUENCY BAR CHART



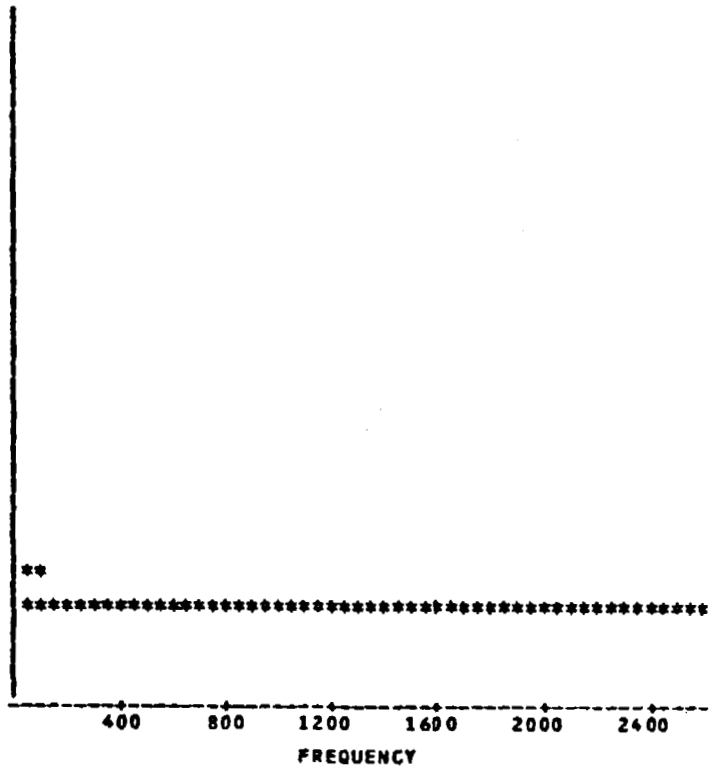
FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
1	1	0.17	0.17
0	1	0.00	0.17
0	1	0.00	0.17
0	1	0.00	0.17
0	1	0.00	0.17
0	1	0.00	0.17
0	1	0.00	0.17
0	1	0.00	0.17
0	1	0.00	0.17
0	1	0.00	0.17
0	1	0.00	0.17
0	1	0.00	0.17
0	1	0.00	0.17
0	1	0.00	0.17
0	1	0.00	0.17
0	1	0.00	0.17
0	1	0.00	0.17
0	1	0.00	0.17
0	1	0.00	0.17
594	595	99.83	100.00

FREQUENCY BAR CHART



FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
1	1	0.01	0.01
0	1	0.00	0.01
0	1	0.00	0.01
0	1	0.00	0.01
0	1	0.00	0.01
0	1	0.00	0.01
0	1	0.00	0.01
0	1	0.00	0.01
0	1	0.00	0.01
0	1	0.00	0.01
0	1	0.00	0.01
0	1	0.00	0.01
0	1	0.00	0.01
0	1	0.00	0.01
0	1	0.00	0.01
1	2	0.01	0.02
5	7	0.04	0.06
58	65	0.47	0.53
1348	1413	11.03	11.57
10803	12216	88.43	100.00

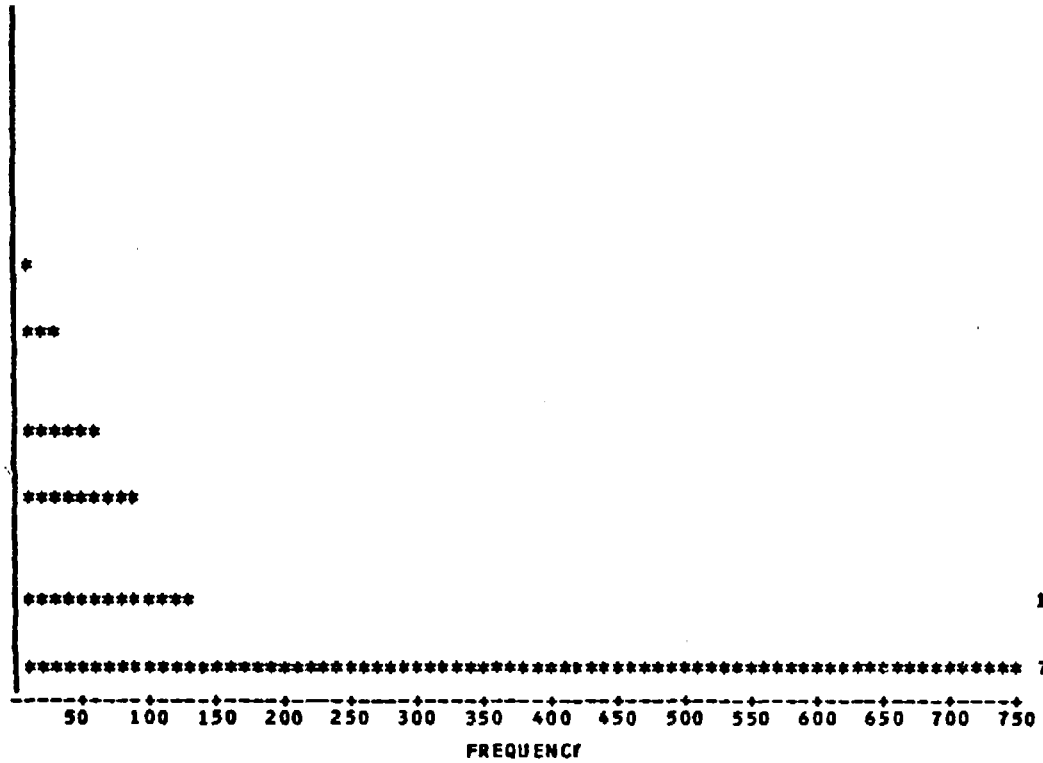
FREQUENCY BAR CHART



MIDPOINT GRA7	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
5.5	1	1	0.04	0.04
11.0	0	1	0.00	0.04
16.5	0	1	0.00	0.04
22.0	0	1	0.00	0.04
27.5	0	1	0.00	0.04
33.0	0	1	0.00	0.04
38.5	0	1	0.00	0.04
44.0	0	1	0.00	0.04
49.5	0	1	0.00	0.04
55.0	0	1	0.00	0.04
60.5	0	1	0.00	0.04
66.0	0	1	0.00	0.04
71.5	0	1	0.00	0.04
77.0	0	1	0.00	0.04
82.5	0	1	0.00	0.04
88.0	4	5	0.15	0.18
93.5	121	126	4.47	4.66
99.0	2579	2705	95.31	99.96
104.5	0	2705	0.00	99.96
110.0	1	2706	0.04	100.00

FREQ & CUMFREQ CHART MAT=FA LAB=C COL42-44 84 17:17 SUNDAY, MARCH 20, 1988 45

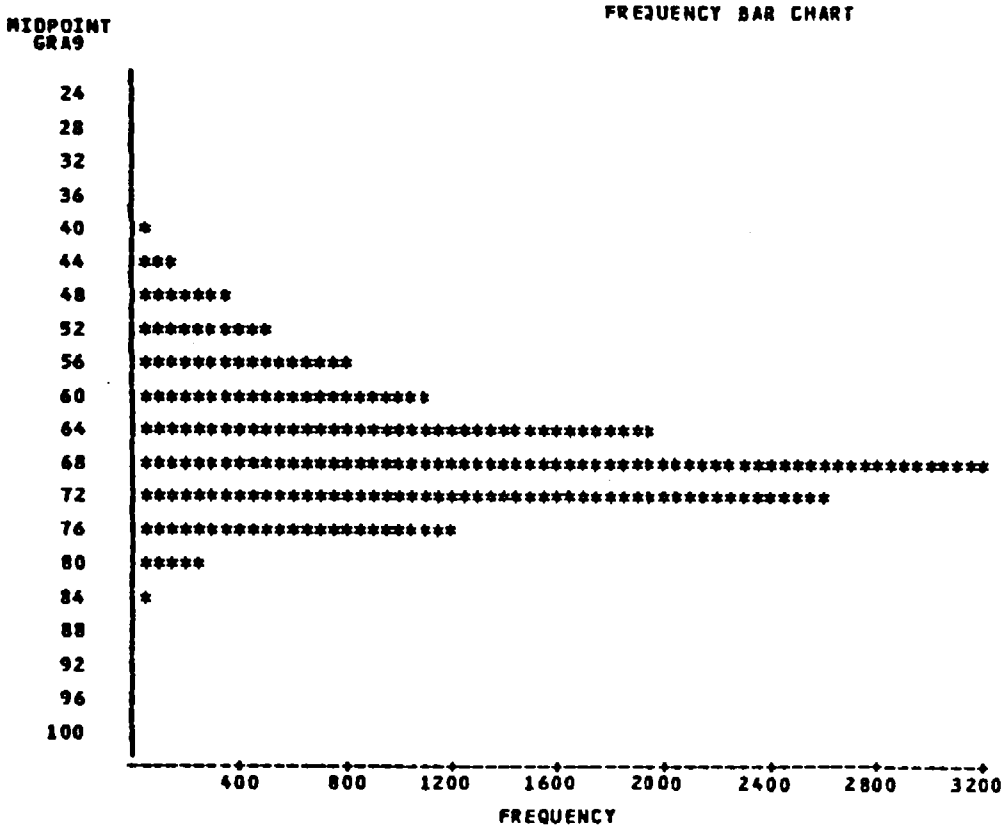
FREQUENCY BAR CHART



MIDPOINT GRAT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
92.4	1	1	0.09	0.09
92.8	0	1	0.00	0.09
93.2	2	3	0.18	0.28
93.6	0	3	0.00	0.28
94.0	3	6	0.28	0.55
94.4	0	6	0.00	0.55
94.8	0	6	0.00	0.55
95.2	11	17	1.02	1.57
95.6	0	17	0.00	1.57
96.0	33	50	3.05	4.62
96.4	0	50	0.00	4.62
96.8	0	50	0.00	4.62
97.2	63	113	5.82	10.44
97.6	0	113	0.00	10.44
98.0	87	200	8.04	18.48
98.4	0	200	0.00	18.48
98.8	0	200	0.00	18.48
99.2	134	334	12.38	30.87
99.6	0	334	0.00	30.87
100.0	748	1082	69.13	100.00

FREQ & CUMFREQ CHART MAT=FA LAB=P COL48-50 #16 17:17 SUNDAY, MARCH 20, 1988 11

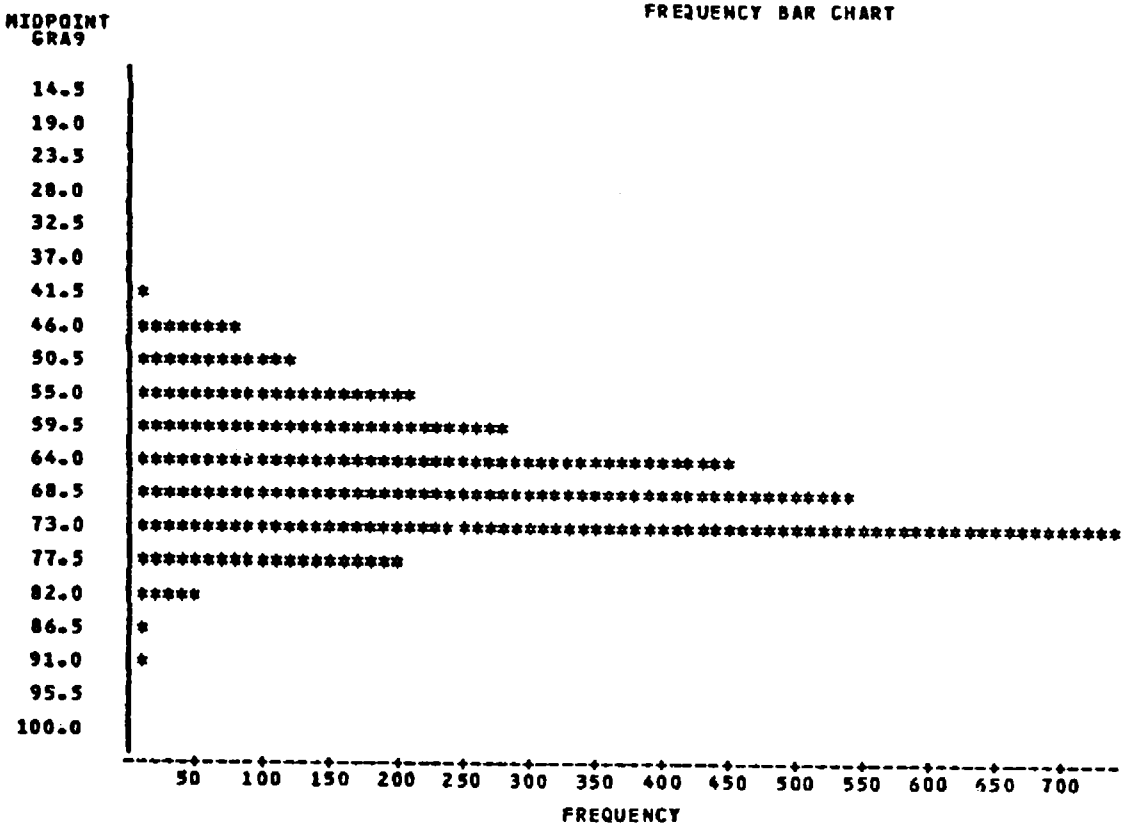
FREQUENCY BAR CHART



MIDPOINT GRA9	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
24	3	3	0.02	0.02
28	4	7	0.03	0.06
32	5	12	0.04	0.10
36	7	19	0.06	0.16
40	31	50	0.25	0.41
44	139	189	1.14	1.55
48	372	561	3.04	4.59
52	514	1075	4.21	8.80
56	806	1881	6.60	15.39
60	1098	2979	8.99	24.38
64	1945	4924	15.92	40.30
68	3185	8109	26.07	66.36
72	2595	10704	21.24	87.60
76	1183	11887	9.68	97.28
80	273	12160	2.23	99.52
84	33	12193	0.27	99.79
88	15	12208	0.12	99.91
92	6	12214	0.05	99.96
96	4	12218	0.03	99.99
100	1	12219	0.01	100.00

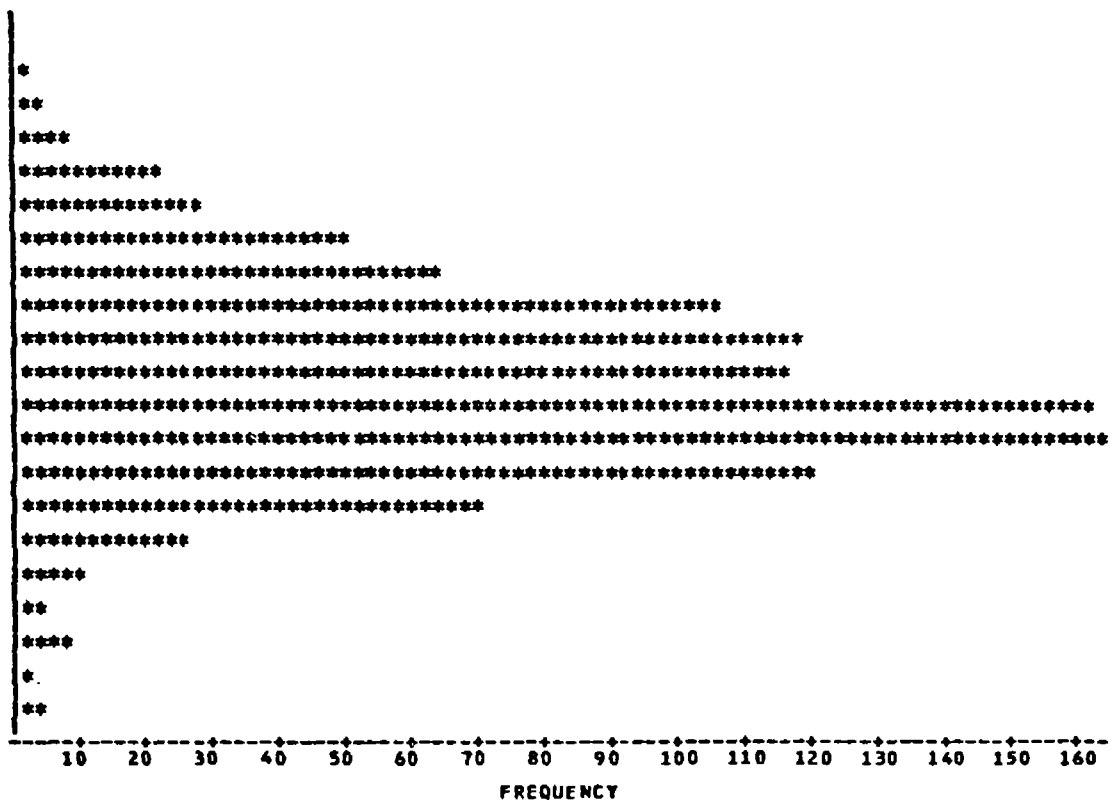
FREQ & CUMFREQ CHART MAT=FA LAB=D COL48-50 #16 17:17 SUNDAY, MARCH 20, 1988 29

FREQUENCY BAR CHART



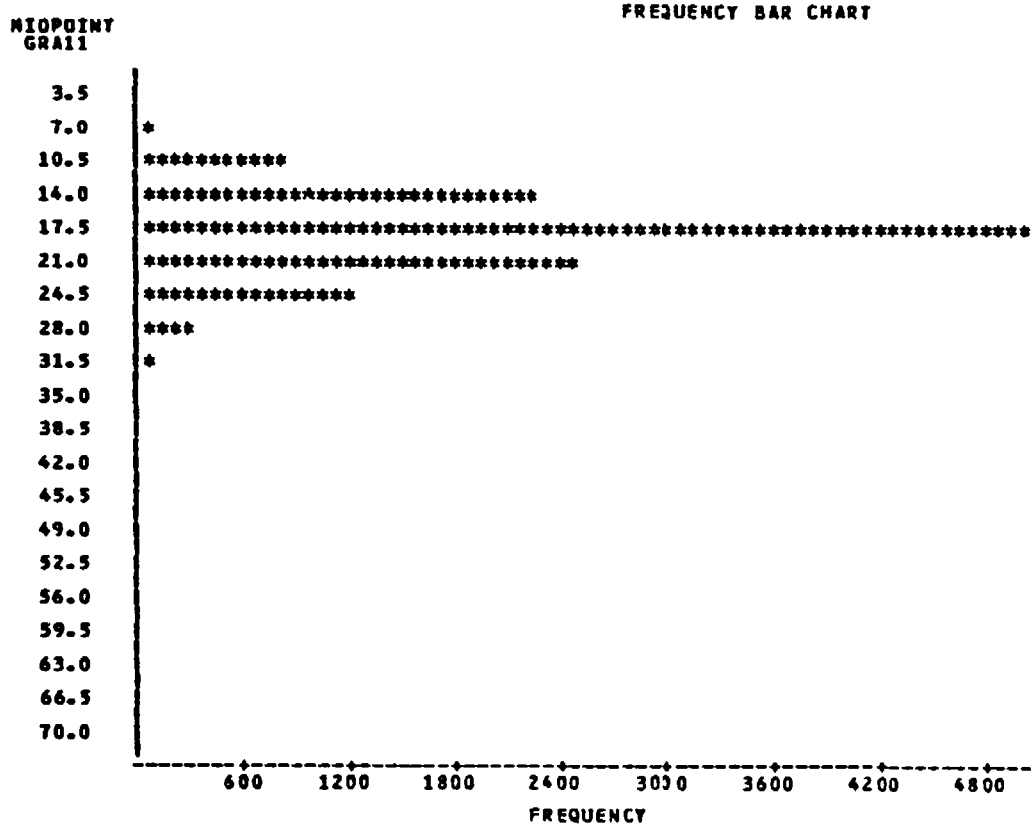
FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
1	1	0.04	0.04
0	1	0.00	0.04
0	1	0.00	0.04
1	2	0.04	0.07
1	3	0.04	0.11
1	4	0.04	0.15
10	14	0.37	0.52
83	97	3.07	3.58
115	212	4.25	7.83
213	425	7.87	15.70
276	701	10.20	25.90
454	1155	16.77	42.67
540	1695	19.95	62.62
743	2438	27.45	90.06
204	2642	7.54	97.60
46	2688	1.70	99.30
10	2698	0.37	99.67
5	2703	0.18	99.85
3	2706	0.11	99.96
1	2707	0.04	100.00

FREQUENCY BAR CHART



MIDPOINT GRA9	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
35	0	0	0.00	0.00
38	1	1	0.09	0.09
41	4	5	0.37	0.46
44	7	12	0.65	1.11
47	21	33	1.95	3.06
50	28	61	2.59	5.65
53	49	110	4.54	10.19
56	64	174	5.93	16.13
59	106	280	9.82	25.95
62	117	397	10.84	36.79
65	115	512	10.66	47.45
68	162	674	15.01	62.47
71	164	838	15.20	77.66
74	119	957	11.03	88.69
77	70	1027	6.49	95.18
80	25	1052	2.32	97.50
83	9	1061	0.83	98.33
86	4	1065	0.37	98.70
89	8	1073	0.74	99.44
92	2	1075	0.19	99.63
95	4	1079	0.37	100.00

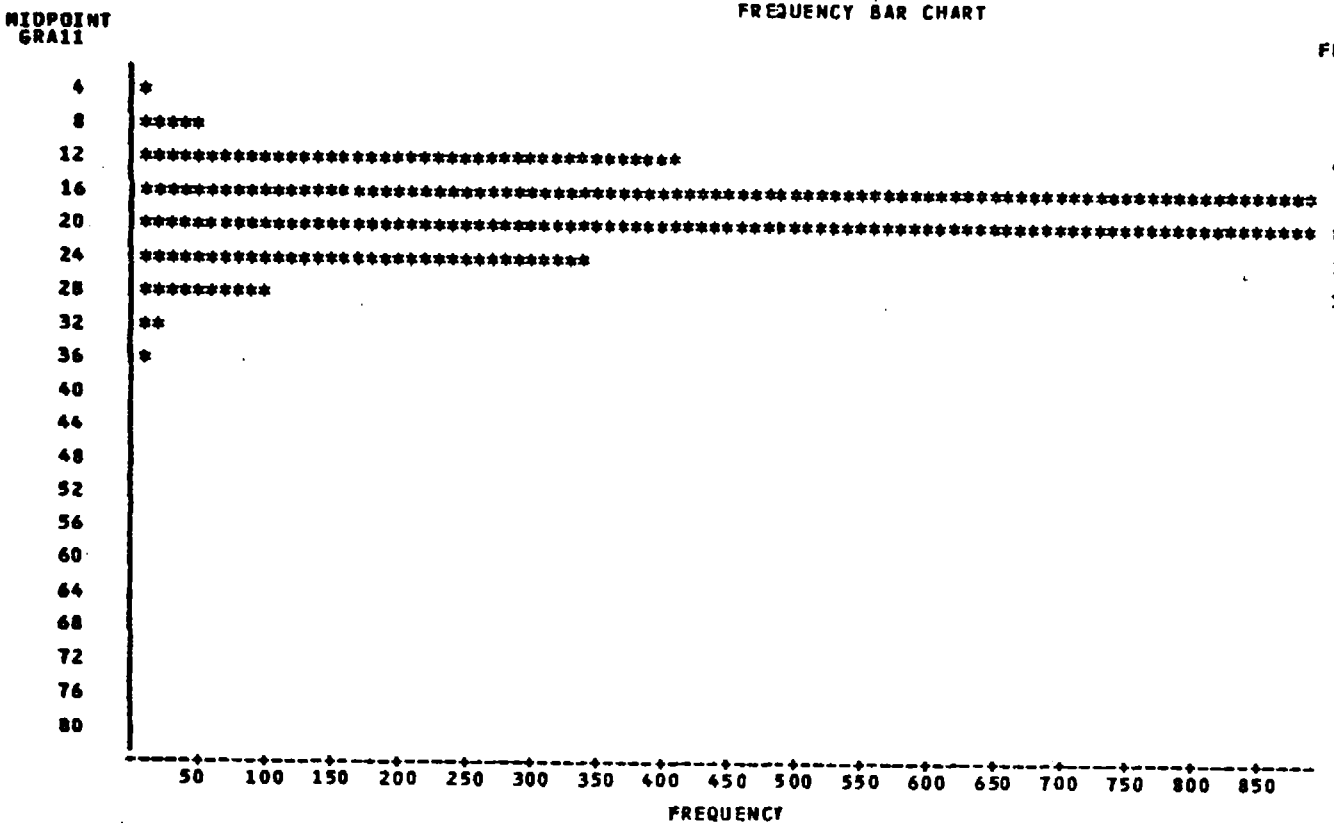
FREQUENCY BAR CHART



MIDPOINT GRAIN	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
3.5	8	8	0.07	0.07
7.0	55	63	0.45	0.52
10.5	825	888	6.75	7.27
14.0	2248	3136	18.40	25.67
17.5	5021	8157	41.10	66.76
21.0	2465	10622	20.18	86.94
24.5	1204	11826	9.85	96.79
28.0	289	12115	2.37	99.16
31.5	79	12194	0.65	99.80
35.0	9	12203	0.07	99.88
38.5	8	12211	0.07	99.94
42.0	1	12212	0.01	99.95
45.5	1	12213	0.01	99.96
49.0	1	12214	0.01	99.97
52.5	0	12214	0.00	99.97
56.0	0	12214	0.00	99.97
59.5	0	12214	0.00	99.97
63.0	2	12216	0.02	99.98
66.5	0	12216	0.00	99.98
70.0	2	12218	0.02	100.00

FREQ & CUMFREQ CHART MAT=FA LAB=D COL57-59 $50 17:17 SUNDAY, MARCH 20, 1988 31

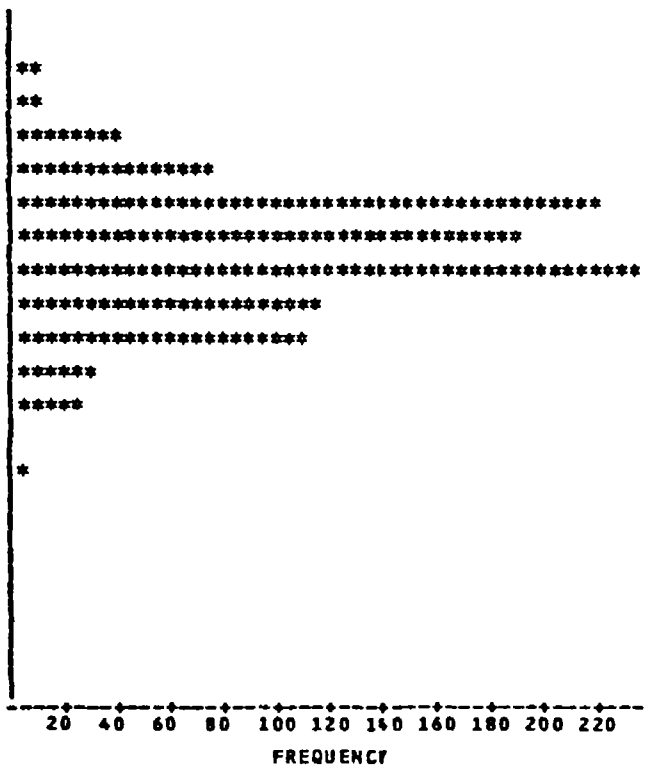
FREQUENCY BAR CHART



FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
6	6	0.22	0.22
49	55	1.81	2.03
412	467	15.21	17.25
885	1352	32.68	49.93
888	2240	32.79	82.72
338	2578	12.48	95.20
104	2682	3.84	99.04
15	2697	0.55	99.59
7	2704	0.26	99.85
2	2706	0.07	99.93
0	2706	0.00	99.93
1	2707	0.04	99.96
0	2707	0.00	99.96
0	2707	0.00	99.96
0	2707	0.00	99.96
0	2707	0.00	99.96
0	2707	0.00	99.96
0	2707	0.00	99.96
1	2708	0.04	100.00
0	2708	0.00	100.00

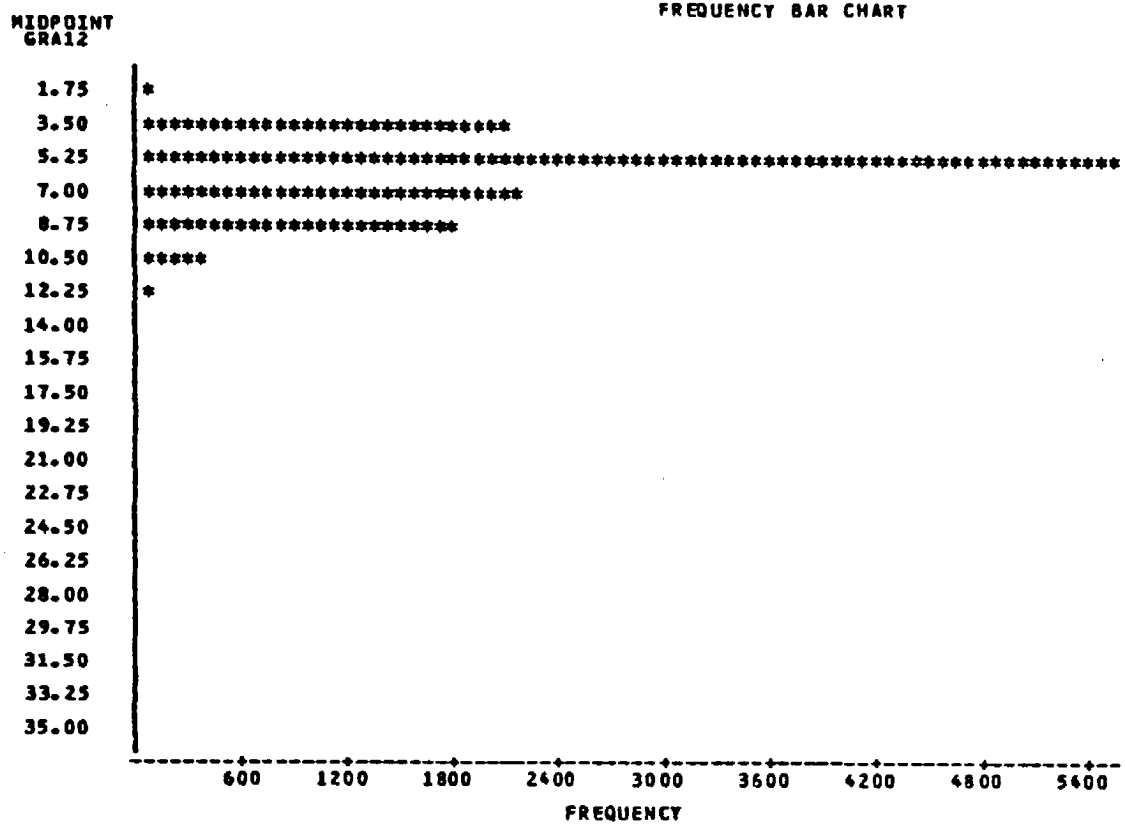
FREQ & CUMFREQ CHART MAT=FA LAB=C COL57-59 #50 17:17 SUNDAY, MARCH 20, 1988 49

FREQUENCY BAR CHART



MIDPOINT GRAIN	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
2.5	0	0	0.00	0.00
5.0	11	11	1.02	1.02
7.5	8	19	0.74	1.76
10.0	42	61	3.90	5.66
12.5	75	136	6.96	12.63
15.0	222	358	20.61	33.24
17.5	190	548	17.64	50.88
20.0	236	784	21.91	72.79
22.5	117	901	10.86	83.66
25.0	108	1009	10.03	93.69
27.5	32	1041	2.97	96.66
30.0	26	1067	2.41	99.07
32.5	1	1068	0.09	99.16
35.0	3	1071	0.28	99.44
37.5	2	1073	0.19	99.63
40.0	2	1075	0.19	99.81
42.5	1	1076	0.09	99.91
45.0	1	1077	0.09	100.00
47.5	0	1077	0.00	100.00
50.0	0	1077	0.00	100.00

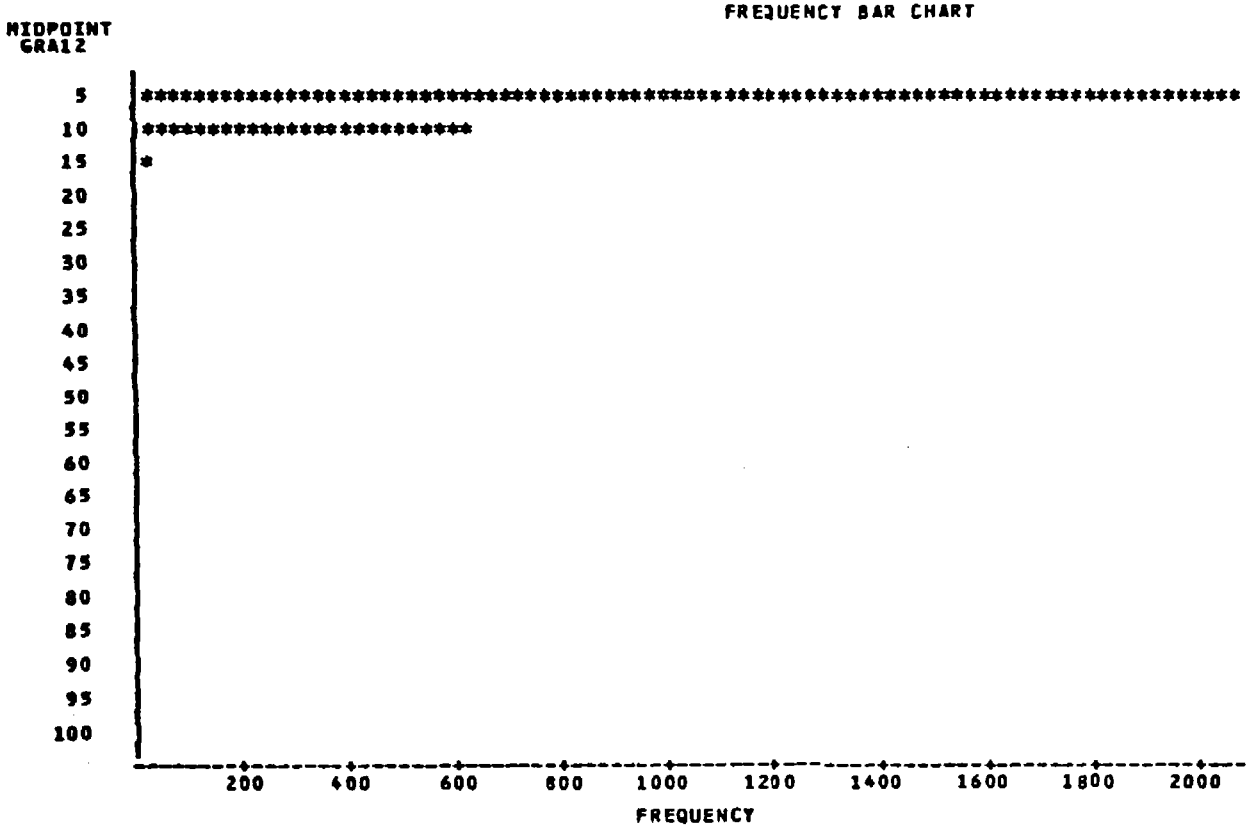
FREQUENCY BAR CHART



FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
102	102	0.84	0.84
2117	2219	17.33	18.17
5568	7787	45.59	63.75
2157	9944	17.66	81.41
1790	11734	14.66	96.07
351	12085	2.87	98.94
64	12149	0.52	99.47
16	12165	0.13	99.60
27	12192	0.22	99.82
10	12202	0.08	99.90
8	12210	0.07	99.97
1	12211	0.01	99.98
1	12212	0.01	99.98
0	12212	0.00	99.98
1	12213	0.01	99.99
0	12213	0.00	99.99
0	12213	0.00	99.99
1	12214	0.01	100.00
0	12214	0.00	100.00
0	12214	0.00	100.00

FREQ & CUMFREQ CHART MAT=FA LAB=D COL60-62 #100 17:17 SUNDAY, MARCH 20, 1988 33

FREQUENCY BAR CHART



MIDPOINT GRA12	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
5	2075	2075	76.57	76.57
10	615	2690	22.69	99.26
15	14	2704	0.52	99.78
20	5	2709	0.18	99.96
25	0	2709	0.00	99.96
30	0	2709	0.00	99.96
35	0	2709	0.00	99.96
40	0	2709	0.00	99.96
45	0	2709	0.00	99.96
50	0	2709	0.00	99.96
55	0	2709	0.00	99.96
60	0	2709	0.00	99.96
65	0	2709	0.00	99.96
70	0	2709	0.00	99.96
75	0	2709	0.00	99.96
80	0	2709	0.00	99.96
85	0	2709	0.00	99.96
90	1	2710	0.04	100.00
95	0	2710	0.00	100.00
100	0	2710	0.00	100.00

FREQUENCY BAR CHART

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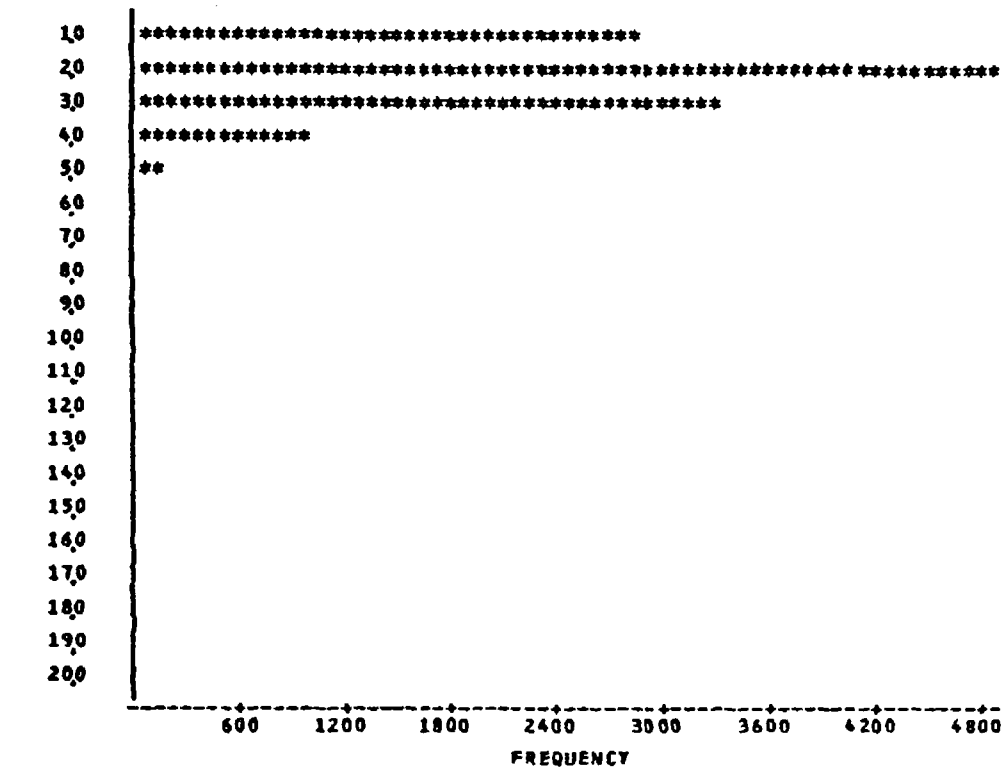
MIDPOINT
 GRA12
  1.5  |******                                                                  32    32    2.96    2.96
  3.0  |***********                                                             57    89    5.28    8.24
  4.5  |*************************************************************************348   437   32.22   40.46
  6.0  |*************************************************                       246   683   22.78   63.24
  7.5  |*****************************************************                   272   955   25.19   88.43
  9.0  |*************                                                            63  1018    5.83   94.26
 10.5  |**********                                                               48  1066    4.44   98.70
 12.0  |*                                                                         3  1069    0.28   98.98
 13.5  |*                                                                         6  1075    0.56   99.54
 15.0  |                                                                          0  1075    0.00   99.54
 16.5  |                                                                          2  1077    0.19   99.72
 18.0  |                                                                          0  1077    0.00   99.72
 19.5  |                                                                          2  1079    0.19   99.91
 21.0  |                                                                          0  1079    0.00   99.91
 22.5  |                                                                          0  1079    0.00   99.91
 24.0  |                                                                          0  1079    0.00   99.91
 25.5  |                                                                          1  1080    0.09  100.00
 27.0  |                                                                          0  1080    0.00  100.00
 28.5  |                                                                          0  1080    0.00  100.00
 30.0  |                                                                          0  1080    0.00  100.00
       |-----+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
         20  40  60  80 100 120 140 160 180 200 220 240 260 280 300 320 340
                                  FREQUENCY
```

FREQ & CUMFREQ CHART MAT=FA LAB=P COL63-65 #200 17:17 SUNDAY, MARCH 20, 1988 17

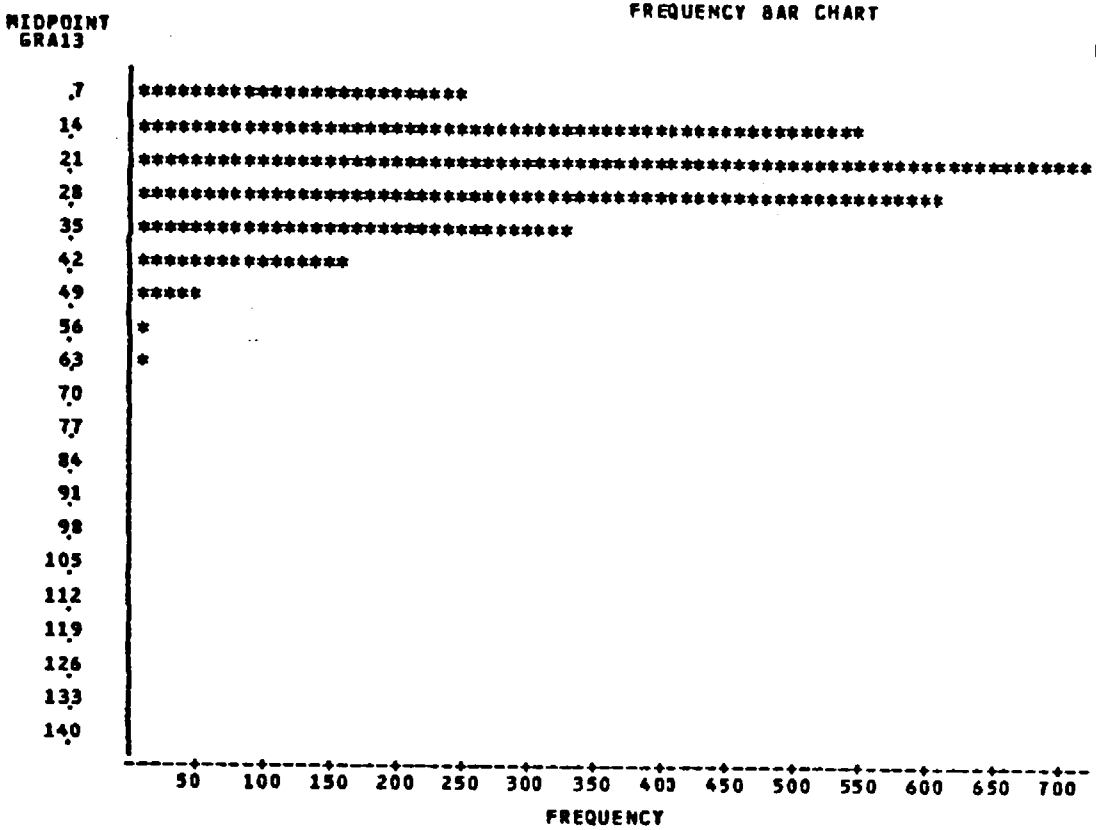
FREQUENCY BAR CHART



	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
1.0	2879	2879	23.59	23.59
2.0	4845	7724	39.70	63.29
3.0	3295	11019	27.00	90.29
4.0	942	11961	7.72	98.01
5.0	145	12106	1.19	99.20
6.0	26	12132	0.21	99.41
7.0	12	12144	0.10	99.51
8.0	9	12153	0.07	99.58
9.0	9	12162	0.07	99.66
10.0	12	12174	0.10	99.75
11.0	14	12188	0.11	99.87
12.0	9	12197	0.07	99.94
13.0	3	12200	0.02	99.97
14.0	2	12202	0.02	99.98
15.0	0	12202	0.00	99.98
16.0	0	12202	0.00	99.98
17.0	0	12202	0.00	99.98
18.0	2	12204	0.02	100.00
19.0	0	12204	0.00	100.00
20.0	0	12204	0.00	100.00

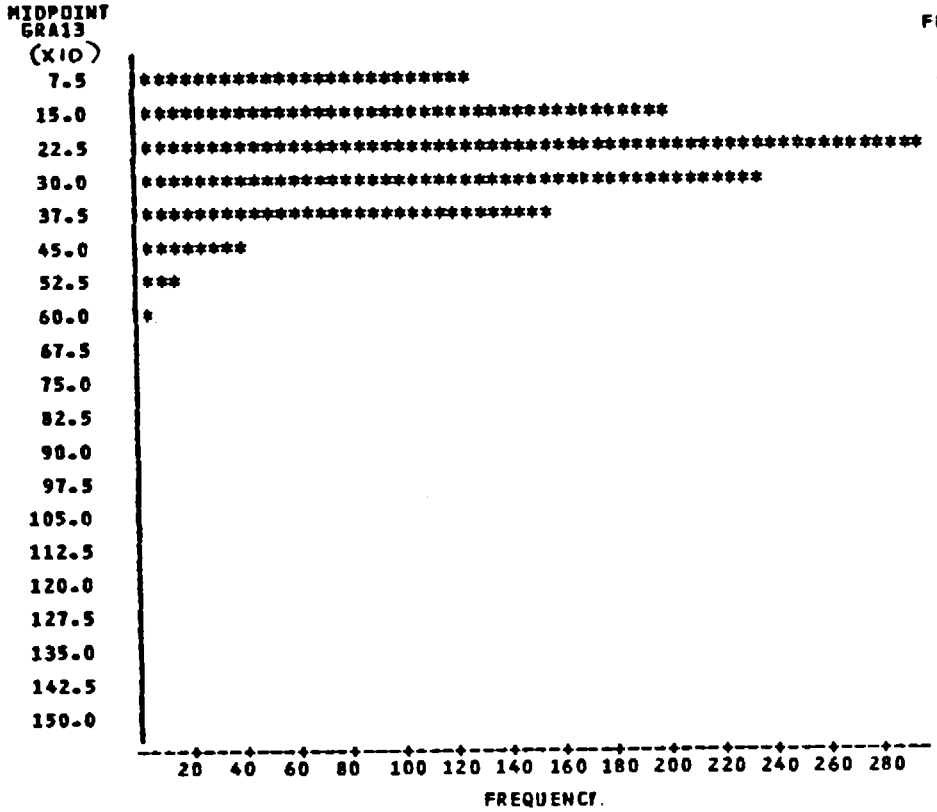
FREQ & CUMFREQ CHART MAT=FA LAB=D COL63-65 #200 17:17 SUNDAY, MARCH 20, 1988 35

FREQUENCY BAR CHART



FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
252	252	9.37	9.37
550	802	20.45	29.81
715	1517	26.58	56.39
614	2131	22.83	79.22
328	2459	12.19	91.41
156	2615	5.80	97.21
47	2662	1.75	98.96
7	2669	0.26	99.22
8	2677	0.30	99.52
0	2677	0.00	99.52
2	2679	0.07	99.59
0	2679	0.00	99.59
3	2682	0.11	99.70
3	2685	0.11	99.81
1	2686	0.04	99.85
0	2686	0.00	99.85
3	2689	0.11	99.96
0	2689	0.00	99.96
0	2689	0.00	99.96
1	2690	0.04	100.00

FREQUENCY BAR CHART



FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
127	127	11.79	11.79
200	327	18.57	30.36
296	623	27.48	57.85
233	856	21.63	79.48
156	1012	14.48	93.96
40	1052	3.71	97.68
15	1067	1.39	99.07
6	1073	0.56	99.63
1	1074	0.09	99.72
0	1074	0.00	99.72
0	1074	0.00	99.72
1	1075	0.09	99.81
0	1075	0.00	99.81
1	1076	0.09	99.91
0	1076	0.00	99.91
0	1076	0.00	99.91
0	1076	0.00	99.91
0	1076	0.00	99.91
0	1076	0.00	99.91
1	1077	0.09	100.00

Material	mtl. code	tests col 1,2	value	column.	no. of obs.	lab p	lab d	lab c	lab Δ	pur P	pur D

X.

coarse agg. pcc p,s,b,u — CA — gradation — m43 — column number ?

Material	mtl. code	tests col 1,2	value	column.	no. of obs.	strength 5	strength 6	strength 7	strength 8	Day 7	Day 28

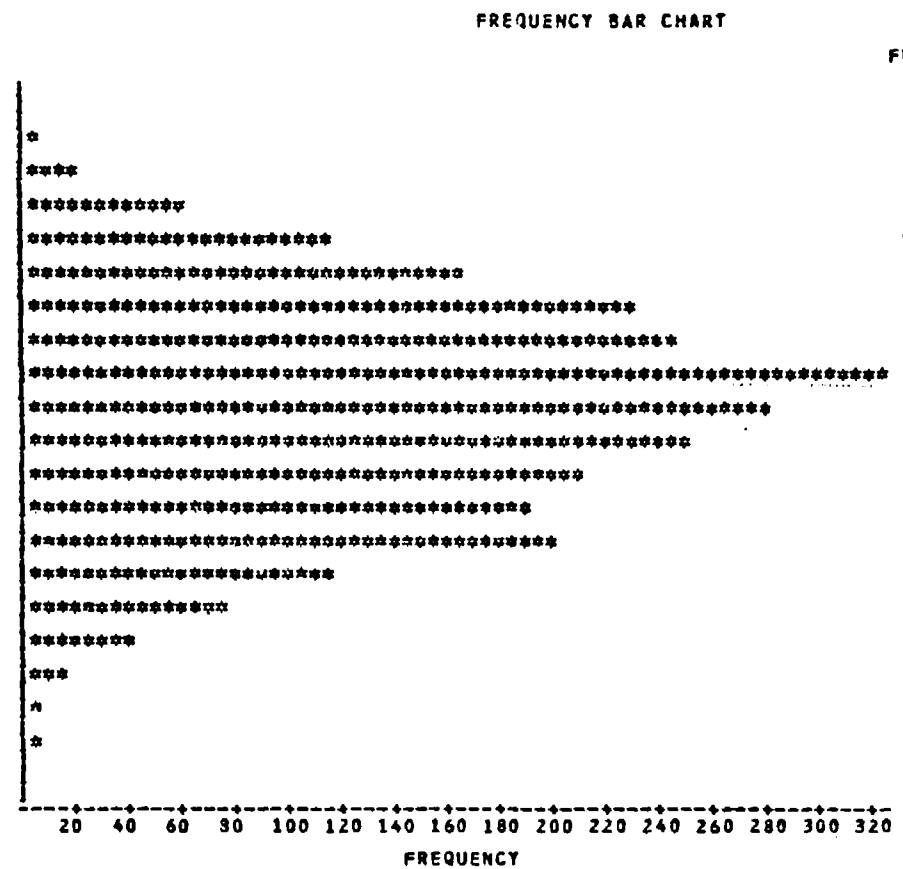
Y.

PCC pavement	comp. str. 28	K6	69-73	no record for pavement
	slump	K4	39-41	
	entrained air	K4	21-23	

Material	mtl. code	tests col 1,2	value	column.	no. of obs.	strn 5	6	7	8	day 7	28
Z.											
PCC Struc.		comp. str.	K6	69-73	5017	2546	177	113	2181	1	5016
		slump	K4	39-41	2914	1424	124	76	1290		
		entrained air	K4	21-23	1506	752	89	39	626		

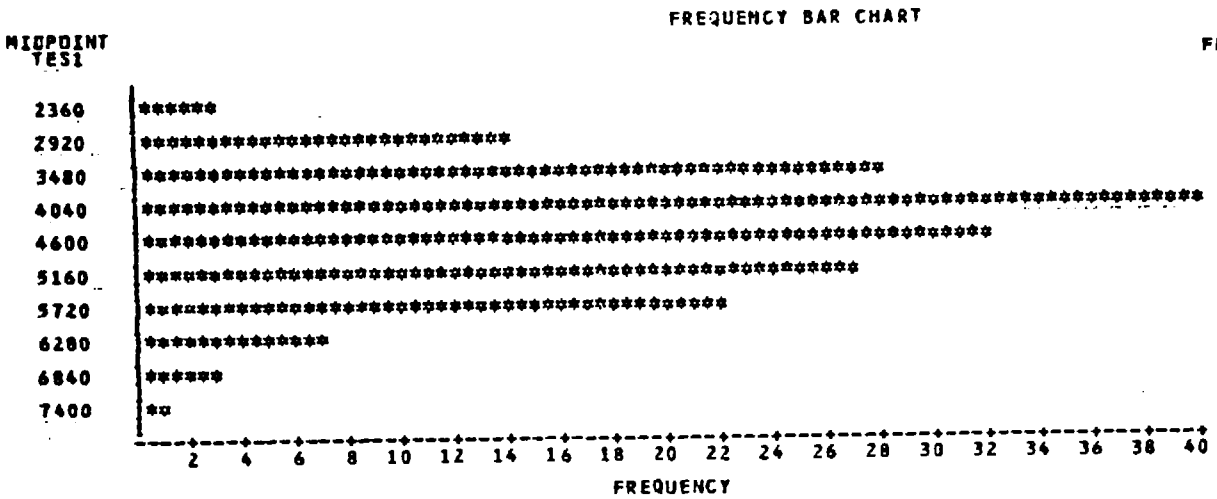
Mat.	test	total	str/day	#	mean	std	min	max	25%	75%
Z.										
PCC Stru.	comp. str.	5017	5/7	1						
	(test1 34-38)		5/28	2545	4107.84	1006.82	1397	7430	3384	4875
			6/28	177	4467.82	984.80	1950	7395	3715	5150
			7/28	113	4488.09	950.12	2060	6650	3826	5077
			8/28	2181	5023.19	908.61	2060	7430	4341	5670
	(test2 52-56)		5/28	2545	4111.10	1001.21	1392	7360	3385	4857
			6/28	177	4487.13	984.23	2328	6954	3715	5211
			7/28	113	4459.56	927.79	2060	6580	3790	5040
			8/28	2181	5023.24	915.19	2060	7500	4340	5690
	slump	2914	5/	1424	3.48.38	.88 90	.25	8.00	3.00	4.00
			6/	124	3.55.85	1.01.57	1.50	8.00	3.00	4.25
			7/	76						
			8/	1290	3.64.23	.69 95	.40	6.50	3.00	4.00
	entrained air	1506	5/	752	4.4 43	1.3.36	.6	8.8	4.0	5.2
			6/	89						
			7/	39						
			8/	626	4.2 47	1.0 24	.9	10.0	3.5	5.0

FREQUENCY BAR CHART



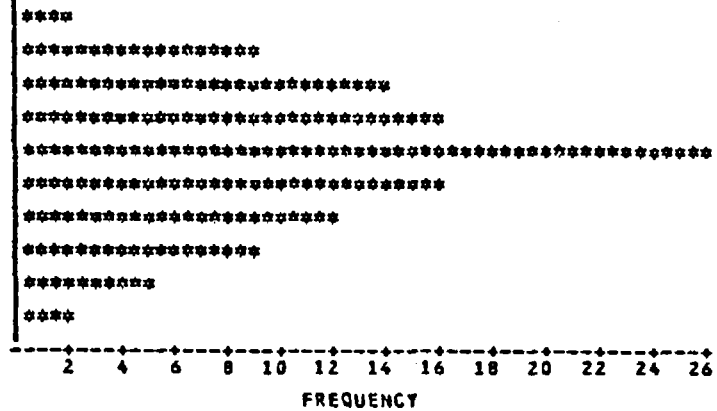
MIDPOINT TES1	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
1330	2	2	0.08	0.08
1635	6	8	0.24	0.31
1940	21	29	0.83	1.14
2245	59	88	2.32	3.46
2550	114	202	4.48	7.94
2855	163	365	6.40	14.34
3160	232	597	9.12	23.46
3465	244	841	9.59	33.05
3770	323	1164	12.69	45.74
4075	278	1442	10.92	56.66
4380	252	1694	9.90	66.56
4685	209	1903	8.21	74.77
4990	189	2092	7.43	82.20
5295	199	2291	7.82	90.02
5600	115	2406	4.52	94.54
5905	73	2479	2.87	97.41
6210	41	2520	1.61	99.02
6515	15	2535	0.59	99.61
6820	3	2538	0.12	99.72
7125	5	2543	0.20	99.92
7430	2	2545	0.08	100.00

FREQUENCY BAR CHART



FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
3	3	1.69	1.69
14	17	7.91	9.60
28	45	15.82	25.42
40	85	22.60	48.02
32	117	18.08	66.10
27	144	15.25	81.36
22	166	12.43	93.79
7	173	3.95	97.74
3	176	1.69	99.44
1	177	0.56	100.00

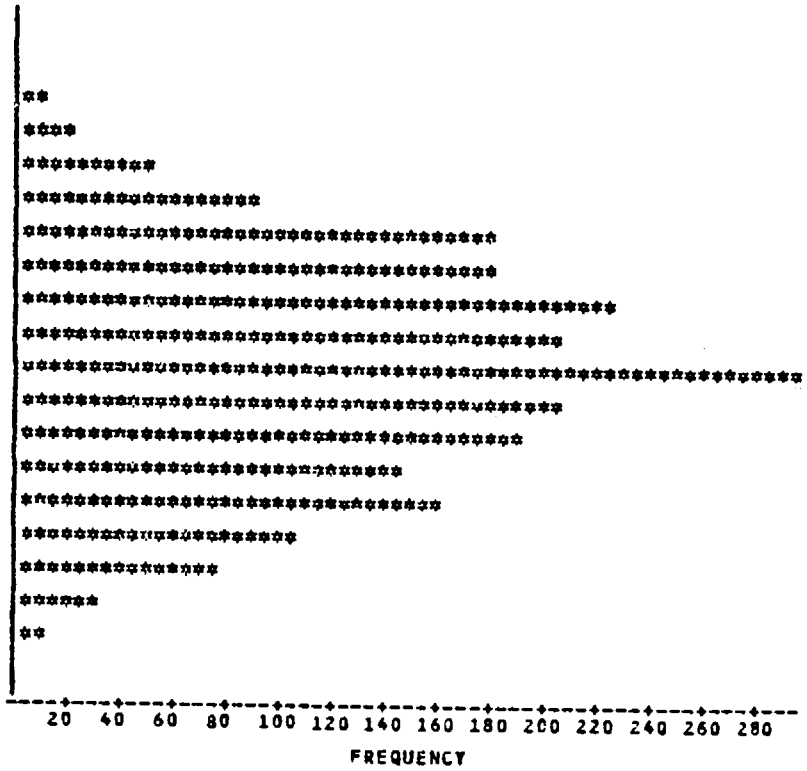
FREQUENCY BAR CHART



MIDPOINT TES1	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
2200	2	2	1.77	1.77
2650	2	4	1.77	3.54
3100	9	13	7.96	11.50
3550	14	27	12.39	23.89
4000	16	43	14.16	38.05
4450	26	69	23.01	61.06
4900	16	85	14.16	75.22
5350	12	97	10.62	85.84
5800	9	106	7.96	93.81
6250	5	111	4.42	98.23
6700	2	113	1.77	100.00

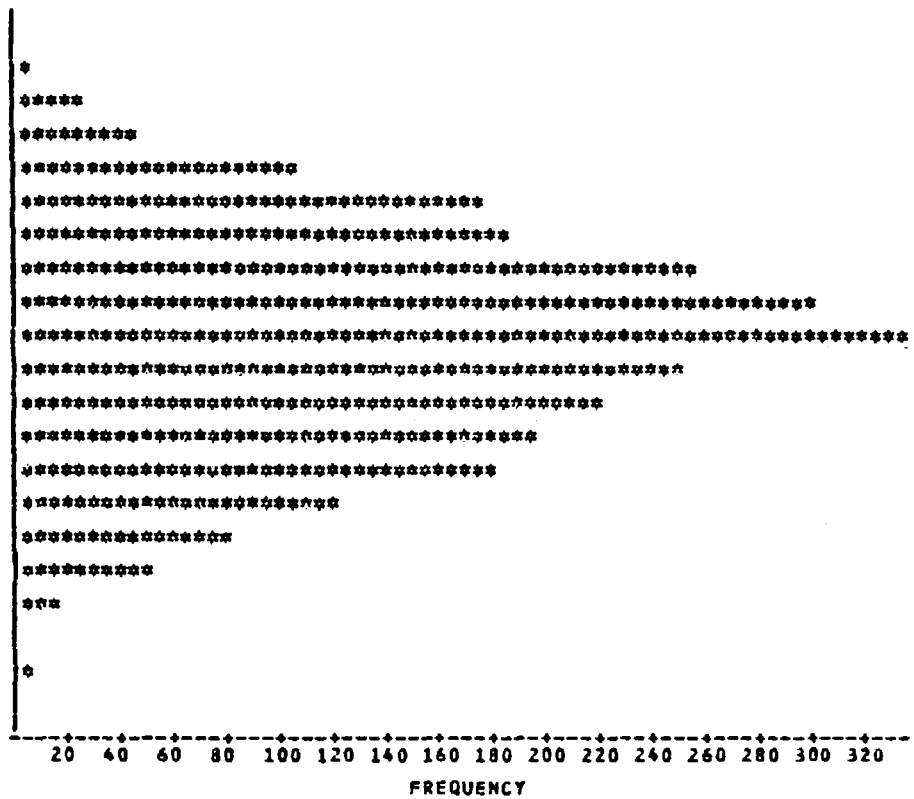
FREQ AND CUMFREQ CHART FOR K4 CLASS=S STR=7 TES1 280 18:51 TUESDAY, MARCH 22, 1988 13

FREQUENCY BAR CHART



FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
2	2	0.09	0.09
0	2	0.00	0.09
11	13	0.50	0.60
20	33	0.92	1.51
49	82	2.25	3.76
89	171	4.08	7.84
179	350	8.21	16.05
181	531	8.30	24.35
227	758	10.41	34.75
207	965	9.49	44.25
296	1261	13.57	57.82
203	1464	9.31	67.13
192	1656	8.80	75.93
143	1799	6.56	82.49
162	1961	7.43	89.91
104	2065	4.77	94.68
77	2142	3.53	98.21
28	2170	1.28	99.50
9	2179	0.41	99.91
2	2181	0.09	100.00

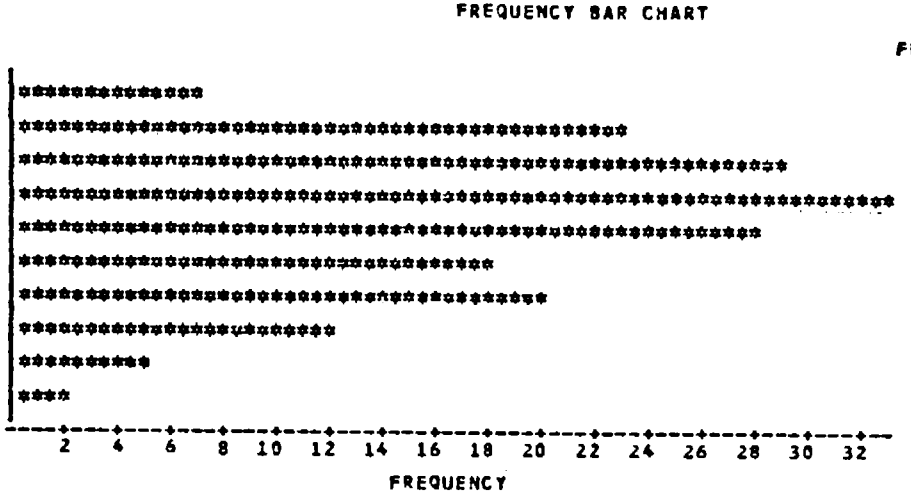
FREQUENCY BAR CHART



MIDPOINT TES2	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
1300	2	2	0.08	0.08
1605	4	6	0.16	0.24
1910	24	30	0.94	1.18
2215	46	76	1.81	2.99
2520	106	182	4.17	7.15
2825	174	356	6.84	13.99
3130	183	539	7.19	21.18
3435	254	793	9.98	31.16
3740	299	1092	11.75	42.91
4045	333	1425	13.08	55.99
4350	250	1675	9.82	65.82
4655	218	1893	8.57	74.38
4960	197	2090	7.74	82.12
5265	179	2269	7.03	89.16
5570	122	2391	4.79	93.95
5875	78	2469	3.06	97.01
6180	51	2520	2.00	99.02
6485	17	2537	0.67	99.69
6790	2	2539	0.08	99.76
7095	4	2543	0.16	99.92
7400	2	2545	0.08	100.00

FREQ AND CUMFREQ CHART FOR K4 CLASS=S STR=6 TES2 28D 18:51 TUESDAY, MARCH 22, 1988 21

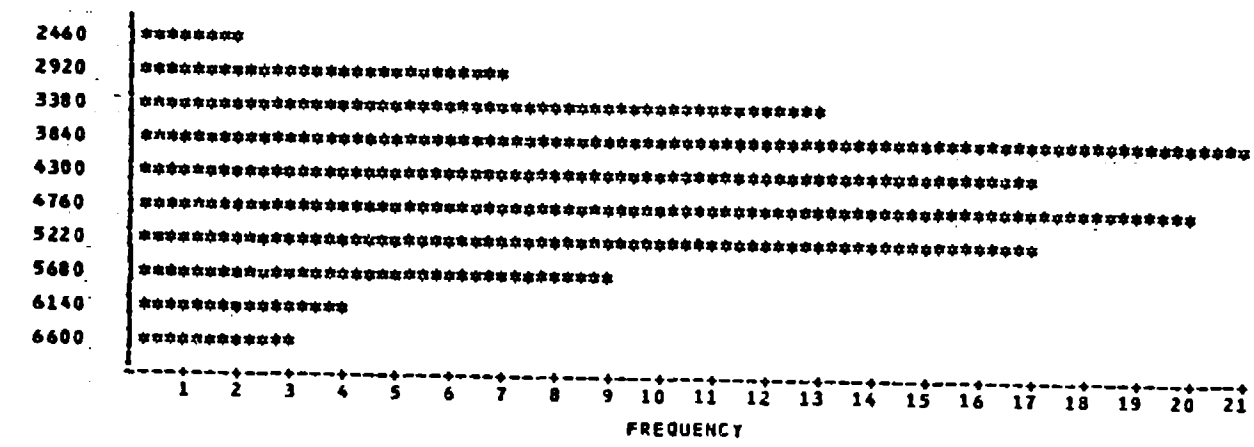
FREQUENCY BAR CHART



MIDPOINT TES2	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
2770	7	7	3.95	3.95
3240	23	30	12.99	16.95
3710	29	59	16.38	33.33
4180	33	92	18.64	51.98
4650	28	120	15.82	67.80
5120	18	138	10.17	77.97
5590	20	158	11.30	89.27
6060	12	170	6.78	96.05
6530	5	175	2.82	98.87
7000	2	177	1.13	100.00

FREQ AND CUMFREQ CHART FOR K4 CLASS=S STR=7 TES2 28D 18:51 TUESDAY, MARCH 22, 1988 23

FREQUENCY BAR CHART

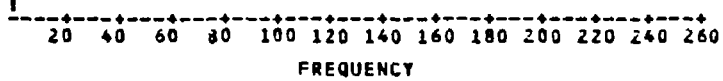


FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
2	2	1.77	1.77
7	9	6.19	7.96
13	22	11.50	19.47
21	43	18.58	38.05
17	60	15.04	53.10
20	80	17.70	70.80
17	97	15.04	85.84
9	106	7.96	93.81
4	110	3.54	97.35
3	113	2.65	100.00

FREQ AND CUMFREQ CHART FOR K4 CLASS=S STR=8 TES2 28D 18:51 TUESDAY, MARCH 22, 1988 25

FREQUENCY BAR CHART

MIDPOINT TES2	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
2275	3	3	0.14	0.14
2550	3	6	0.14	0.28
2825	14	20	0.64	0.92
3100	23	43	1.05	1.97
3375	43	86	1.97	3.94
3650	97	183	4.45	8.39
3925	160	343	7.34	15.73
4200	190	533	8.71	24.44
4475	214	747	9.81	34.25
4750	251	998	11.51	45.76
5025	262	1260	12.01	57.77
5300	199	1459	9.12	66.90
5575	187	1646	8.57	75.47
5850	153	1799	7.02	82.49
6125	153	1952	7.02	89.50
6400	114	2066	5.23	94.73
6675	84	2150	3.85	98.58
6950	19	2169	0.87	99.45
7225	11	2180	0.50	99.95
7500	1	2181	0.05	100.00

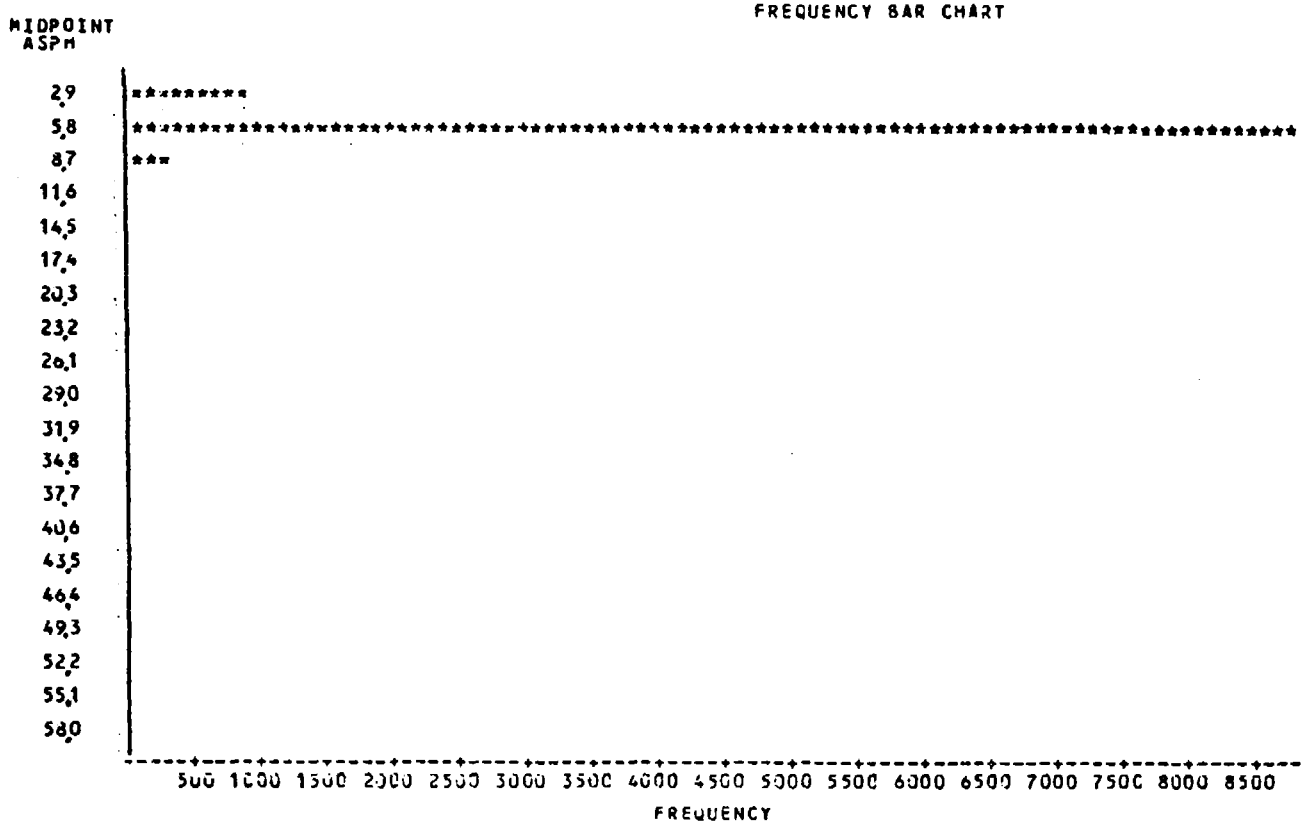


Material	mtl. code	tests col 1,2	value	column.	no. of obs.	p	lab d	lab c	Δ
A.5.									
asphalt concrete	AC	asph content	M2	68-70	14582	10021	3186	1354	21
materials		gradation 3/8"	M2	36-38	16085	11074	3596	1384	31
gradation		gradation #8	M2	45-47	16170	11157	3609	1373	31
tabulation		gradation #40	M2	54-56	14399	9875	3286	1207	31
		gradation #200	M2	63-65	15744	10783	3605	1325	31

Mat.	test	total	lab/pur	#	mean	std	min	max	25%	75%
A.5.										
AC	asph content	14582	p /	10021	5.2.52	1.6.24	.4	57.1	4.7	5.4
			d /	3186	5.1.49	.9 65	.2	13.5	4.7	5.4
			c /	1354	5.2.66	.9 90	.7	13.7	4.7	5.6
	gradation 3/8"	16085	p /	11074	64.70	13.40	2	100	60	73
			d /	3596	67.80	11.88	21	100	63	74
			c /	1384	69.19	11.32	26	100	63	75
	gradation #8	16170	p /	11157	42.41	8.63	1	129	38	47
			d /	3609	41.46	9.44	4	122	37	46
			c /	1373	41.67	9.10	2	110	37	46
	gradation #40	14399	p /	9875	67.75	132.19	1	996	14	23
			d /	3286	44.20	102.78	1	997	15	22
			c /	1207	17.74	4.25	2	35	15	20
	gradation #200	15744	p /	10783	8.5.13	16.9 20	.1	91.6	1.8	5.7
			d /	3605	6.3 38	11.1 96	.1	91.5	3.3	5.8
			c /	1325	4.3.70	2.0 80	.1	16.9	3.4	5.6

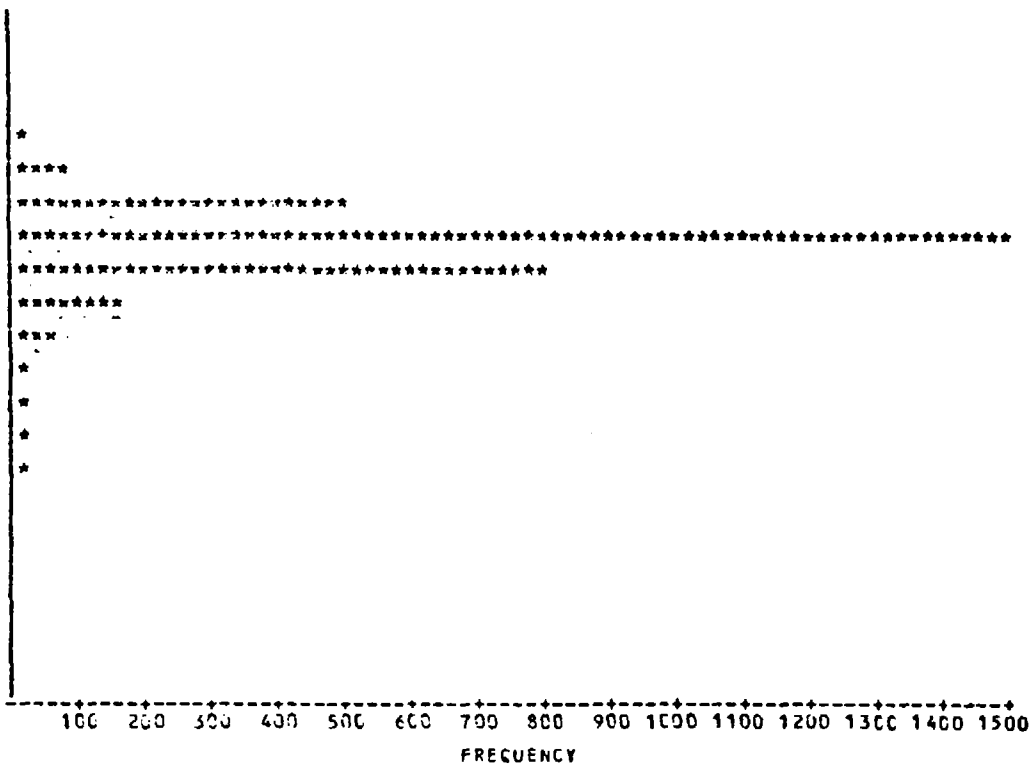
MAT=AC MATERIAL CARD LAB=P COL68-70 ASPH 13:12 MONDAY, MARCH 27, 1988 15

FREQUENCY BAR CHART



MIDPOINT ASPH	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
2.9	893	893	8.91	8.91
5.8	8767	9660	87.49	96.40
8.7	292	9952	2.91	99.31
11.6	45	9997	0.45	99.76
14.5	17	10014	0.17	99.93
17.4	0	10014	0.00	99.93
20.3	0	10014	0.00	99.93
23.2	0	10014	0.00	99.93
26.1	0	10014	0.00	99.93
29.0	0	10014	0.00	99.93
31.9	0	10014	0.00	99.93
34.8	0	10014	0.00	99.93
37.7	0	10014	0.00	99.93
40.6	0	10014	0.00	99.93
43.5	0	10014	0.00	99.93
46.4	1	10015	0.01	99.94
49.3	1	10016	0.01	99.95
52.2	1	10017	0.01	99.96
55.1	1	10018	0.01	99.97
58.0	3	10021	0.03	100.00

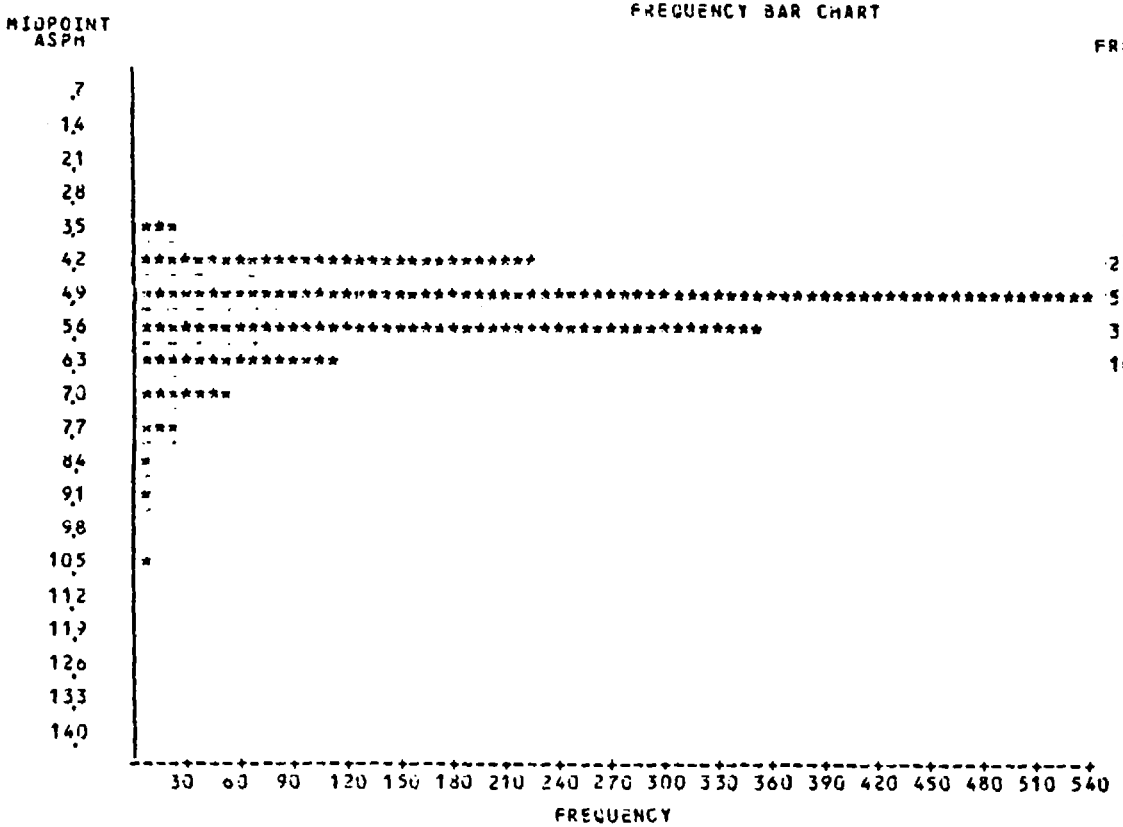
FREQUENCY BAR CHART



MIDPOINT ASPH	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
.7	2	2	0.06	0.06
1.4	0	2	0.00	0.06
2.1	0	2	0.00	0.06
2.8	13	15	0.41	0.47
3.5	71	86	2.23	2.70
4.2	502	588	15.76	18.46
4.9	1496	2084	46.96	65.41
5.6	796	2880	24.98	90.40
6.3	164	3044	5.15	95.54
7.0	57	3101	1.79	97.33
7.7	11	3112	0.35	97.68
8.4	27	3139	0.85	98.52
9.1	14	3153	0.44	98.96
9.8	14	3167	0.44	99.40
10.5	8	3175	0.25	99.65
11.2	5	3180	0.16	99.81
11.9	2	3182	0.06	99.87
12.6	0	3182	0.00	99.87
13.3	4	3186	0.13	100.00
14.0	0	3186	0.00	100.00

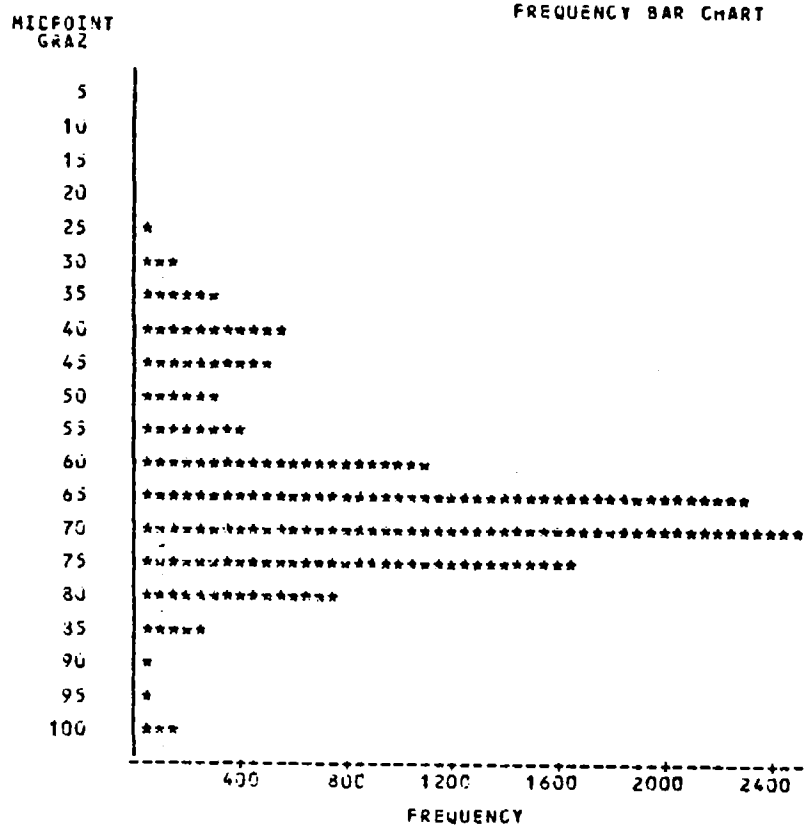
MAT=AC MATERIAL CARD LAB=C COL68-70 ASPH 13:12 MONDAY, MARCH 21, 1988 50

FREQUENCY BAR CHART



MIDPOINT ASPH	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
.7	1	1	0.07	0.07
1.4	0	1	0.00	0.07
2.1	1	2	0.07	0.15
2.8	0	2	0.00	0.15
3.5	22	24	1.62	1.77
4.2	226	250	16.69	18.46
4.9	543	793	40.10	58.57
5.6	352	1145	26.00	84.56
6.3	109	1254	8.05	92.61
7.0	52	1306	3.84	96.45
7.7	23	1329	1.70	98.15
8.4	9	1338	0.66	98.82
9.1	5	1343	0.37	99.19
9.8	2	1345	0.15	99.34
10.5	7	1352	0.52	99.85
11.2	0	1352	0.00	99.85
11.9	0	1352	0.00	99.85
12.6	1	1353	0.07	99.93
13.3	0	1353	0.00	99.93
14.0	1	1354	0.07	100.00

FREQUENCY BAR CHART



FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
2	2	0.02	0.02
5	7	0.05	0.06
7	14	0.06	0.13
10	24	0.09	0.22
57	81	0.51	0.73
151	232	1.36	2.09
304	536	2.75	4.84
558	1094	5.04	9.88
501	1595	4.52	14.40
288	1883	2.60	17.00
394	2277	3.56	20.56
1108	3385	10.01	30.57
2304	5689	20.81	51.37
2514	8203	22.70	74.07
1665	9868	15.04	89.11
726	10594	6.56	95.67
246	10840	2.22	97.89
59	10899	0.53	98.42
47	10946	0.42	98.84
128	11074	1.16	100.00

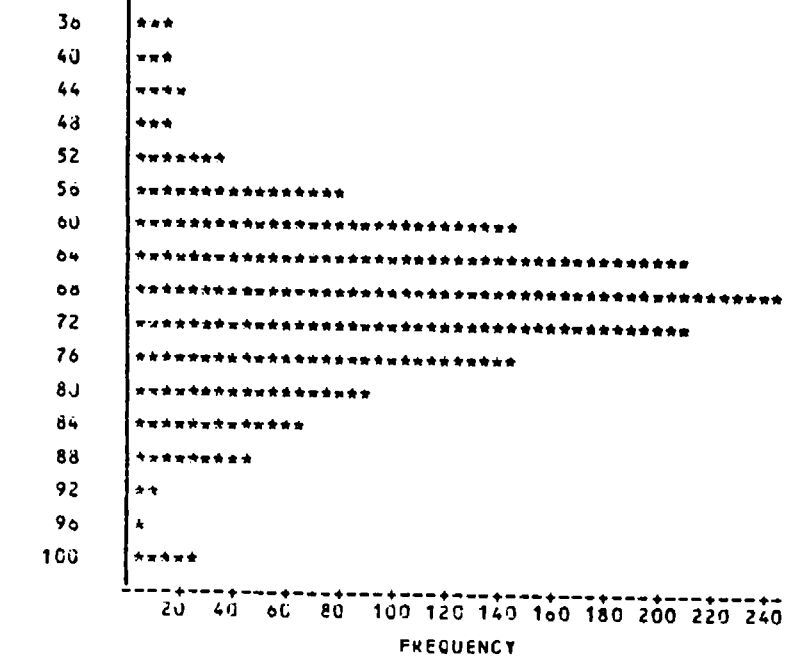
MAT=AC MATERIAL CARD LAB=D COL36-38 3/8IN 13:12 MONDAY, MARCH 21, 1988 25

FREQUENCY BAR CHART

```
MIDPOINT
 GRAD
   24  |*
   28  |*
   32  |****
   36  |*******
   40  |**********
   44  |*********
   48  |*******
   52  |*************
   56  |************************
   60  |*****************************************
   64  |*************************************************************************
   68  |*****************************************************************************************
   72  |*****************************************************************************************
   76  |*****************************************************
   80  |****************************
   84  |*************
   88  |*****
   92  |***
   96  |**
  100  |**********
       +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
        30  60  90 120 150 180 210 240 270 300 330 360 390 420 450 480 510 540 570 600 630
                                  FREQUENCY
```

MIDPOINT GRAD	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
24	5	5	0.14	0.14
28	8	13	0.22	0.36
32	28	41	0.78	1.14
36	53	94	1.47	2.61
40	73	167	2.03	4.64
44	68	235	1.89	6.54
48	51	286	1.42	7.95
52	97	383	2.70	10.65
56	171	554	4.76	15.41
60	327	881	9.09	24.50
64	579	1460	16.10	40.60
68	639	2099	17.77	58.37
72	621	2720	17.27	75.64
76	422	3142	11.74	87.37
80	208	3350	5.78	93.16
84	98	3448	2.73	95.88
88	38	3486	1.06	96.94
92	20	3506	0.56	97.50
96	16	3522	0.44	97.94
100	74	3596	2.06	100.00

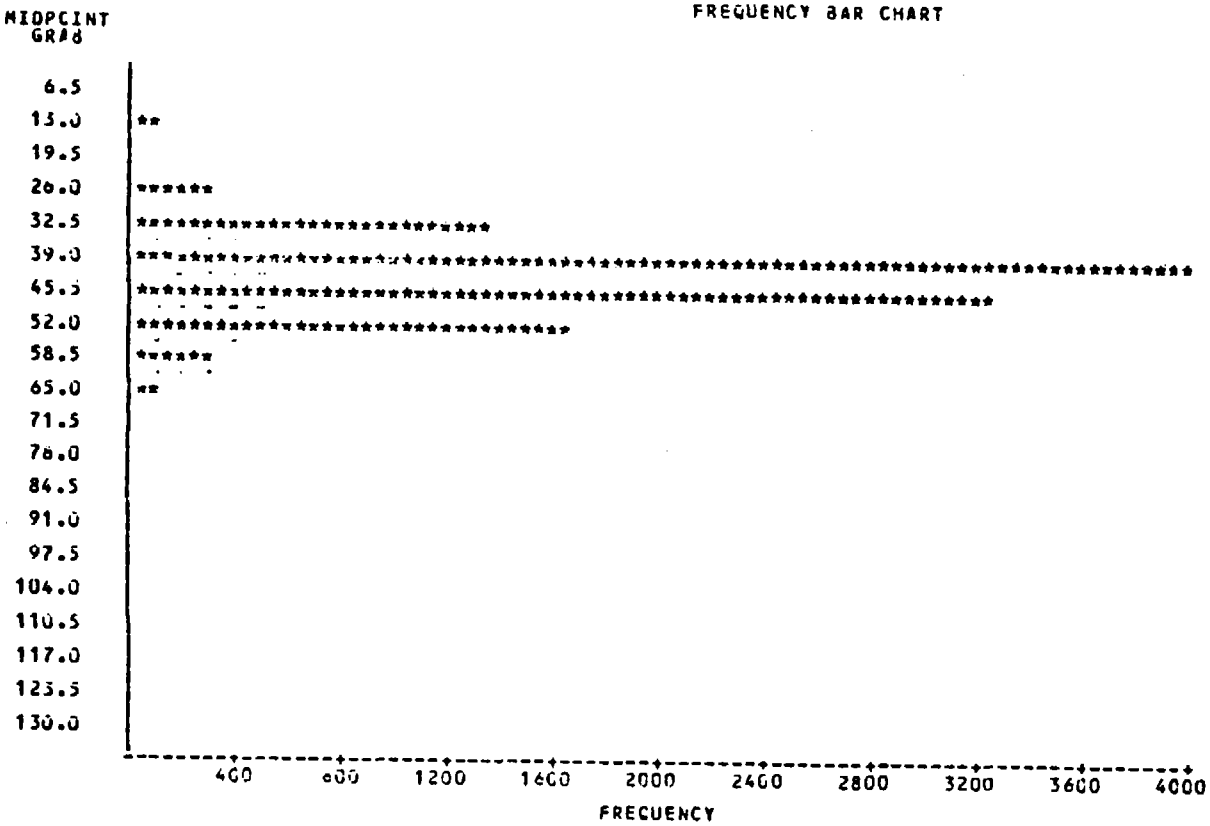
FREQUENCY BAR CHART



FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
1	1	0.07	0.07
2	3	0.14	0.22
0	3	0.00	0.22
14	17	1.01	1.23
14	31	1.01	2.24
22	53	1.59	3.83
16	69	1.16	4.99
37	106	2.67	7.66
78	184	5.64	13.29
146	330	10.55	23.84
209	539	15.10	38.95
245	784	17.70	56.65
212	996	15.32	71.97
144	1140	10.40	82.37
91	1231	6.58	88.95
63	1294	4.55	93.50
47	1341	3.40	96.89
11	1352	0.79	97.69
6	1358	0.43	98.12
26	1384	1.88	100.00

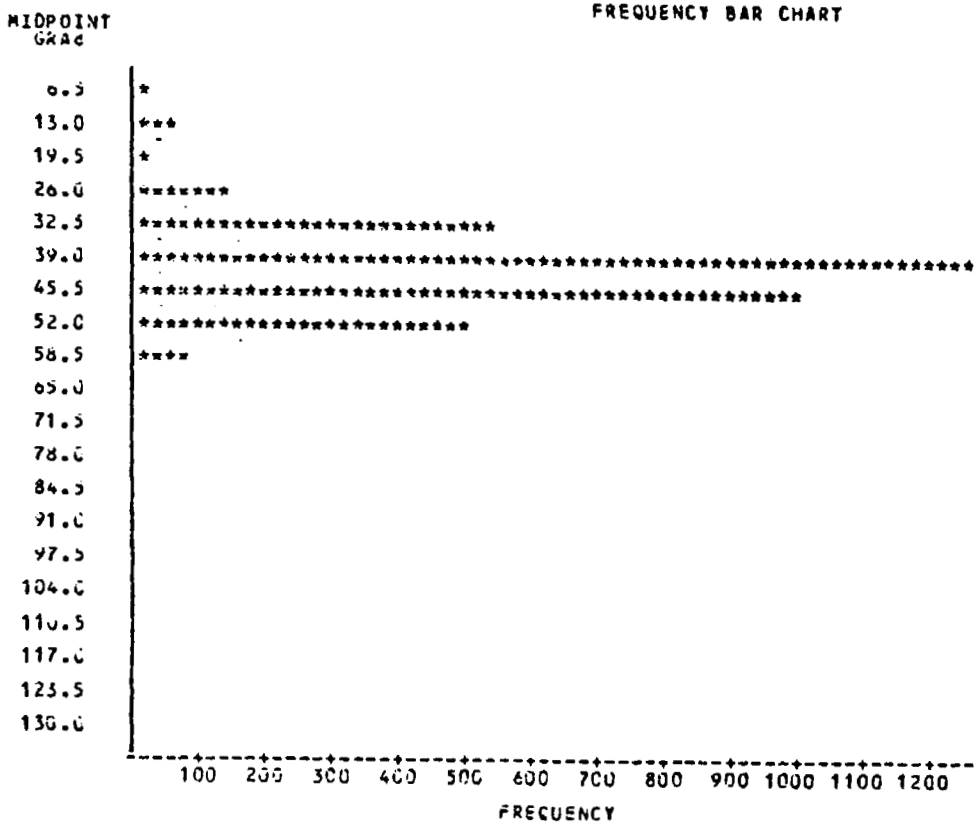
MAT=AC MATERIAL CARC LAB=P COL45-47 #8 13:12 MONDAY, MARCH 21, 1988 9

FREQUENCY BAR CHART



FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
17	17	0.15	0.15
88	105	0.79	0.94
24	129	0.22	1.16
311	440	2.79	3.94
1358	1798	12.17	16.12
4013	5811	35.97	52.08
3267	9078	29.28	81.37
1642	10720	14.72	96.08
290	11010	2.60	98.68
97	11107	0.87	99.55
12	11119	0.11	99.66
0	11119	0.00	99.66
1	11120	0.01	99.67
1	11121	0.01	99.68
0	11121	0.00	99.68
7	11128	0.06	99.74
15	11143	0.13	99.87
11	11154	0.10	99.97
2	11156	0.02	99.99
1	11157	0.01	100.00

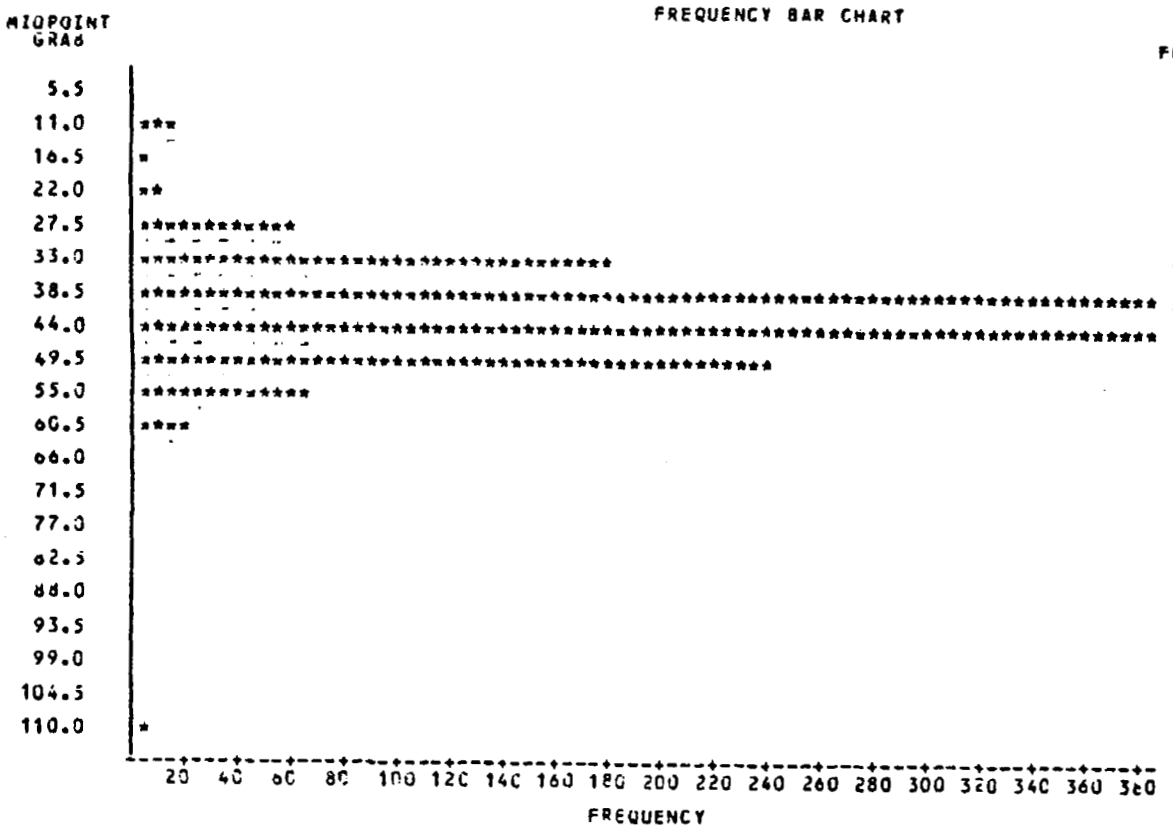
FREQUENCY BAR CHART



FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
11	11	0.30	0.30
54	65	1.50	1.80
14	79	0.39	2.19
138	217	3.82	6.01
534	751	14.80	20.81
1261	2012	34.94	55.75
1001	3013	27.74	83.49
495	3508	13.72	97.20
74	3582	2.05	99.25
7	3589	0.19	99.45
0	3589	0.00	99.45
1	3590	0.03	99.47
1	3591	0.03	99.50
1	3592	0.03	99.53
1	3593	0.03	99.56
6	3599	0.17	99.72
4	3603	0.11	99.83
2	3605	0.06	99.89
4	3609	0.11	100.00
0	3609	0.00	100.00

MAT=AC MATERIAL CARC LAB=C COL45-47 #8 13:12 MONDAY, MARCH 21, 1988 44

FREQUENCY BAR CHART

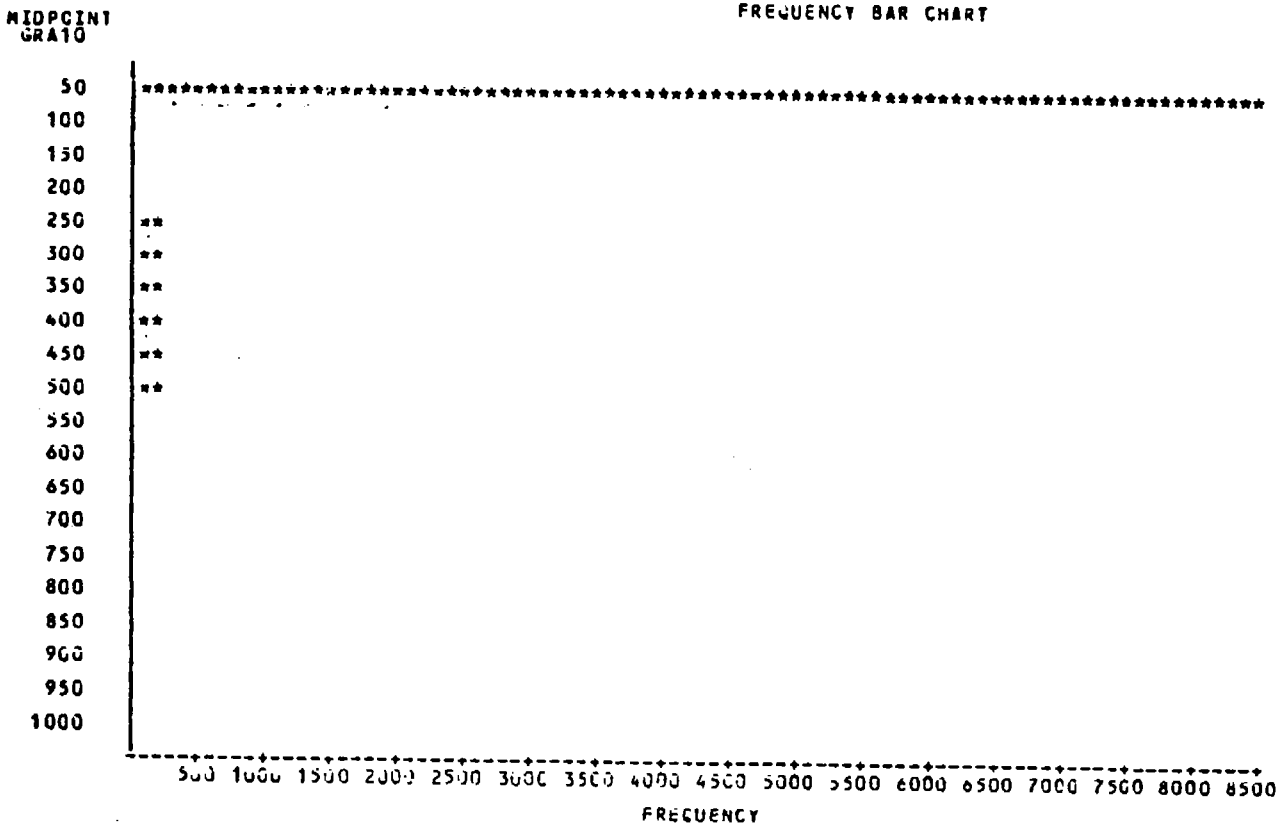


FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
2	2	0.15	0.15
14	16	1.02	1.17
5	21	0.36	1.53
11	32	0.80	2.33
61	93	4.44	6.77
179	272	13.04	19.81
383	655	27.90	47.71
385	1040	28.04	75.75
241	1281	17.55	93.30
63	1344	4.59	97.89
21	1365	1.53	99.42
1	1366	0.07	99.49
0	1366	0.00	99.49
0	1366	0.00	99.49
1	1367	0.07	99.56
1	1368	0.07	99.64
0	1368	0.00	99.64
0	1368	0.00	99.64
2	1370	0.15	99.78
3	1373	0.22	100.00

MAT=4C MATERIAL CARD LAB=P COL54-56 #4C

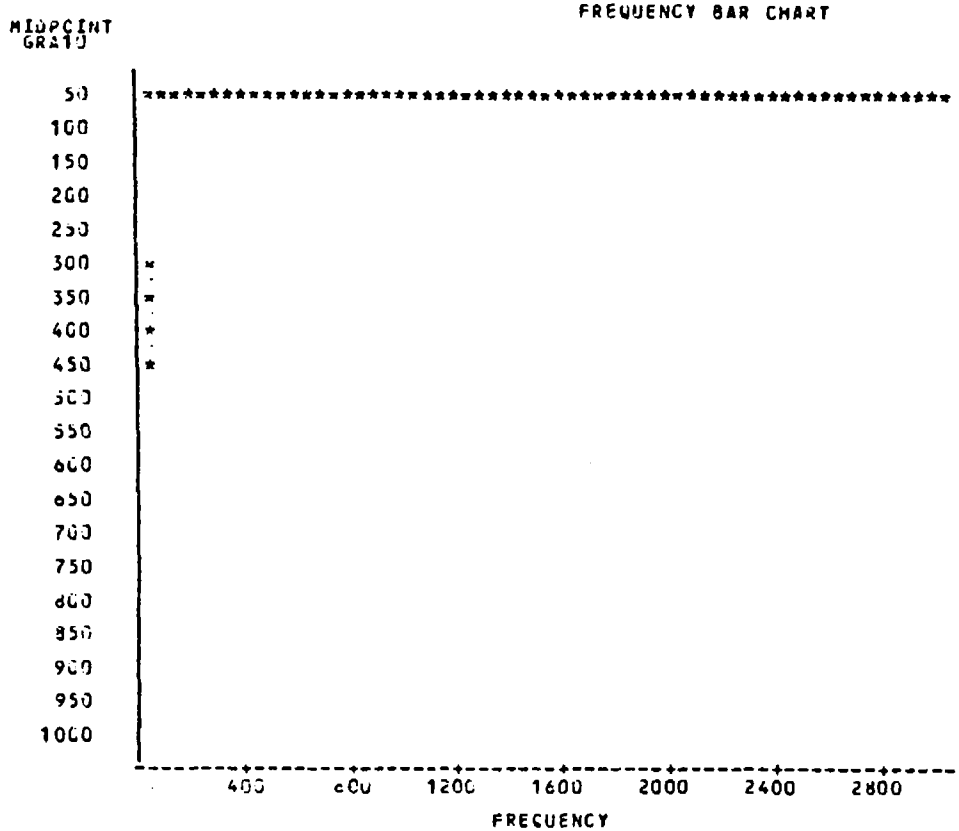
FREQUENCY BAR CHART

13:12 MONDAY, MARCH 21, 1988 11



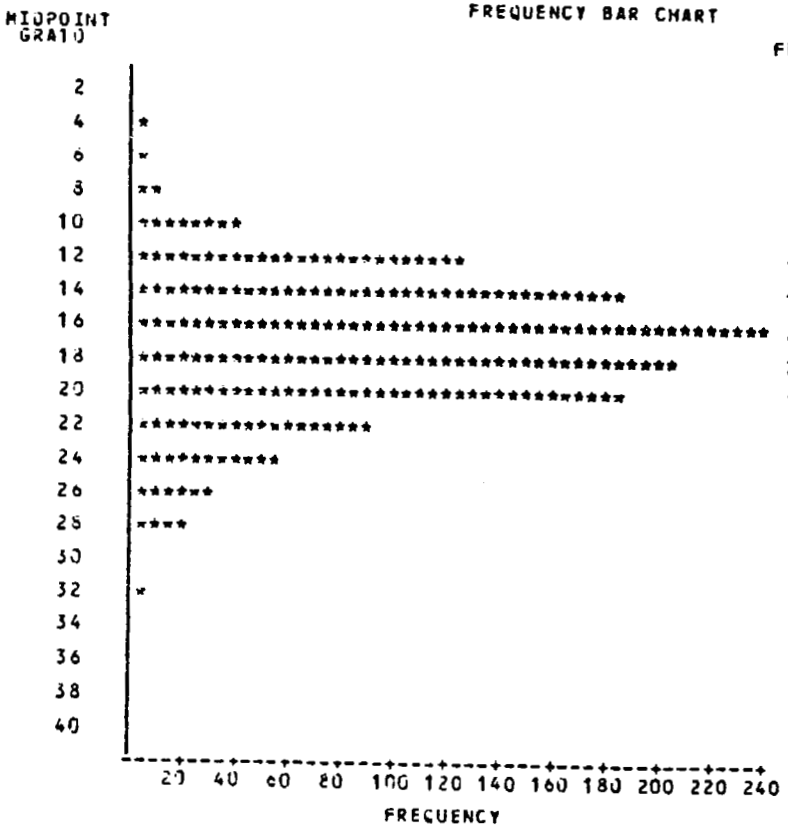
FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
8518	8518	86.26	86.26
0	8518	0.00	86.26
6	8524	0.06	86.32
41	8565	0.42	86.73
154	8719	1.56	88.29
184	8903	1.86	90.16
222	9125	2.25	92.41
249	9374	2.52	94.93
244	9618	2.47	97.40
221	9839	2.24	99.64
14	9853	0.14	99.78
1	9854	0.01	99.79
0	9854	0.00	99.79
3	9857	0.03	99.82
10	9867	0.10	99.92
2	9869	0.02	99.94
1	9870	0.01	99.95
0	9870	0.00	99.95
0	9870	0.00	99.95
5	9875	0.05	100.00

FREQUENCY BAR CHART



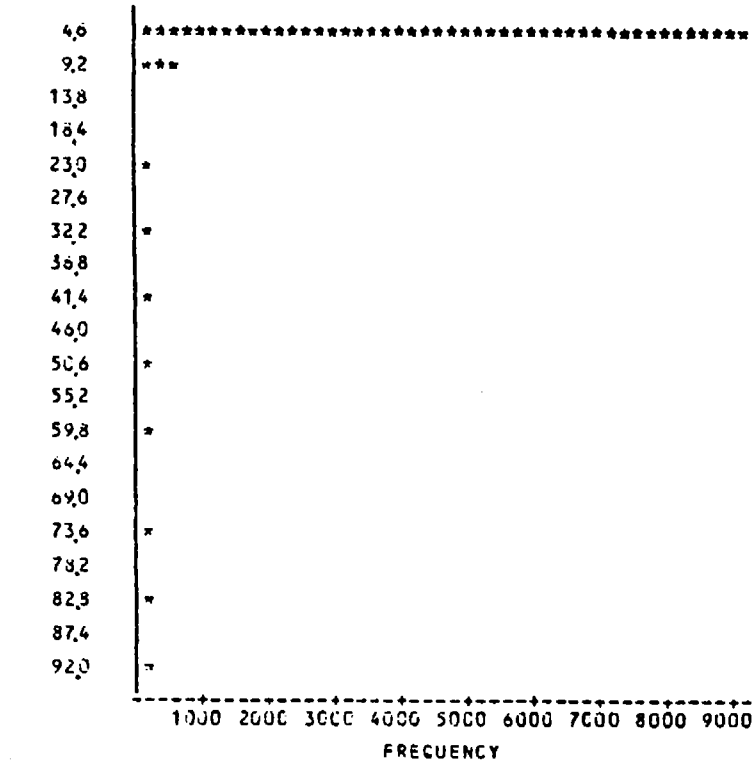
MIDPOINT GRAID	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
50	3052	3052	92.88	92.88
100	1	3053	0.03	92.91
150	2	3055	0.06	92.97
200	15	3070	0.46	93.43
250	12	3082	0.37	93.79
300	47	3129	1.43	95.22
350	53	3182	1.61	96.84
400	28	3210	0.85	97.69
450	36	3246	1.10	98.78
500	22	3268	0.67	99.45
550	6	3274	0.18	99.63
600	0	3274	0.00	99.63
650	0	3274	0.00	99.63
700	0	3274	0.00	99.63
750	1	3275	0.03	99.67
800	3	3278	0.09	99.76
850	1	3279	0.03	99.79
900	3	3282	0.09	99.88
950	1	3283	0.03	99.91
1000	3	3286	0.09	100.00

FREQUENCY BAR CHART



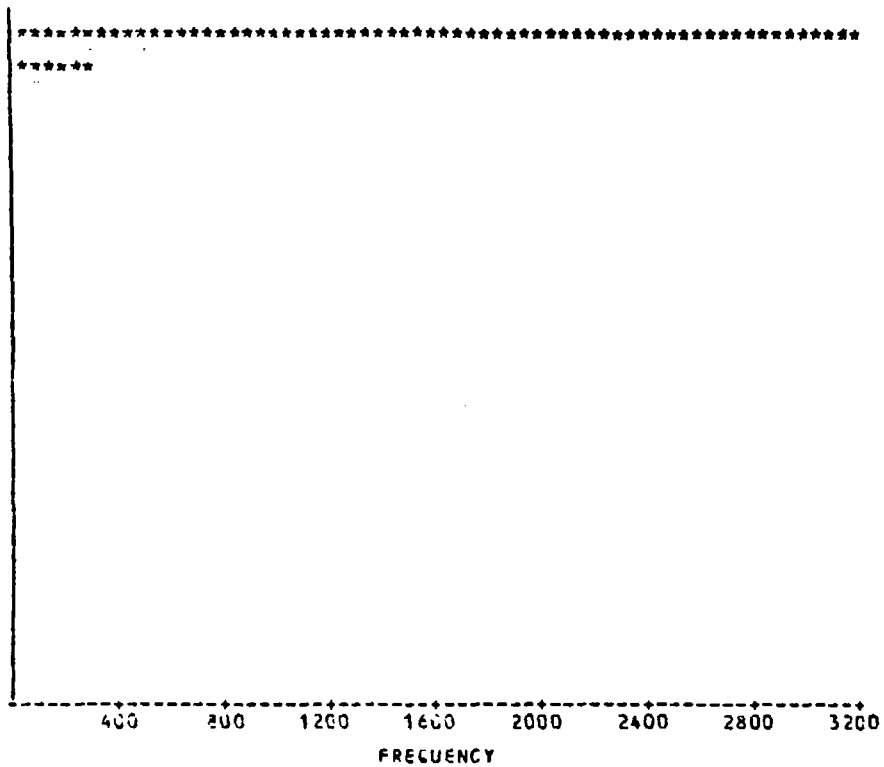
FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
2	2	0.17	0.17
3	5	0.25	0.41
3	8	0.25	0.66
8	16	0.66	1.33
40	56	3.31	4.64
127	183	10.52	15.16
187	370	15.49	30.65
240	610	19.88	50.54
206	816	17.07	67.61
187	1003	15.49	83.10
92	1095	7.62	90.72
56	1151	4.64	95.36
32	1183	2.65	98.01
18	1201	1.49	99.50
2	1203	0.17	99.67
3	1206	0.25	99.92
1	1207	0.08	100.00
0	1207	0.00	100.00
0	1207	0.00	100.00
0	1207	0.00	100.00

FREQUENCY BAR CHART



MIDPOINT GRA13	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
4.6	9203	9203	85.35	85.35
9.2	575	9778	5.33	90.68
13.8	17	9795	0.16	90.84
18.4	0	9795	0.00	90.84
23.0	123	9918	1.14	91.98
27.6	0	9918	0.00	91.98
32.2	121	10039	1.12	93.10
36.8	0	10039	0.00	93.10
41.4	124	10163	1.15	94.25
46.0	0	10163	0.00	94.25
50.6	121	10284	1.12	95.37
55.2	0	10284	0.00	95.37
59.8	135	10419	1.25	96.62
64.4	0	10419	0.00	96.62
69.0	1	10420	0.01	96.63
73.6	117	10537	1.09	97.72
78.2	0	10537	0.00	97.72
82.8	117	10654	1.09	98.80
87.4	0	10654	0.00	98.80
92.0	129	10783	1.20	100.00

FREQUENCY BAR CHART



MIDPOINT GRAIN	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
4.6	3177	3177	88.13	88.13
9.2	283	3460	7.85	95.98
13.8	8	3468	0.22	96.20
18.4	0	3468	0.00	96.20
23.0	14	3482	0.39	96.59
27.6	1	3483	0.03	96.62
32.2	20	3503	0.55	97.17
36.8	0	3503	0.00	97.17
41.4	17	3520	0.47	97.64
46.0	0	3520	0.00	97.64
50.6	18	3538	0.50	98.14
55.2	0	3538	0.00	98.14
59.8	12	3550	0.33	98.47
64.4	0	3550	0.00	98.47
69.0	2	3552	0.06	98.53
73.6	19	3571	0.53	99.06
78.2	0	3571	0.00	99.06
82.8	15	3586	0.42	99.47
87.4	0	3586	0.00	99.47
92.0	19	3605	0.53	100.00

FREQUENCY BAR CHART

MIDPOINT GRAIS		FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
8.5	**********	159	159	12.00	12.00
17.0	*******	36	195	2.72	14.72
25.5	**********	67	262	5.06	19.77
34.0	**********	198	460	14.94	34.72
42.5	**********	241	701	18.19	52.91
51.0	**********	268	969	20.23	73.13
59.5	**********	177	1146	13.36	86.49
68.0	**********	101	1247	7.62	94.11
76.5	*********	44	1291	3.32	97.43
85.0	***	17	1308	1.28	98.72
93.5	*	7	1315	0.53	99.25
102.0	*	4	1319	0.30	99.55
110.5		2	1321	0.15	99.70
119.0		2	1323	0.15	99.85
127.5		0	1323	0.00	99.85
136.0		0	1323	0.00	99.85
144.5		0	1323	0.00	99.85
153.0		0	1323	0.00	99.85
161.5		1	1324	0.08	99.92
170.0		1	1325	0.08	100.00

20 40 60 80 100 120 140 160 180 200 220 240 260

FREQUENCY

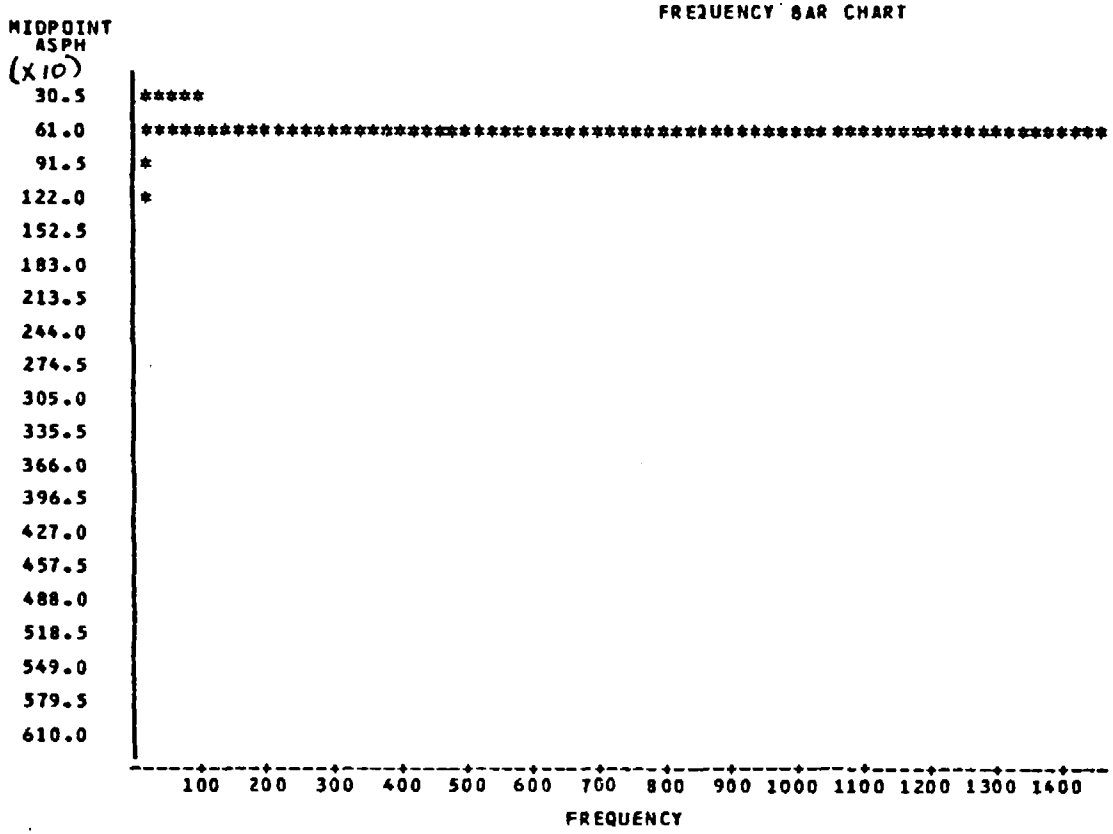
Material	mtl. code	tests col 1,2	value	column.	no. of obs.	p	lab d	lab c	lab Δ
A 6.									
asphalt concrete	AC	asph content	M2*	45-47	3771	3771	0	0	0
pay factor		gradation 3/8"	M2*	30-32	4554	4554	0	0	0
tabulation		gradation #8	M2*	36-38	4554	4554	0	0	0
		gradation #40	M2*	39-41	3860	3860	0	0	0
		gradation #200	M2*	42-44	4554	4554	0	0	0

Mat.	test	total	lab/pur	#	mean	std	min	max	25%	75%
A 6.										
AC	asph content	3771	p /	3771	5.172	.564	2.5	10.7	4.8	5.5
	gradation 3/8"	4554	p /	4554	66.38	7.65	36	100	61	71
	gradation #8	4554	p /	4554	38.65	6.47	12	62	34	43
	gradation #40	3860	p /	3860	17.89	4.53	5	49	14	21
	gradation #200	4554	p /	4554	4.710	1.517	.3	10.5	3.9	5.6

Material	mtl. code	tests col 1,2	value	column.	no. of obs.	p	lab d	lab c	Δ
A 9.									
asphalt concrete fr.ction course	FC	ash. content	M2	68-70	2299	1603	459	227	10
		gradation #4	M2	42-44	2240	1514	494	227	5
		gradation #8	M2	45-47	2231	1513	489	224	5
		gradation #200	M2	63-65	2167	1456	486	220	5
		moisture cont.	M2	76-78	640	481	158	1	0

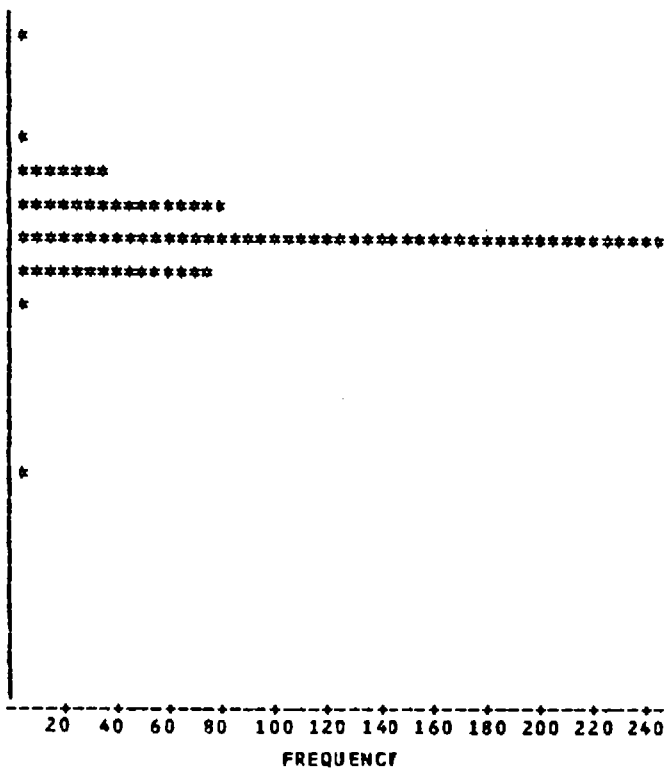
Mat.	test	total	lab/pur	#	mean	std	min	max	25%	75%
A9.										
FC	asph content	2299	p /	1603	6.0 13	2.8 08	.5	60.5	5.5	6.2
			d /	459	5.6 10	1.2 30	.5	15.6	5.1	6.0
			c /	227	5.4 84	.9 81	2.8	13.8	5.1	5.8
	gradation #4	2240	p /	1514	41.79	11.23	4	100	35	48
			d /	494	41.75	11.63	3	100	36	48
			c /	227	43.10	10.33	4	88	37	49
	gradation #8	2231	p /	1513	13.63	8.97	1	91	10	15
			d /	489	13.05	7.68	1	78	10	14
			c /	224	13.41	7.54	1	64	10	15
	gradation #200	2167	p /	1456	2.4 53	1.6 59	.1	12.9	1.5	3.1
			d /	486	2.2 41	1.3 41	.1	8.2	1.4	2.8
			c /	220	2.2 46	1.5 62	.1	14.2	1.1	3.0
	moisture cont.	640	p /	481	6.71	64.30	1	999	1	2
			d /	158	2.24	2.57	1	24	1	2
			c /	1						

FREQUENCY BAR CHART



MIDPOINT ASPH (X10)	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
30.5	94	94	5.86	5.86
61.0	1462	1556	91.20	97.07
91.5	22	1578	1.37	98.44
122.0	18	1596	1.12	99.56
152.5	3	1599	0.19	99.75
183.0	0	1599	0.00	99.75
213.5	0	1599	0.00	99.75
244.0	0	1599	0.00	99.75
274.5	0	1599	0.00	99.75
305.0	0	1599	0.00	99.75
335.5	0	1599	0.00	99.75
366.0	0	1599	0.00	99.75
396.5	0	1599	0.00	99.75
427.0	0	1599	0.00	99.75
457.5	0	1599	0.00	99.75
488.0	0	1599	0.00	99.75
518.5	0	1599	0.00	99.75
549.0	1	1600	0.06	99.81
579.5	2	1602	0.12	99.94
610.0	1	1603	0.06	100.00

FREQUENCY BAR CHART



MIDPOINT ASPH	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
.8	3	3	0.65	0.65
1.5	1	4	0.22	0.87
2.4	0	4	0.00	0.87
3.2	4	8	0.87	1.74
4.0	34	42	7.41	9.15
4.8	82	124	17.86	27.02
5.6	244	368	53.16	80.17
6.4	73	441	15.90	96.08
7.2	7	448	1.53	97.60
8.0	2	450	0.44	98.04
8.8	0	450	0.00	98.04
9.6	1	451	0.22	98.26
10.4	2	453	0.44	98.69
11.2	3	456	0.65	99.35
12.0	1	457	0.22	99.56
12.8	0	457	0.00	99.56
13.6	0	457	0.00	99.56
14.4	1	458	0.22	99.78
15.2	1	459	0.22	100.00
16.0	0	459	0.00	100.00

FREQUENCY BAR CHART

```
MIDPOINT
 ASPH
  2.6  |*                                                          1
  3.2  |*                                                          2
  3.8  |**                                                         4
  4.4  |*********                                                 17
  5.0  |*********************************                         63
  5.6  |*************************************************************** 112
  6.2  |***********                                                22
  6.8  |*                                                          2
  7.4  |*                                                          1
  8.0  |                                                           0
  8.6  |                                                           0
  9.2  |                                                           0
  9.8  |                                                           0
 10.4  |                                                           0
 11.0  |*                                                          1
 11.6  |*                                                          1
 12.2  |                                                           0
 12.8  |                                                           0
 13.4  |                                                           0
 14.0  |*                                                          1
       ----+----+----+----+----+----+----+----+----+----+
           10   20   30   40   50   60   70   80   90  100  110
                          FREQUENCY
```

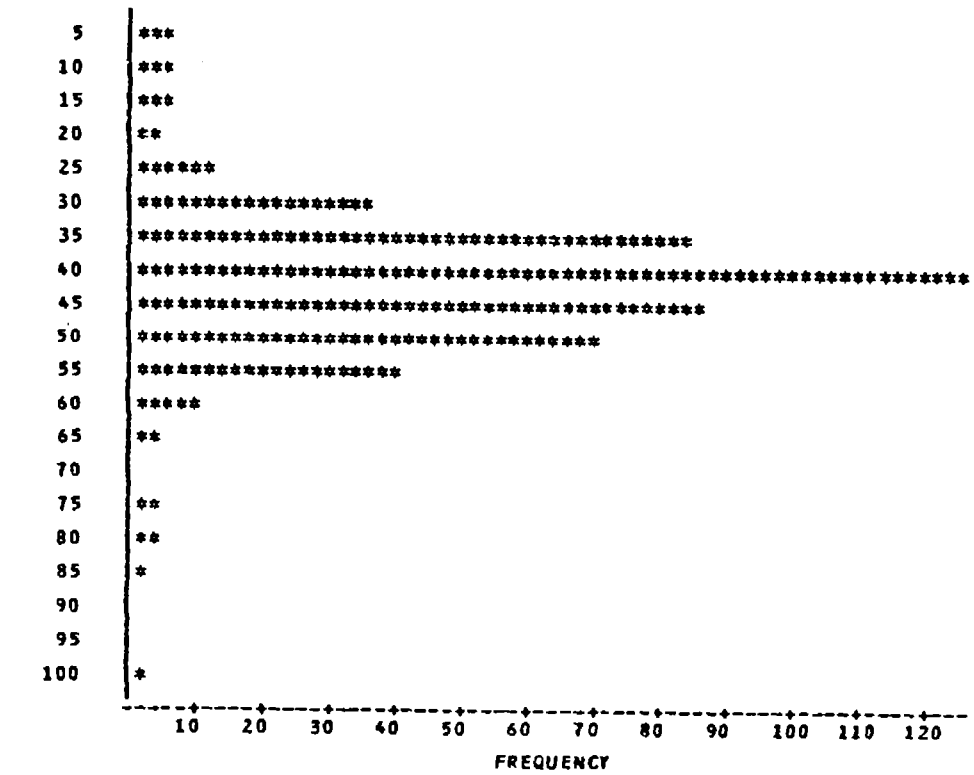
MIDPOINT ASPH	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
2.6	1	1	0.44	0.44
3.2	2	3	0.88	1.32
3.8	4	7	1.76	3.08
4.4	17	24	7.49	10.57
5.0	63	87	27.75	38.33
5.6	112	199	49.34	87.67
6.2	22	221	9.69	97.36
6.8	2	223	0.88	98.24
7.4	1	224	0.44	98.68
8.0	0	224	0.00	98.68
8.6	0	224	0.00	98.68
9.2	0	224	0.00	98.68
9.8	0	224	0.00	98.68
10.4	0	224	0.00	98.68
11.0	1	225	0.44	99.12
11.6	1	226	0.44	99.56
12.2	0	226	0.00	99.56
12.8	0	226	0.00	99.56
13.4	0	226	0.00	99.56
14.0	1	227	0.44	100.00

FREQUENCY BAR CHART

```
MIDPOINT
 GRAT
   5  |**                                                                  8     8    0.53    0.53
  10  |***                                                                15    23    0.99    1.52
  15  |****                                                               21    44    1.39    2.91
  20  |***                                                                17    61    1.12    4.03
  25  |*******                                                            37    98    2.44    6.47
  30  |************************                                         121   219    7.99   14.46
  35  |*****************************************************            272   491   17.97   32.43
  40  |*****************************************************************340   831   22.46   54.89
  45  |*******************************************************           277  1108   18.30   73.18
  50  |*************************************                             194  1302   12.81   86.00
  55  |***************************                                      135  1437    8.92   94.91
  60  |*********                                                          46  1483    3.04   97.95
  65  |**                                                                 12  1495    0.79   98.75
  70  |                                                                    2  1497    0.13   98.88
  75  |*                                                                   3  1500    0.20   99.08
  80  |*                                                                   5  1505    0.33   99.41
  85  |                                                                    0  1505    0.00   99.41
  90  |                                                                    0  1505    0.00   99.41
  95  |                                                                    0  1505    0.00   99.41
 100  |**                                                                  9  1514    0.59  100.00
      ----+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
          20  40  60  80 100 120 140 160 180 200 220 240 260 280 300 320 340
                                FREQUENCY
```

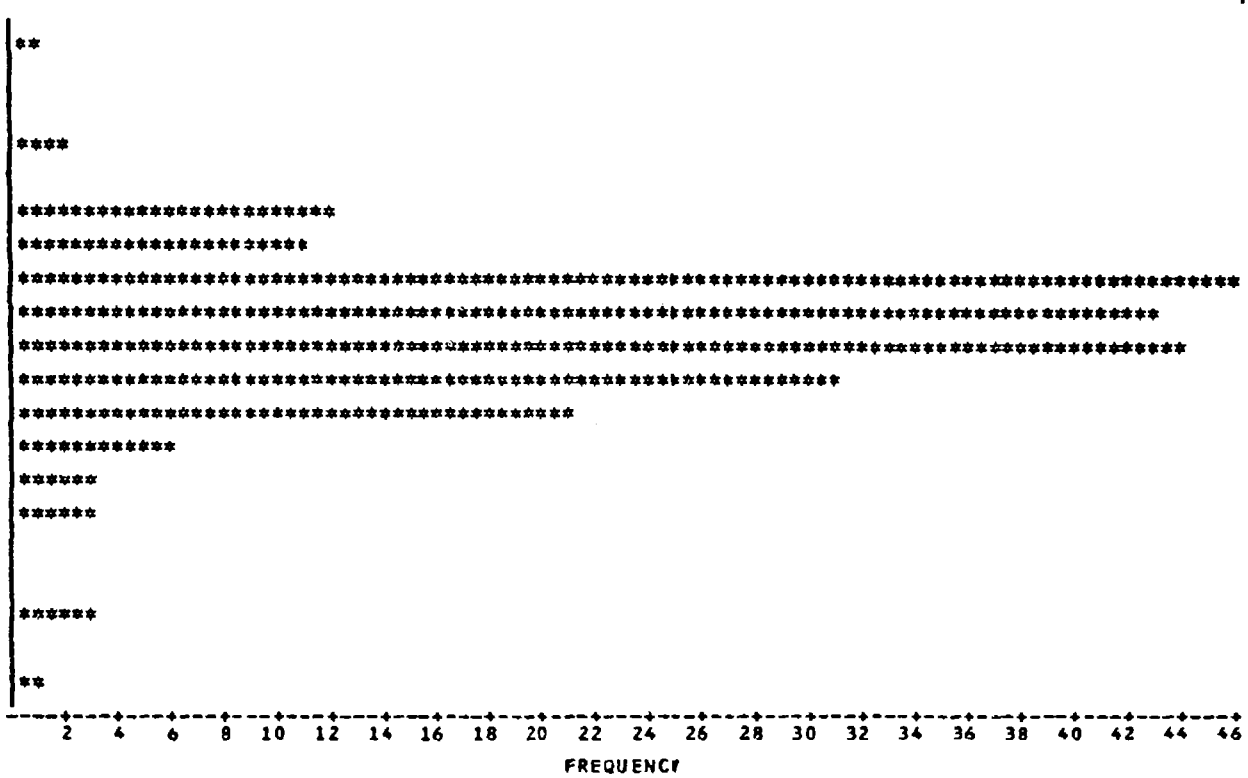
FREQ & CUMFREQ CHART MAT=FC LAB=D COL42-44 84 2:48 MONDAY, MARCH 21, 1988 31

FREQUENCY BAR CHART



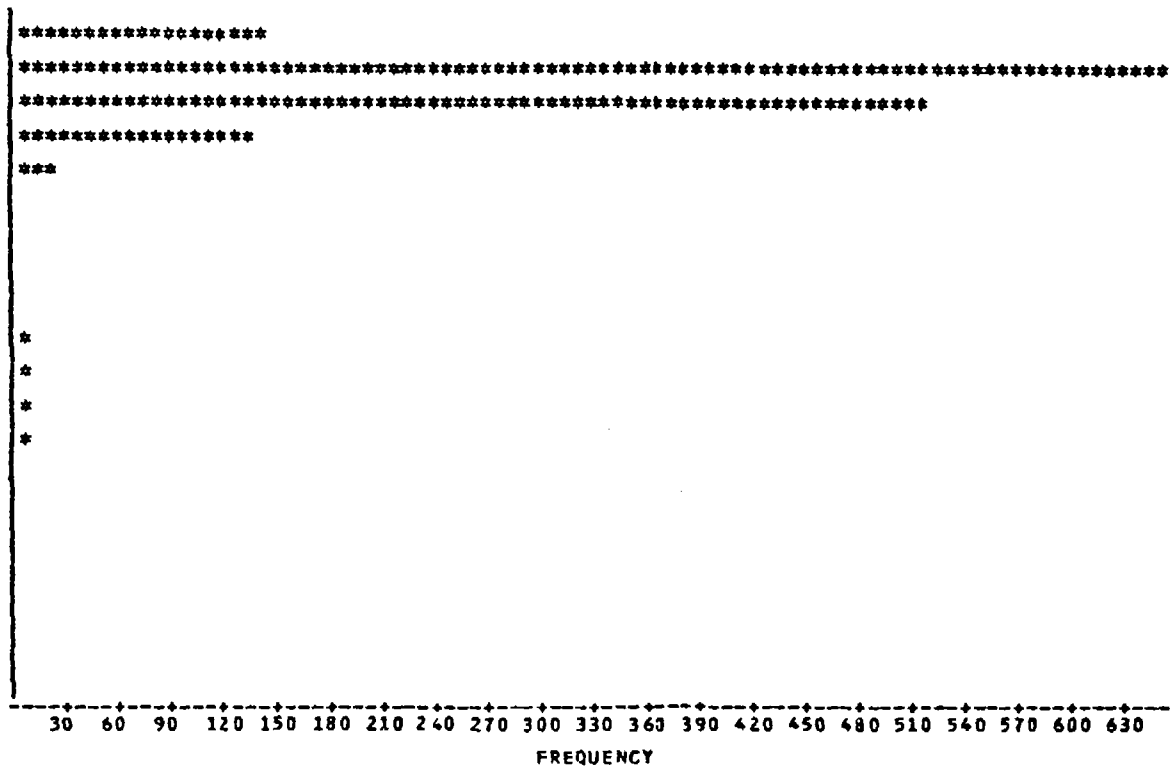
FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
6	6	1.21	1.21
6	12	1.21	2.43
5	17	1.01	3.44
3	20	0.61	4.05
12	32	2.43	6.48
36	68	7.29	13.77
84	152	17.00	30.77
126	278	25.51	56.28
85	363	17.21	73.48
69	432	13.97	87.45
39	471	7.89	95.34
9	480	1.82	97.17
4	484	0.81	97.98
0	484	0.00	97.98
3	487	0.61	98.58
3	490	0.61	99.19
2	492	0.40	99.60
0	492	0.00	99.60
0	492	0.00	99.60
2	494	0.40	100.00

FREQUENCY BAR CHART



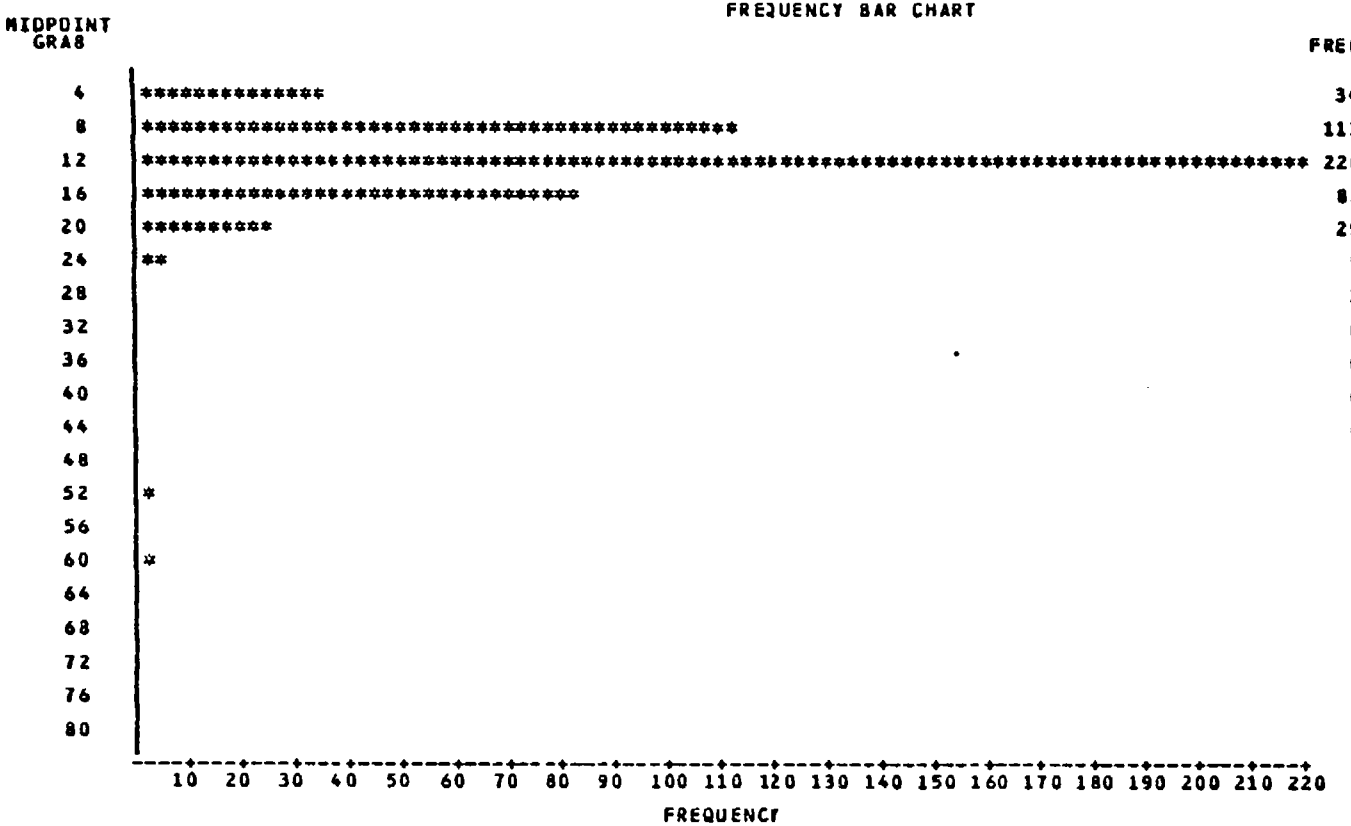
MIDPOINT GRAT	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
4.5	1	1	0.44	0.44
9.0	0	1	0.00	0.44
13.5	0	1	0.00	0.44
18.0	2	3	0.88	1.32
22.5	0	3	0.00	1.32
27.0	12	15	5.29	6.61
31.5	11	26	4.85	11.45
36.0	46	72	20.26	31.72
40.5	43	115	18.94	50.66
45.0	44	159	19.38	70.04
49.5	31	190	13.66	83.70
54.0	21	211	9.25	92.95
58.5	6	217	2.64	95.59
63.0	3	220	1.32	96.92
67.5	3	223	1.32	98.24
72.0	0	223	0.00	98.24
76.5	0	223	0.00	98.24
81.0	3	226	1.32	99.56
85.5	0	226	0.00	99.56
90.0	1	227	0.44	100.00

FREQUENCY BAR CHART



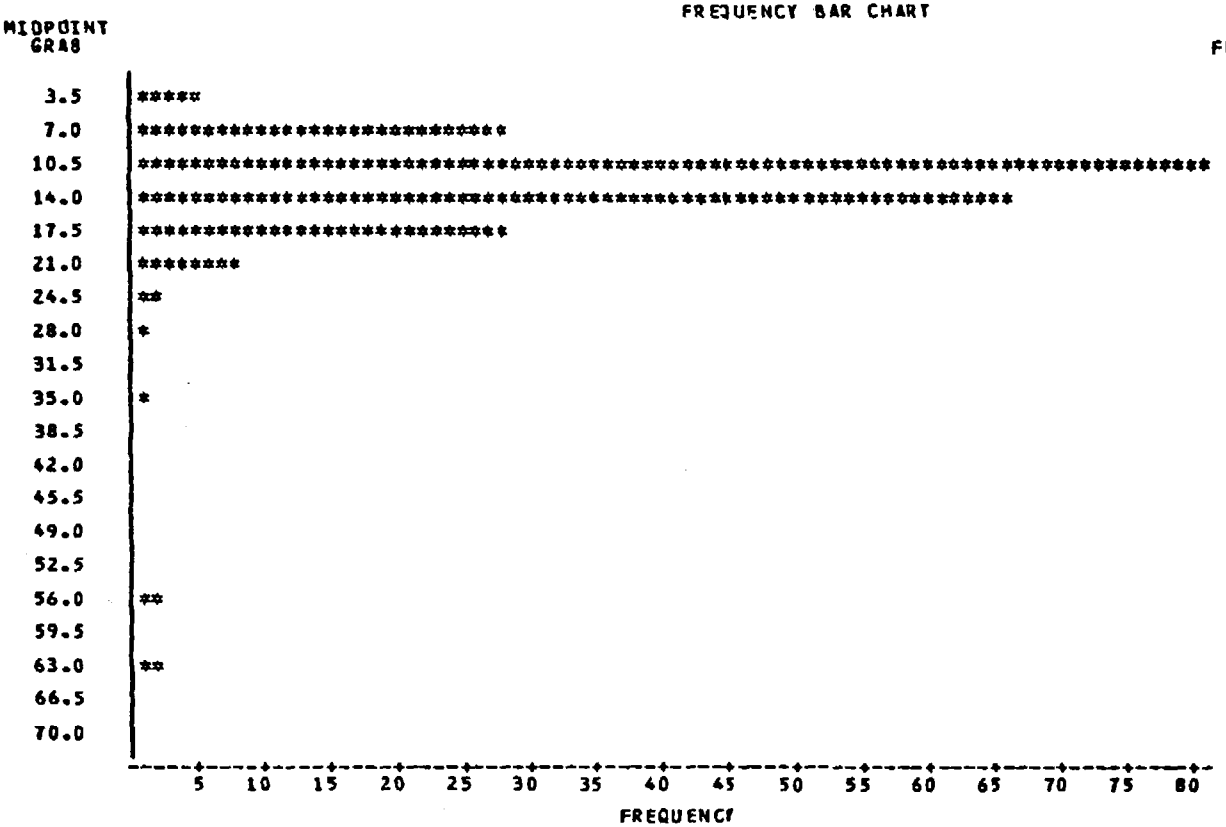
MIDPOINT GRAB	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
5	139	139	9.19	9.19
10	653	792	43.16	52.35
15	519	1311	34.30	86.65
20	135	1446	8.92	95.57
25	25	1471	1.65	97.22
30	2	1473	0.13	97.36
35	1	1474	0.07	97.42
40	0	1474	0.00	97.42
45	1	1475	0.07	97.49
50	7	1482	0.46	97.95
55	8	1490	0.53	98.48
60	11	1501	0.73	99.21
65	6	1507	0.40	99.60
70	1	1508	0.07	99.67
75	1	1509	0.07	99.74
80	1	1510	0.07	99.80
85	2	1512	0.13	99.93
90	1	1513	0.07	100.00
95	0	1513	0.00	100.00
100	0	1513	0.00	100.00

FREQUENCY BAR CHART



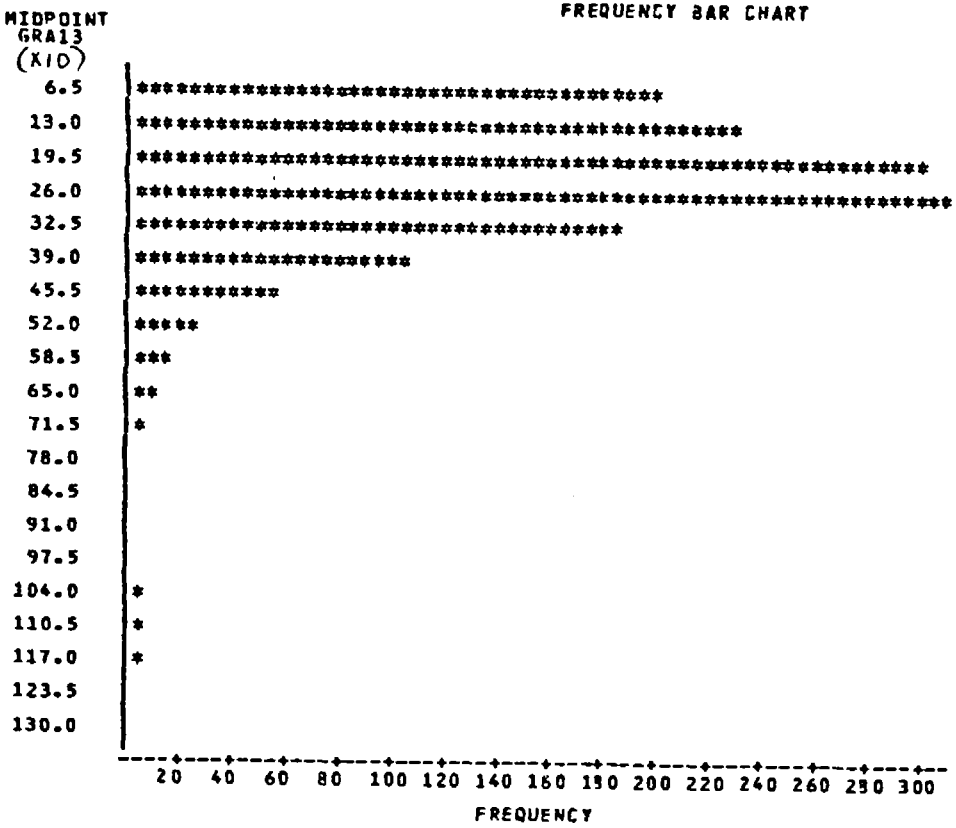
MIDPOINT GRA8	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
4	34	34	6.95	6.95
8	113	147	23.11	30.06
12	220	367	44.99	75.05
16	83	450	16.97	92.02
20	25	475	5.11	97.14
24	5	480	1.02	98.16
28	1	481	0.20	98.36
32	0	481	0.00	98.36
36	0	481	0.00	98.36
40	0	481	0.00	98.36
44	0	481	0.00	98.36
48	0	481	0.00	98.36
52	2	483	0.41	98.77
56	0	483	0.00	98.77
60	3	486	0.61	99.39
64	1	487	0.20	99.59
68	0	487	0.00	99.59
72	1	488	0.20	99.80
76	1	489	0.20	100.00
80	0	489	0.00	100.00

FREQUENCY BAR CHART



MIDPOINT GRA8	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
3.5	5	5	2.23	2.23
7.0	28	33	12.50	14.73
10.5	81	114	36.16	50.89
14.0	66	180	29.46	80.36
17.5	28	208	12.50	92.86
21.0	8	216	3.57	96.43
24.5	2	218	0.89	97.32
28.0	1	219	0.45	97.77
31.5	0	219	0.00	97.77
35.0	1	220	0.45	98.21
38.5	0	220	0.00	98.21
42.0	0	220	0.00	98.21
45.5	0	220	0.00	98.21
49.0	0	220	0.00	98.21
52.5	0	220	0.00	98.21
56.0	2	222	0.89	99.11
59.5	0	222	0.00	99.11
63.0	2	224	0.89	100.00
66.5	0	224	0.00	100.00
70.0	0	224	0.00	100.00

FREQUENCY BAR CHART



FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
199	199	13.67	13.67
228	427	15.66	29.33
300	727	20.60	49.93
310	1037	21.29	71.22
184	1221	12.64	83.86
107	1328	7.35	91.21
53	1381	3.64	94.85
26	1407	1.79	96.63
13	1420	0.89	97.53
9	1429	0.62	98.15
3	1432	0.21	98.35
2	1434	0.14	98.49
1	1435	0.07	98.56
2	1437	0.14	98.70
0	1437	0.00	98.70
4	1441	0.27	98.97
7	1448	0.48	99.45
5	1453	0.34	99.79
2	1455	0.14	99.93
1	1456	0.07	100.00

FREQUENCY BAR CHART

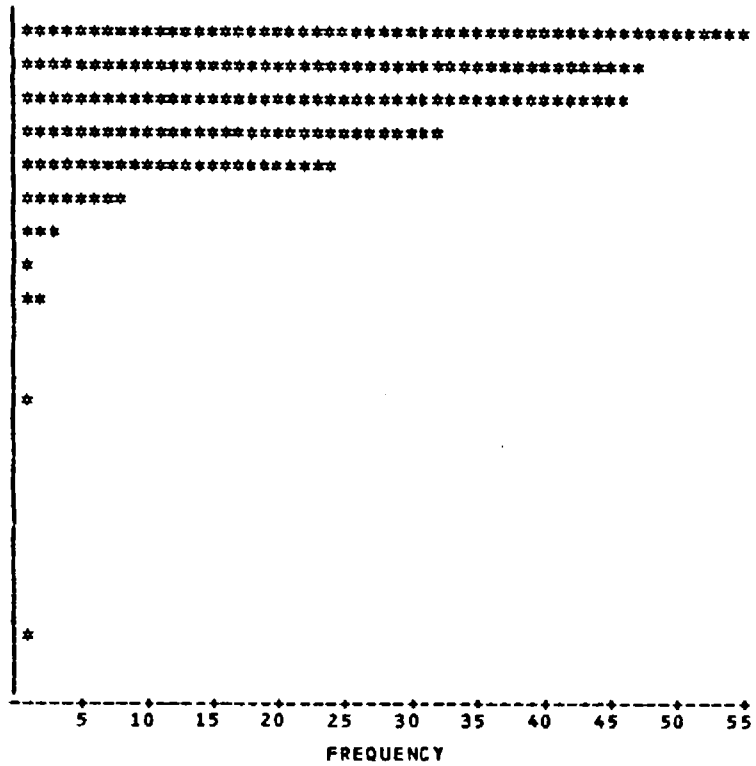
MIDPOINT GRA13 (XID)		FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
4.5	**********	38	38	7.82	7.82
9.0	**********	46	84	9.47	17.28
13.5	**********	62	146	12.76	30.04
18.0	**********	101	247	20.78	50.82
22.5	**********	67	314	13.79	64.61
27.0	**********	71	385	14.61	79.22
31.5	**********	35	420	7.20	86.42
36.0	*********	18	438	3.70	90.12
40.5	******	12	450	2.47	92.59
45.0	****	8	458	1.65	94.24
49.5	****	8	466	1.65	95.88
54.0	***	5	471	1.03	96.91
58.5	*	1	472	0.21	97.12
63.0	***	5	477	1.03	98.15
67.5	**	4	481	0.82	98.97
72.0	*	2	483	0.41	99.38
76.5	*	2	485	0.41	99.79
81.0	*	1	486	0.21	100.00
85.5		0	486	0.00	100.00
90.0		0	486	0.00	100.00

10 20 30 40 50 50 70 80 90 100

FREQUENCY

FREQ & CUMFREQ CHART MAT=FC LAB=C COL56-65 #200 2:48 MONDAY, MARCH 21, 1988 57

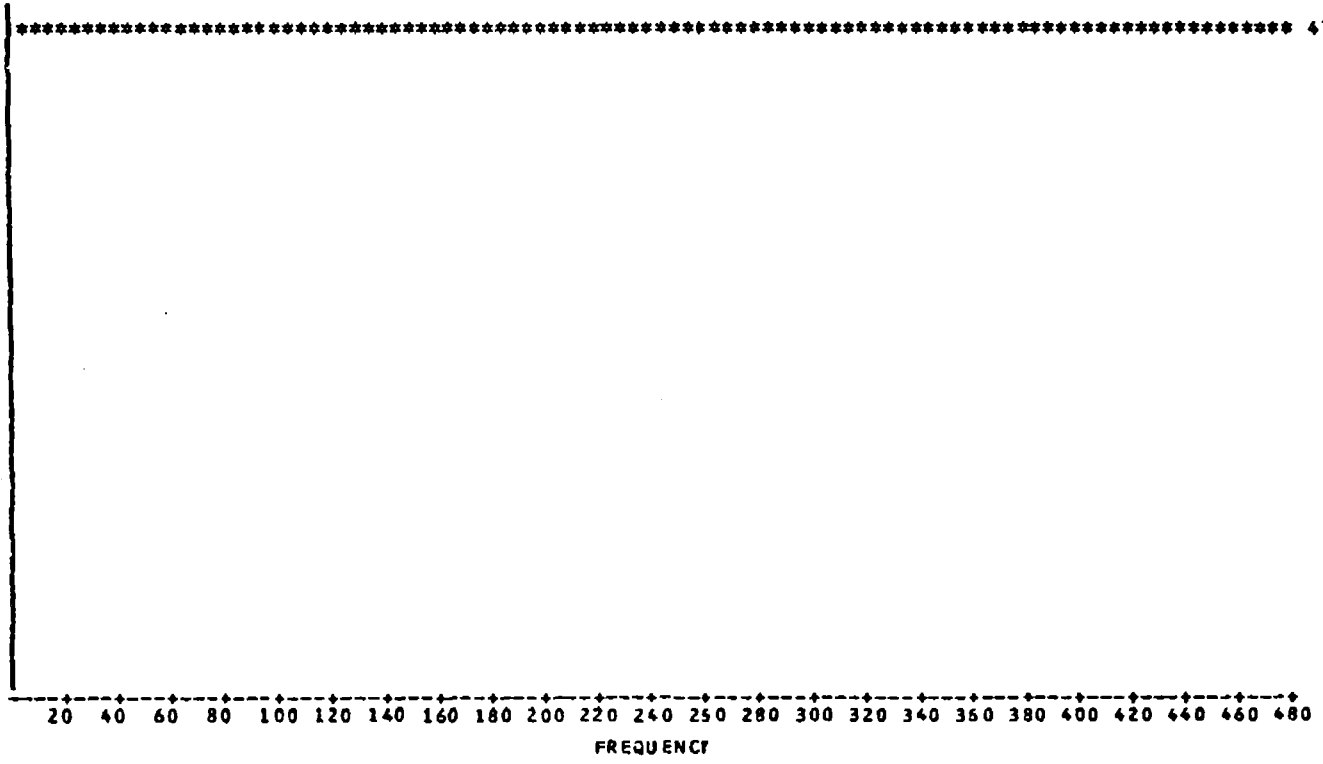
FREQUENCY BAR CHART



MIDPOINT GRA13 (X/D)	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
7.5	55	55	25.00	25.00
15.0	47	102	21.36	46.36
22.5	46	148	20.91	67.27
30.0	32	180	14.55	81.82
37.5	24	204	10.91	92.73
45.0	8	212	3.64	96.36
52.5	3	215	1.36	97.73
60.0	1	216	0.45	98.18
67.5	2	218	0.91	99.09
75.0	0	218	0.00	99.09
82.5	0	218	0.00	99.09
90.0	1	219	0.45	99.55
97.5	0	219	0.00	99.55
105.0	0	219	0.00	99.55
112.5	0	219	0.00	99.55
120.0	0	219	0.00	99.55
127.5	0	219	0.00	99.55
135.0	0	219	0.00	99.55
142.5	1	220	0.45	100.00
150.0	0	220	0.00	100.00

FREQ & CUMFREQ CHART MAT=FC LAB=P COL76-78 MOIS 2:48 MONDAY, MARCH 21, 1988 20

FREQUENCY BAR CHART



MIDPOINT MOIS	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
50	479	479	99.58	99.58
100	0	479	0.00	99.58
150	0	479	0.00	99.58
200	0	479	0.00	99.58
250	0	479	0.00	99.58
300	0	479	0.00	99.58
350	0	479	0.00	99.58
400	0	479	0.00	99.58
450	0	479	0.00	99.58
500	0	479	0.00	99.58
550	0	479	0.00	99.58
600	0	479	0.00	99.58
650	0	479	0.00	99.58
700	0	479	0.00	99.58
750	0	479	0.00	99.58
800	0	479	0.00	99.58
850	0	479	0.00	99.58
900	0	479	0.00	99.58
950	0	479	0.00	99.58
1000	2	481	0.42	100.00

FREQUENCY BAR CHART

```
MIDPOINT
 MOIS
  2.4  |*************************************************************************
  4.8  |******
  7.2  |***
  9.6  |**
 12.0  |*
 14.4  |
 16.8  |
 19.2  |
 21.6  |
 24.0  |*
       |----+----+----+----+----+----+----+----+----+----+----+----+----+
            10   20   30   40   50   60   70   80   90  100  110  120  130
                                   FREQUENCY
```

MIDPOINT MOIS	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
2.4	135	135	85.44	85.44
4.8	12	147	7.59	93.04
7.2	5	152	3.16	96.20
9.6	4	156	2.53	98.73
12.0	1	157	0.63	99.37
14.4	0	157	0.00	99.37
16.8	0	157	0.00	99.37
19.2	0	157	0.00	99.37
21.6	0	157	0.00	99.37
24.0	1	158	0.63	100.00