NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D.C.

Presentation Materials
Mr.Knerr

SOURCES OF HIGH PARTICLE COUNTS

1. **SAMPLING ERRORS**
   METHOD
   LOCATION
   AIRCRAFT CONDITION-FLIGHT HISTORY
2. **APC ERRORS**
   CALIBRATION
   SATURATION
   HARD VS SOFT CONTAMINANTS,BUBBLES
3. **MAINTENANCE**
   BYPASSING CASE DRAIN
   TIME BASE FILTER CHANGE VS FLUID
   SAMPLING
   POP-UP INDICATOR RELIABILITY
4. **SYSTEM CONDITION**
   FLOW SURGES,BACKFLOW
   VIBRATION & SHOCK
   TEMPERATURE
5. **INGESTION SOURCES**
   PUMP,CASE DRAIN
   ROD SEALS AND EXCLUDERS,PISTON SEALS
   REPAIR
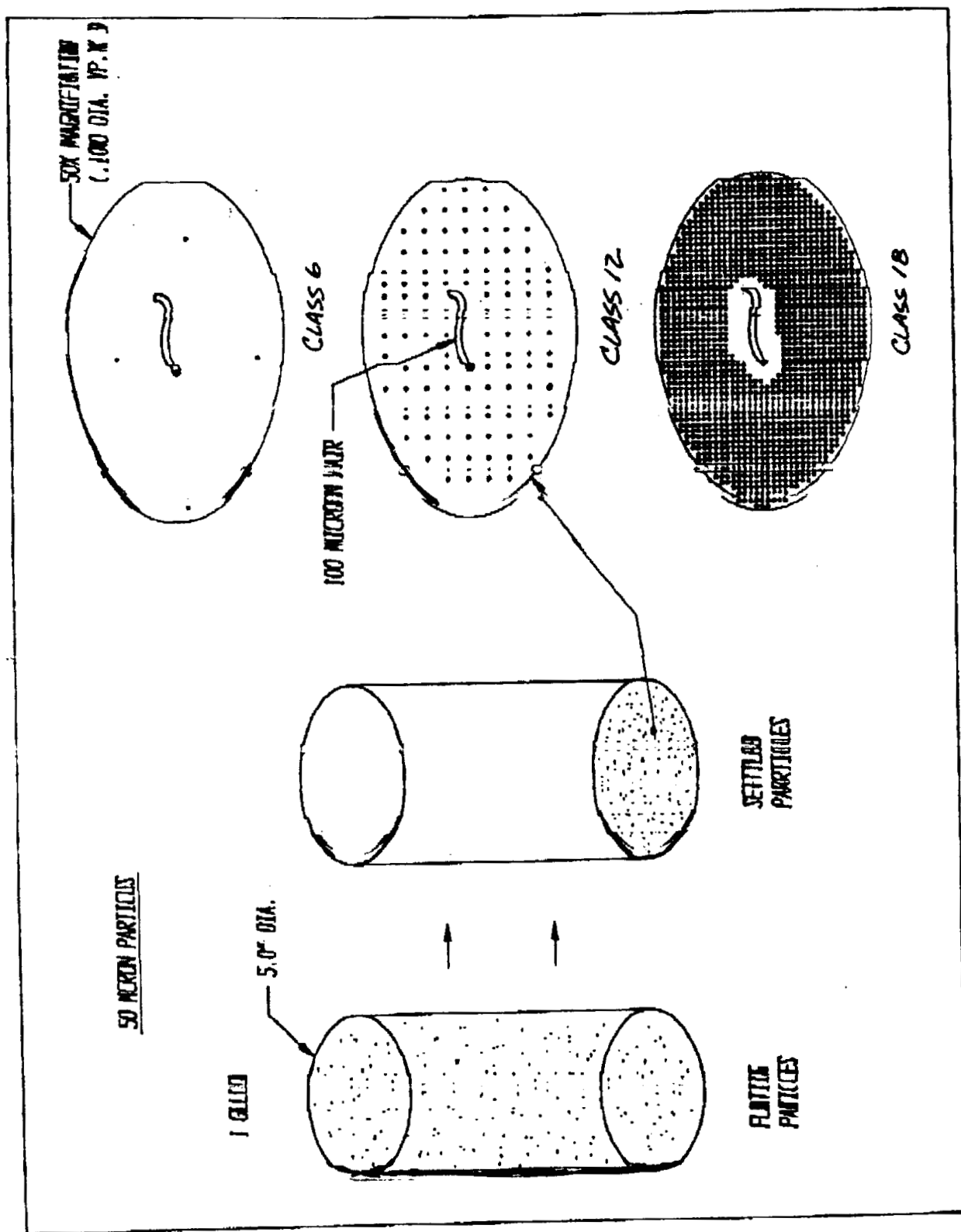6. **FILTRATION SYSTEM**
   DAMAGED OR FAULTY FILTER ELEMENTS
   FACTORS WHICH AFFECT B RATING IN
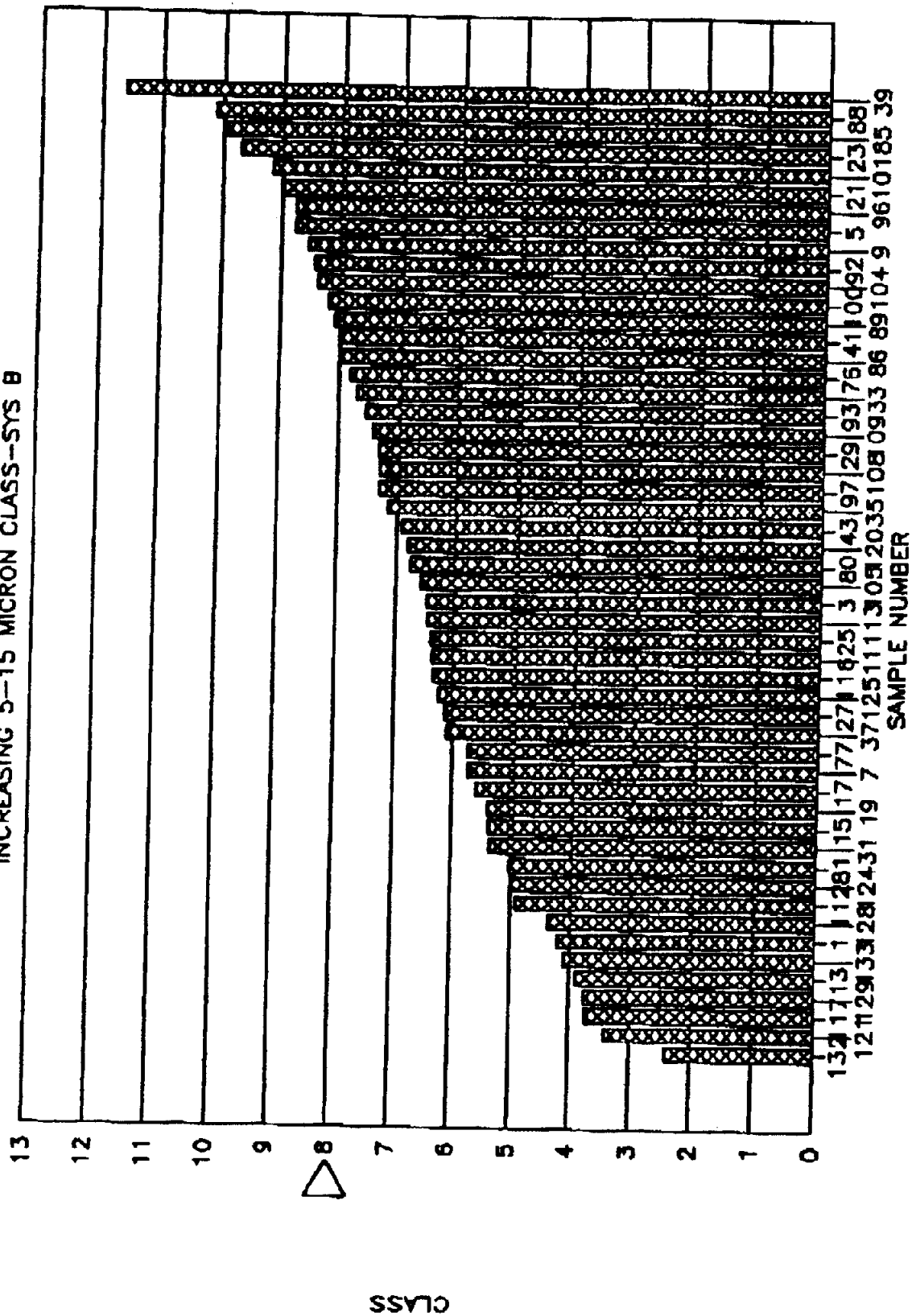   SERVICE
   CLEANABLE VS DISPOSABLE ELEMENTS
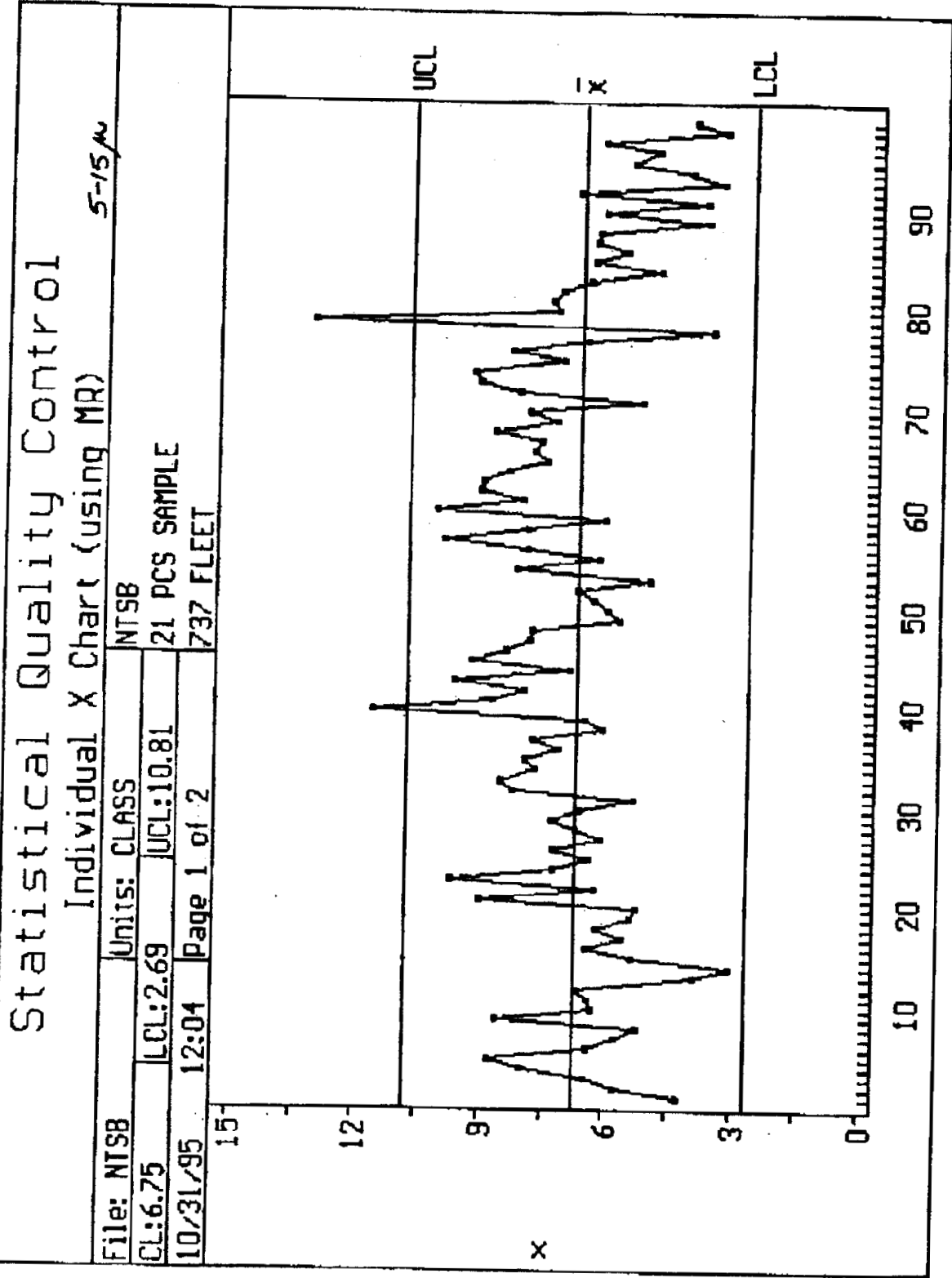7. **FLUID**
   PHOSPHATE ESTER BREAKDOWN DUE TO
   OVERTEMP, WATER CONTENT, CHLORINE

50X MAGNIFICATION
(.1000 DIA. VP. X 9

CLASS 6

CLASS 12

CLASS 18

100 MICRON HAIR

50 MICRON PARTICLES

5.0" DIA.

1 GALLON

SETTLED
PARTICLES

FLOATED
PARTICLES

IN SERVICE AIRPLANE FLUID DATA

INCREASING 5–15 MICRON CLASS–SYS B

CLASS

13
12
11
10
9
8
7
6
5
4
3
2
1
0

SAMPLE NUMBER

Statistical Quality Control

Individual X Chart (using MR)

5-15µ

File: NTSB	Units: CLASS		NTSB
CL:6.75	LCL:2.69	UCL:10.81	21 PCS SAMPLE
10/31/95	12:04	Page 1 of 2	737 FLEET

Statistical Quality Control

Histogram

5-15µ

Cp:0.71	Cpk:0.22		Units: CLASS		NTSB
File: NTSB		LSL:0.00	USL:8.00		21 PCS SAMPLE
10/31/95	11:57	Page 1 of 1			737 FLEET

Frequency histogram with x-axis values: 0.00, 2.42, 2.95, 3.49, 4.02, 4.56, 5.09, 5.62, 6.16, 6.69, 7.23, 7.76, 8.28, 8.83, 9.36, 9.90, 10.43, 10.96, 11.50, 12.03, 12.57, 13.10, 16.00. Y-axis Frequency from 0.0 to 19.0.

FLIGHT 427

5-15 u ALL SAMPLES

CLASS

SAMPLE NUMBER
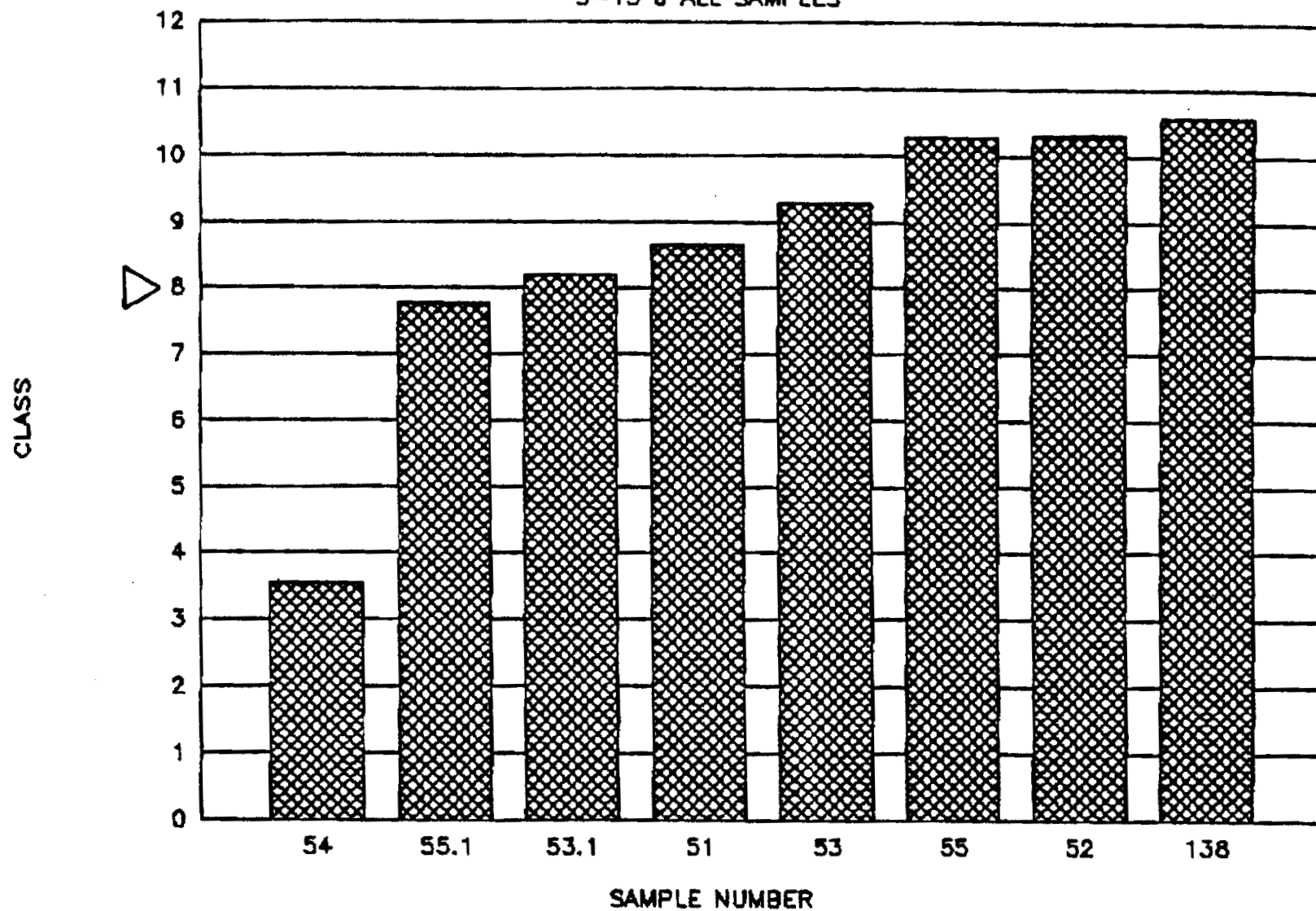
CEP TEST BENCH 4 & 9

5-15 u AUTOMATIC COUNTS

CLASS

| | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

SAMPLE NUMBER

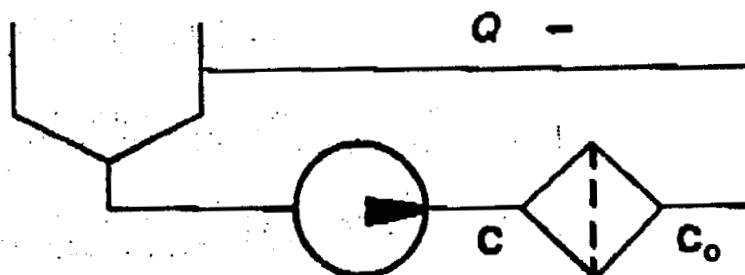941121 950227 931011 940506 941121 940506 950227 931011
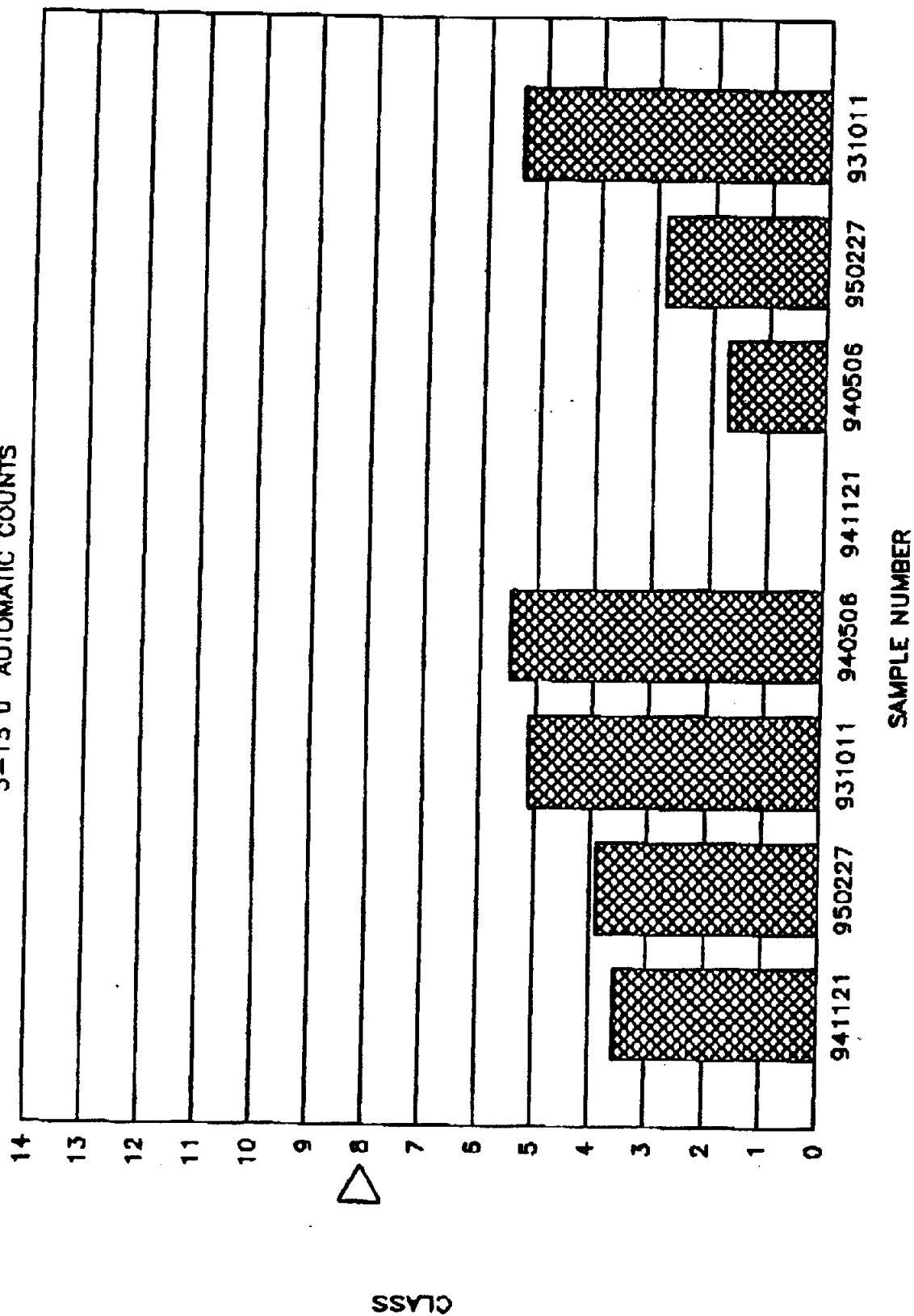
SAE AIR 4543

PROBLEM: Excessive hydraulic system cleanup time.

ISSUE: Hydraulic system cleanup time is excessive after contamination due to a component failure or from external contaminant ingression.

ILLUSTRATION:

Equation expressing the variation in the concentration of particles over time, assuming an initial concentration (C_i), an idealized system with instantaneous mixing in the reservoir and no contamination "traps" in the system:

$$\frac{C}{C_i} = e^{-\frac{Qt}{v}\left(1 - \frac{1}{\beta}\right)}$$

C	=	Concentration of particles upstream of filter.
C_i	=	Initial concentration of particles at time t = 0.
C_o	=	Concentration of particles downstream of filter.
β	=	Ratio of concentration upstream of filter to concentration downstream of filter (measure of filter efficiency).
Q	=	Flow rate.
t	=	Time.
v	=	System volume.

SOLUTION:
1. Use a system filter with higher efficiency.
2. Use "green run" filter of higher efficiency than system filter, and high efficiency (MIL-F-81836)GSE filter.
3. Increase flow rate.
4. Increase fluid temperature which will increase Reynolds number, removing contaminant settled in quiescent areas.
5. Design systems without contamination traps. Use smooth transitions, eliminate unnecessary bends and corners.
6. Use of additional system filters (i.e., return line, case drain, last chance, reservoir vent, etc.).